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

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

N69 Listowel Bypass

Environmental Impact Statement

Volume 4 of 4: Appendix

May 2017

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Appendix 1.1 EIA Screening Report

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N69 Listowel Bypass

Enviromental Impact Assessment Screening Report

April 2013

Rev 1

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Contents

1 Introduction

Kerry County Council (KCC) and their National Road Design Office (NRDO) are progressing the design of the N69 Listowel Bypass. The scheme is approximately 7km in length and consists of a bypass of Listowel town linking the N69 Tralee Road with the N69 Tarbert Road to include a new bridge crossing of the River Feale.

The purpose of this report is to identify the legal requirement or otherwise for an Environmental Impact Assessment (EIA) for the project. This EIA Screening Report, documents the methodology applied during the screening of the proposed road development, with reference to relevant legislation and guidance documents.

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2 Description of the Proposed Devolvement

2.1 Scheme Location

The existing N69 commences in Tralee and runs northwards through the heritage town of Listowel and the ferry port village of Tarbert. It then follows the mouth of the River Shannon through the industrial Port of Foynes before terminating at Limerick City. The proposed N69 Listowel Bypass location is shown in Figure 1: Scheme Location.

2.2 The Proposed Scheme

The proposed Bypass is approximately 7km in length and consists of a bypass of Listowel town linking the N69 Tralee Road with the N69 Tarbert Road to include a new bridge crossing of the River Feale, see Figure 2: Site Plan (with the chosen route option).

The proposed bridge crossing of the River Feale will be over a section of the Lower Shannon Special Area of Conservation (SAC site code 002165), see Figure 3; Site Plan with the SAC boundary.

2.3 The Need for the Scheme

The N69 is the main access route to Limerick/Galway/Dublin for residents in North Kerry and provides a less congested alternative to the N21 National Primary Route between Tralee and Limerick. It carries a high volume of Heavy Commercial Vehicles (HCV's) travelling through North Kerry and to/from the Port of Foynes. It is a popular route for tourists accessing the Killimer-Tarbert ferry and also for its scenic views across the Shannon estuary.

The need for this scheme has been outlined in National and Local Road Development Policy documents and Scheme Specific Reports and has been set out in detail in the Phase 2 Route Selection Report, July 2012. The applicable road improvement policy for this scheme is set out in the following National and Local Policy Documents:

- *The National Development Plan, 2007-2013;*
- *National Spatial Strategy for Ireland, 2002-2020;*
- *National Road Needs Study, 1998;*
- *National Secondary Roads Needs Study Network Options Report - South West Region, 2011;*
- *South West Regional Authority - Regional Planning Guidelines, 2010-2022;*
- *Kerry County Development Plan, 2009-2015;*
- *Listowel Town Development Plan, 2009-2015;*
- *Meitheal Chiarral, 2002-2011;*
- *Road Safety Authority, Road Safety Strategy, 2007-2012;*
- *National Cycle Policy Framework, 2009-2020; and*
- *Kerry Strategic Planning Studies, Settlement Report, 2002.*

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3 Requirement for EIA

3.1 EIA Screening Methodology

Screening is the first stage in the EIA process, whereby a decision is made on whether or not EIA is required. The current requirements for EIA are set out in Part IV of the Roads Act, 1993 and (Amendment) Act 2007, and Part V of the Roads Regulations, 1994 to 2008 (S.I.119 of 1994). In particular, Sections 50 and 51 of the Roads Act 1993 and (Amendment) Act 2007 relate to EIA.

This Screening Assessment was undertaken with particular regard to the following legislation and guidance:

- *Roads Act 1993, the Roads Regulations 1994 and the EIA (Amendment) Regulations 1999; and*
- *Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008).*

3.2 EIA Screening Matrix

The screening matrix for mandatory EIA is shown in Table 3.1. This is based on Table 1 of the NRA Guidance document on Environmental Impact Assessment of National Road Schemes – A Practical Guide, November 2008.

Table 3.1 EIA Screening Matrix

Mandatory		Regulatory Reference	Triggered	If yes why?
Construction of a motorway.		S. 50(1)(a) of the Roads Act, 1993, as substituted by S.9(1)(d)(i) of the Roads Act, 2007.	No	N/A
Construction of a busway.		S. 50(1)(a) of the Roads Act, 1993, as substituted by S.9(1)(d)(i) of the Roads Act, 2007.	No	N/A
Construction of a service area.		S. 50(1)(a) of the Roads Act, 1993, as substituted by S.9(1)(d)(i) of the Roads Act, 2007.	No	N/A
Any prescribed type of proposed road development consisting of the construction of a proposed public road or the improvement of an existing public road, namely:	The construction of a new road of four or more lanes, or the realignment or widening of an existing road so as to provide four or more lanes, where such new, realigned or widened road would be eight kilometres or more in length in a rural area, or 500 metres or more in length in an urban area;	Article 8 of the Roads Regulations, 1994 (Road development prescribed for the purposes of S.50(1)(a) of the Roads Act, 1993).	No	N/A
	The construction of a new bridge or tunnel which would be 100 metres or more in length.	Article 8 of the Roads Regulations, 1994 (Road development prescribed for the purposes of S.50(1)(a) of the Roads Act, 1993).	**Yes**	The N69 Listowel Bypass will involved the crossing of the River Feale and the bridge is likely to be 100m or more in length (to be confirmed following development of the design).
Where An Bord Pleanála (ABP) considers that a proposed road development would be likely to have significant effects on the environment it shall direct the road authority to prepare an EIS.		S. 50(1)(b) of the Roads Act, 1993	**At the discretion of ABP**	No direction has been issued by An Bord Pleanala (ABP) to the Road Authority to prepare an EIS to date. A decision will be based on the outcome of this EIA screening

Mandatory		Regulatory Reference	Triggered	If yes why?
				process.
Where a road authority considers that a proposed road development would be likely to have significant effects on the environment it shall inform ABP in writing and where ABP concurs it shall direct the road authority to prepare an EIS.		S. 50(1)(c) of the Roads Act, 1993.	**At the discretion of ABP**	A decision will be based on the outcome of this EIA screening process.
Where a proposed road development would be located on certain environmental sites the road authority shall decide whether the proposed road development would be likely to have significant effects on the environment. "The sites concerned are":	(i) Special Area of Conservation (SAC)	S. 50(1)(d) of the Roads Act, 1993, as inserted by Art.14(a) of the EIA (Amendment) Regulations, 1999	**Yes**	The proposed Bypass includes a new bridge crossing of the River Feale. The River Feale forms part of the Lower Shannon Special Area of Conservation (SAC, site code 002165).
	(ii) A site notified in accordance with Regulation 4 of the European Communities (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997)		No	N/A
	(iii) Special Protection Area		No	N/A
	(iv) A site where consultation has been initiated in accordance with Article 5 of Council Directive 92/43/EC of 21 May, 1992, on the conservation of natural habitats and of wild flora and fauna.		No	N/A
	(v) A Nature Reserve within the meaning of sections 15 or 16 of the Wildlife Act, 1976.		No	N/A
	(vi) Refuge for Fauna under section 17 of the Wildlife Act, 1976.		No	N/A

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4 Conclusion

Based on the mandatory requirements of the Roads Regulations 1994, there is a requirement for an EIS when a proposed scheme entails "the construction of a new bridge or tunnel which would be 100 metres or more in length". The N69 Listowel Bypass includes a bridge crossing over the River Feale which is likely to be 100m or more in length, although this will be confirmed following the development of the design.

The mandatory requirements of the Roads Regulations of the Roads Act, 1993, as inserted by Art.14(a) of the EIA (Amendment) Regulations, 1999 state that "Where a proposed road development would be located on certain environmental sites the road authority shall decide whether the proposed road development would be likely to have significant effects on the environment. The proposed bridge crossing of the River Feale will cross over and, depending on the final bridge design, potentially be within a section of the Lower Shannon Special Area of Conservation.

In summary, as the proposed bridge crossing of the River Feale is likely to be greater than 100m and crosses over and is potentially within the Lower Shannon SAC, an EIA is deemed necessary under two of the mandatory triggers.

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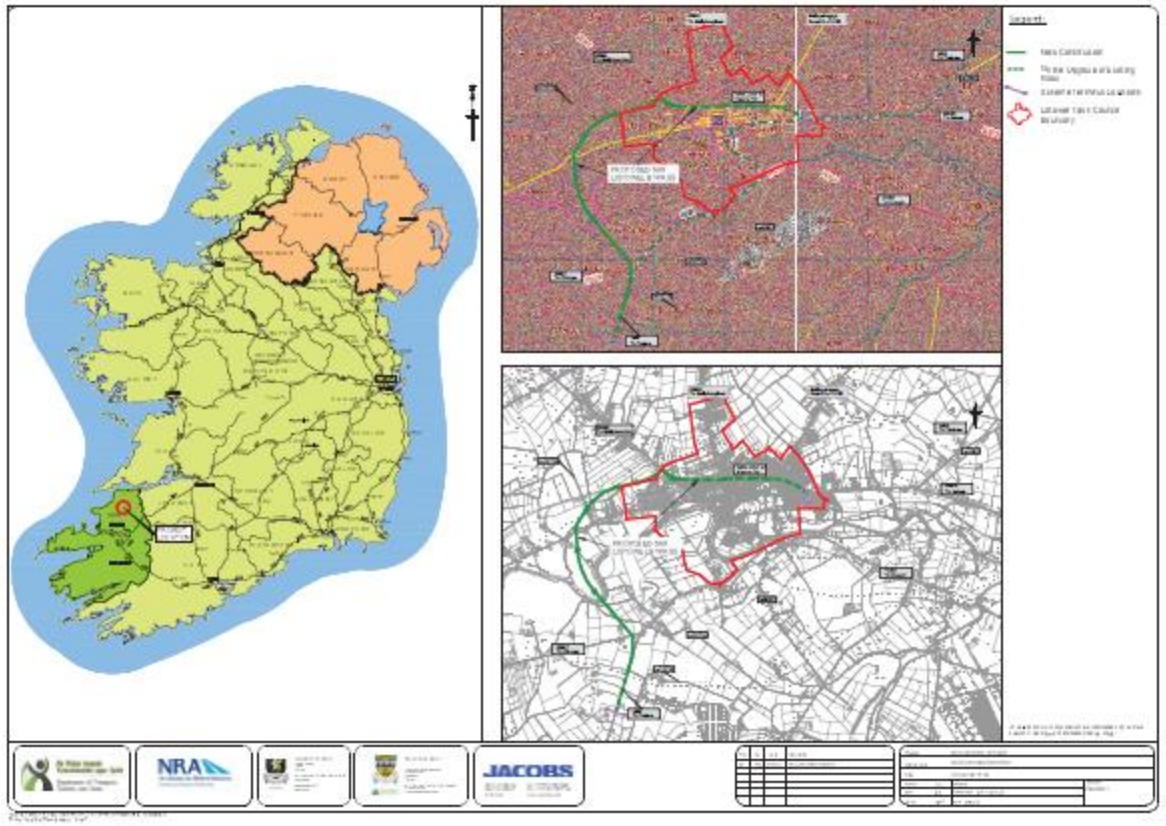
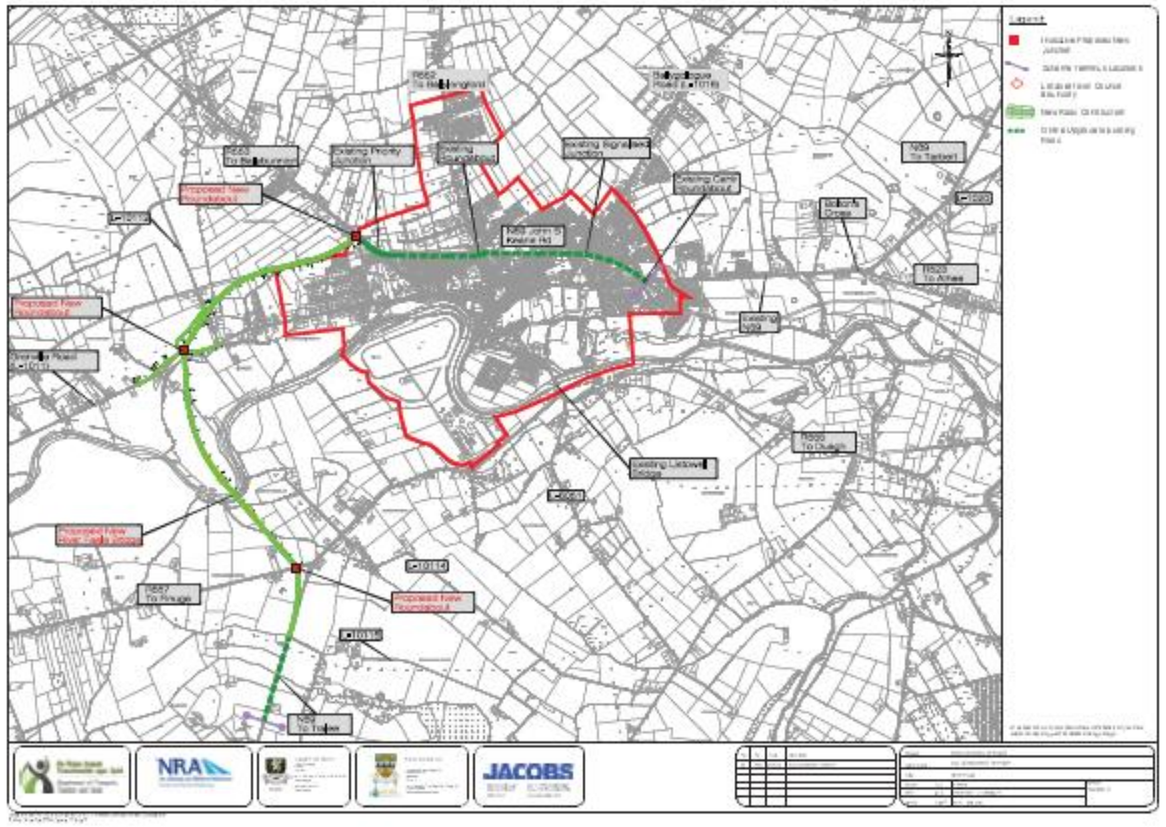
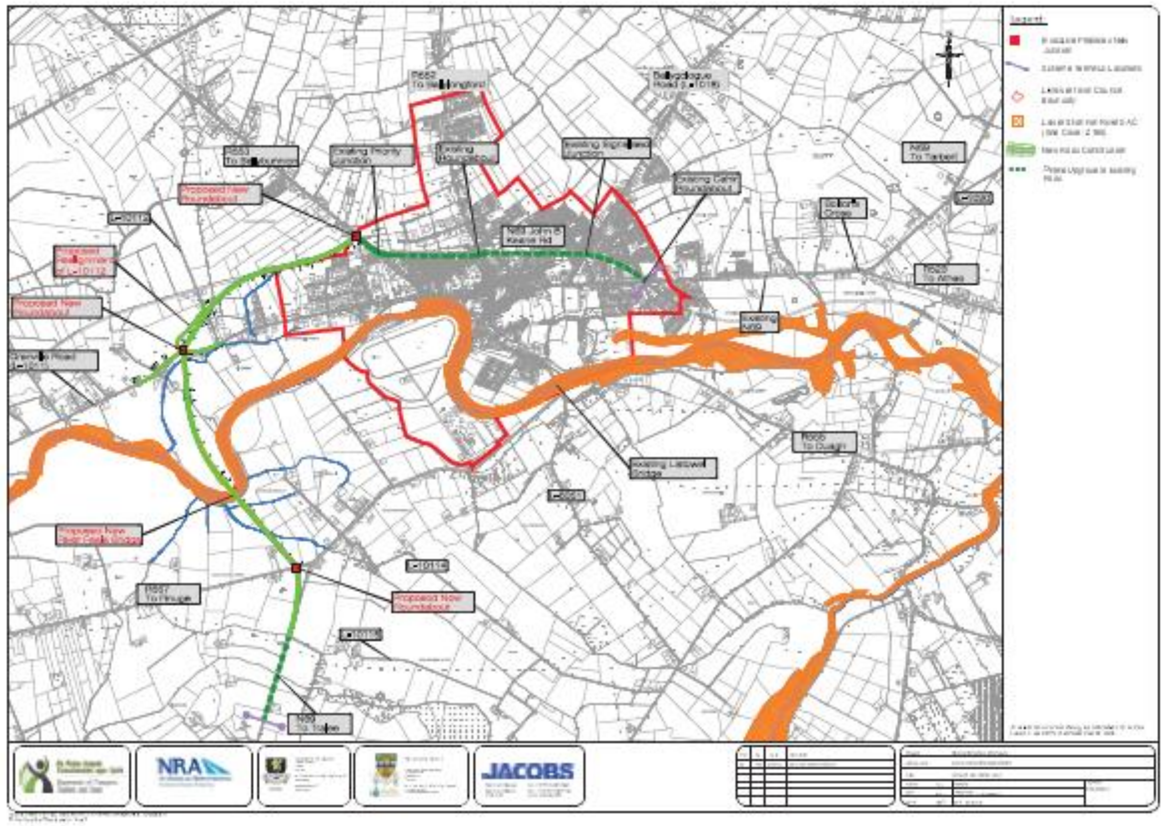
Appendix A Figures

- Figure 1: Location Plan
- Figure 2: Site Plan
- Figure 3: Site Plan with SAC




Legend
New Road Construction
Proposed New Roundabout
Existing Priority Junction
Existing Signalised Junction
N69 John B Keane Rd
N69 To Tarbert
R523 To Athea
Existing N69
R553 To Duagh
Existing Listowel Bridge
R557 To Finuge
N69 To Tralee


Legend
Proposed New Roundabout
Existing Priority Junction
Existing Roundabout
Existing Listowel Bridge
N69 To Tarbert
NRA
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Soil Association 22: Gleys 75%, Acid Brown Earths 15%, Peats 10%

This association occupies 4.86% of the country. It occurs widely on the Clare, Castlecomer, and Abbeyfeale plateaux, and also in parts of north Kerry and north Cork.
Topography varies from flat to rolling. In the aforementioned plateaux, altitudes are mainly between 183 and 304 m but the altitude of the association generally ranges from about 61 to 213 m.

The principal soil usually consists of a very dark brown surface horizon of weak structure and poor consistence about 20 to 25 cm deep. It is formed from till of Upper Carboniferous shale and sandstone composition.

These soils have a limited use range. Owing to their adverse physical properties they are generally unsuitable for tillage. With drainage and lime and fertiliser use, they have a potential for grass

Iascach Intíre Éireann
Inland Fisheries Ireland

Ms Oonagh Duffy,
Senior Environmental Consultant
Jacobs,
Merrion House,
Merrion Road,
Dublin 4.

30 April, 2014

Re-: N69 Listowel Bypass, Fisheries Issues and Queries.

Dear Oonagh.
Further to discussions, site visits and correspondence received today regarding the above bypass the following comments arise. The main impact will be on the River Feale which is a natural salmon fishery containing important stocks of wild salmon but, also stocks of trout lamprey and European eel. IFI's comments on the proposals to date are as follows:

1. **River Feale bridge, Preliminary Design**. Further to my meeting with Sarah Kiernan and the preliminary design map received today IFI does not have any major difficulties with the bridge design that has been discussed and set out on the preliminary plan.
   In particular IFI are satisfied that the main River channel is not going to be impacted on by bridge construction. In particular the deep water area on the eastern shore should not be impacted on as this is an extremely important salmon holding area for both juvenile and adult salmon. It is clear from the drawing that some pile driving work will be required at the top of the left (East) embankment. IFI requests that contractors and designers are made aware of the importance of the pool so as to ensure that construction methodologies used in this area in particular will be detailed and designed to ensure no wastes will discharge into the pool.

2. **Rock armour:** In the course of the site visit the extent of rock armour currently up against the East bank was noted. It was noted that additional rock armour may be required. It will be important that this work is done at an appropriate time of the year especially if in stream works are required to ensure stability of the rock armour. Subject to further confirmation it would be of benefit if some random boulders could be placed in this pool to deter illegal fishing and also to provide appropriate shelter especially during high flow conditions. IFI requests that the provision of some additional in stream boulders be included in the costings for the bridge. This provision could be considered as a limited mitigation measure.

3. **Abutment and pier locations:** IFI currently has no issues in relation to the abutments on the right bank and the pier on the right foreshore. We suggest that the middle pier (on the right foreshore) in particular should be constructed during low flow periods to minimise the risk of water pollution in the area.

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IIE Luimneach, Páirc Gnó Cill Dhéagláin, Bóthar an Duga, Luimneach.
IFI Limerick, Ashbourne Business Park, Dock Road, Limerick.
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4. **Lighting:** In particular on this bridge the provision of "standard lighting" would not be acceptable. However, lighting designed to fall only on the carriageway or in particular on the cycleway would be acceptable in the interest of health and safety. Given the increase in bicycle use generally, the provision of the cycleway is likely to be welcomed and well used. The dedicated cycleway should greatly enhance safety in the area

5. **Attenuation ponds:** IFI notes the provision of at least six attenuation ponds/lagoons along the route of the bypass. From experience in other road schemes we strongly recommend the provision of at least a fore bay formed by the construction of a concrete wall and a series of inverted U pipes sufficient to allow adequate water movement over the wall but still retaining suspended solids and surface water films e.g. oil. It is desirable that the provision of reeds in these attenuation ponds is included as part of the plan for these attenuation areas. The development of this type of constructed wetland can have the effect of significantly reducing pollutants entrained in the surface water drainage.

6. **Underpasses:** With regard to the underpasses IFI considers that it would be most desirable to keep the ground levels as high as possible around the entrances to these underpasses. This should reduce inflow of clean surface water and the situation could be further copper fastened with appropriate interception of surface water flows flowing into the underpass area. In the event that soiled waters accumulating at the underpass need to be treated, IFI recommends that a 2 – 3 stage constructed wetland could be designed to adequately treat effluents arising. It would be important that any discharge is properly licensed in accordance with national legislation and applying the precautionary principle.

7. **Early significant settlement areas:** In the course of the general construction IFI strongly recommends that the contractors should be required, at an early stage, to provide significant temporary settlement to deal with the hydraulic load and entrained pollutants. From recent experience the use of "dirt bag" filter bags will remove a considerable amount of the suspended solids in the effluent and as such they can be very suitable as a final polisher.

8. **Discharge standards:** IFI recommends that whatever system is used a standard of 10 – 15 mg/L of suspended solids should inform the design team with regards to retention time. Limits on other pollutants should also be reasonably strict.

9. **Field drain and small watercourse culverts:** IFI notes that details of other culverts have not yet been presented. We request that all culverts should tend to be overdesigned. Where culverts for drainage are proposed these should be embedded below ground level with the depth of 500 mm at least.

10. **Archaeology, Access Roads site clearance and fencing work:** From previous experience it has been noted that the work of archaeologists and contractors working on the route of the site and preparing the site can cause significant impacts on both the aquatic and terrestrial environments. In particular the removal of excessive amounts

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of spoil can give rise to significant erosion Prior to any contract work under the above categories taking place detailed discussion with IFI especially in the context of methodologies and stream culvert sizing needs to be undertaken. In general terms for small streams a culvert size of 1.2 m is preferable. Where land drains are extremely small a 900 mm culvert should be acceptable.

In the course of the project more detailed discussions between the various parties can take place so as to ensure that the works are carried out in an environmentally sustainable way.

This concludes our observations at this time. Should you require clarification on any matter please do not hesitate to contact me.

Yours sincerely,

Mike Fitzsimons

Mike Fitzsimons
Senior Fisheries Environment Officer.

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Cashen River & Estuary

Species	1% National	1% International	2003/04	2004/05	2006/07	2007/08	2008/09	2011/12	Mean (2006 - 2011)	Peak (2006-2011)
Mute Swan	110				2		12		4	12
Whooper Swan	130	270	288	229			157	257	104	257
Pink-footed Goose		3,500	2					1	0	1
Greylag Goose	50	980						1	0	1
Light-bellied Brent Goose		400			3	9	60	135	52	135
Shelduck	150	3,000		14	14			12	7	14
Wigeon	820	15,000	146	278	76	18	120	458	168	458
Teal	450	5,000			87		23	300	103	300
Mallard	380	20,000	8	12	8	8	46		16	46
Shoveler	25	400						11	3	11
Red-throated Diver	20	3,000			3				1	3
Great Northern Diver		50		4	8		2		3	8
Cormorant	140	1,200	7	18	19		9	4	8	19
Little Egret		1,300			1		5		2	5
Grey Heron	30	2,700	2	4	7	1	3		3	7
Oystercatcher	680	8,200	49	17	68	64	38		43	68
Ringed Plover	150	730	26		32	10	22	21	21	32
Golden Plover	1,700	9,300	9,000	420	4,800	7,500	400	2,000	3,675	7,500
Grey Plover	65	2,500	5		12		2		4	12
Lapwing	2,100	20,000	3,500		2,340	3,000	800	3,000	2,285	3,000
Knot	190	4,500			12			180	48	180
Sanderling	65	1,200	2				4		1	4
Dunlin	880	13,300			800	120	80	84	271	800
Snipe		20,000					8		2	8
Bar-tailed Godwit	160	1,200			4		4	23	8	23
Whimbrel		6,700			56	247			76	247
Curlew	550	8,400	460	495	970	380	220		393	970
Greenshank	20	2,300	1	5	2			14	4	14
Redshank	310	3,900	13	76	224	12	4	25	66	224
Turnstone	120	1,400	24				10	16	7	16
Mediterranean Gull		770						6	2	6
Black-headed Gull		20,000	14		30		18	11	15	30
Ring-billed Gull		20,000						1	0	1
Common Gull		16,400	20	12	105	5	38	130	70	130
Lesser Black-backed Gull		5,500				32		2	9	32
Herring Gull		10,200			6				2	6
Iceland Gull		1,600						2	1	2
Glaucous Gull		2,200		1				1	0	1
Great Black-backed Gull		4,200	14	10	12	8	4	4	7	12
Sandwich Tern					42				11	42
Common Tern						9			2	9

Whooper Swans, Kerry

Site	Subsite	Grid	Date	Count
Cashen River & Estuary	Ballyouneen	Q907342	14.01.05	229
Lixnaw Canal	Lixnaw	Q894306	14.01.05	6
Lixnaw Canal	Ballynagare Bridge	Q887325	14.01.05	6
Cashen River & Estuary	Cashen River Estuary	Q870385	16.01.10	68
Cashen River & Estuary	Ballyouneen	Q907342	17.01.10	391
Lixnaw Canal	Lixnaw	Q894306	17.01.10	6
Crompaun River	Crompaun River	Q853304	17.01.10	9
Cashen River & Estuary	Finuge, Galvins Farm	Q955322	17.01.10	47

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

Cashen River & Estuary

Species	1% National	1% International	2003/04	2004/05	2006/07	2007/08	2008/09	2009/10	2011/12	2013/14
Mute Swan	90				2		12			2
Whooper Swan	150	270	288	229			157	506	257	
Pink-footed Goose		3,500	2						1	
Greylag Goose	50	980							1	
Light-bellied Brent Goose	360	400			3	9	60		135	128
Shelduck	120	3,000		14	14				12	
Wigeon	630	15,000	146	278	76	18	120		458	59
Teal	340	5,000			87		23		300	23
Mallard	290	20,000	8	12	8	8	46			
Shoveler	30	400							11	
Red-throated Diver	20	3,000			3					
Great Northern Diver	20	50		4	8		2			3
Cormorant	120	1,200	7	18	19		9		4	12
Shag		2,000		12						
Little Egret	20	1,300			1		5			2
Grey Heron	25	2,700	2	4	7	1	3			5
Oystercatcher	690	8,200	49	17	68	64	38			70
Ringed Plover	100	730	26		32	10	22		21	55
Golden Plover	1,200	9,300	9,000	420	4,800	7,500	400		2,000	800
Grey Plover	30	2,500	5		12		2			
Lapwing	1,100	20,000	3,500		2,340	3,000	800		3,000	602
Knot	280	4,500			12				180	
Sanderling	60	1,200	2				4			
Dunlin	570	13,300			800	120	80		84	960
Snipe		20,000					8			
Bar-tailed Godwit	150	1,200			4		4		23	36
Whimbrel		6,700			56	247				
Curlew	350	8,400	460	495	970	380	220			10
Greenshank	20	2,300	1	5	2				14	
Redshank	300	3,900	13	76	224	12	4		25	70
Turnstone	95	1,400	24				10		16	
Mediterranean Gull		770							6	1
Black-headed Gull		20,000	14		30		18		11	345
Ring-billed Gull		20,000							1	
Common Gull		16,400	20	12	105	5	38		130	1
Lesser Black-backed Gull		5,500				32			2	24
Herring Gull		10,200			6					34
Iceland Gull		1,600							2	
Glaucous Gull		2,200		1					1	
Great Black-backed Gull		4,200	14	10	12	8	4		4	24
Sandwich Tern					42					
Common Tern						9				

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species. NC indicates that the species may have been present but was not counted.

An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs

11 January, 2017 **Ref:** G Pre00120/2013

Oonagh Duffy
Jacobs
Environmental Consultant |
Sustainable Solutions Business Unit |
Merrion House; Merrion Road;
Dublin 4

Re: N69 Listowel Bypass

A Chara,

I refer to your e-mail of 4 October 2016 concerning the preferred route for the proposed N69 Listowel Bypass, and to the meeting on 18 October 2016 between Jacobs, Scott Cawley and regional staff of the National Parks and Wildlife Service of this Department.

As this is will be a strategic infrastructure development, An Bord Pleanála will be responsible for carrying out the Habitats Directive appropriate assessment. Please forward this letter to the Board, as they will need to consulted in the first instance concerning Habitats Directive assessment.

The following observations are based on the Preferred Route Corridor map (accompanying your e-mail of 4 October 2016). The comments are not comprehensive, and are without prejudice to any recommendation, decision or action that may be taken by the Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs, or by a planning authority in consultation with the Minister, concerning this proposed development.

Information on the legislative requirements for Habitats Directive appropriate assessment and Environmental Impact Assessment can be found on the websites of the Departments of Arts, Heritage, Regional, Rural and Gaeltacht Affairs (DAHRRGA) and the Department of the Environment, Community and Local Government (DECLG), respectively. Conservation objectives for the sites mentioned below are available at www.npws.ie/protected-sites .

The following are considered to be important issues to be addressed in the NIS/EIS:

- *NIS : need for bank protection (e.g. rock-armouring):* The River Feale is a particularly mobile spate river, and the proposed bridge crossing is on an active loop of the river. As the road development will be practically a permanent structure in its flood plain, the NIS should establish if movement of the river is likely to occur in future, and assess any contingency for erosion on either side of the southern pier structure. This is usually done by rock-armouring; however, high wall-like rock-armouring (e.g. see secondary road bridge north of Abbeyfeale) may cause energy deflection and downstream erosion. The construction of the bridge and road in the floodplain of the river will require 'training' of the river to its current course in the vicinity, and the geomorphological effects of this needs to be assessed in terms of the structure and function of the river.
- *NIS: effects on otter mortality*: It was noted that there is a potentially active holt approximately 20m from the proposed road works area, as well as possible inactive holts in the vicinity. It is recommended that any derogation licence be obtained prior to the Oral Hearing for this development. Also, it is particularly important that otter-proof fencing (see Pepper, Holland & Trout (2006) *Wildlife fencing design guide* (CIRIA No. 646)) is properly established and its performance validated, as well as provision made for its perpetual maintenance.
- *EIS : effects on barn owl mortality*: Surveys of barn owl mortality on major roads have shown significant levels of mortality particularly on grassed embankments. For instance, between November 2015 and February 2016, 26 dead barn owls were recorded on the M8 Cork-Dublin motorway. There is published scientific evidence that this can have a serious effect on population of this red-listed bird (see Annex 1 below). The Department welcomes the 5km zone survey being carried out as part of the EIS, but will nevertheless recommend to the Board that adequate proven mitigation will be required for this project.
- *EIS : whooper swan disturbance*: It was noted that up to 250 swans were recorded utilising a field including up to approximately 300m west of the proposed road works. Whooper swan is listed in Annex I of the EU Birds Directive, and there is an obligation to strive to avoid deterioration of habitats of this species outside of protected sites. The EIS should establish whether the temporary unavailability of this area due to disturbance displacement from the road works, or even from the operation of the road, would result in adverse effects on the local population, taking into account the costs of use and likely levels of disturbance at alternative sites. Whether and when restrictions on certain types of works would be necessary to avoid disturbance, especially in late winter, would depend on this data.
- *EIS: effects of mature tree removal*: It is recommended that it is established, at baseline stage, whether the mature or over-mature trees proposed for removal to facilitate the road development, are an essential seasonal component of the habitat of bats which use them. See p. 43 of the European Commission (2007) *Guidance document on the strict protection of animal species of community interest under the Habitats Directive 92/43/EEC*.

ANNEX – Barn owl mortality

Because of scavengers, the recorded M8 data on mortality is likely to be an underestimate (Kociolek and Clevenger, 2009).

Other surveys have found similar high mortality levels:

(1) According to a survey in the west of England, 72% of barn owls encountering a major road are likely to be killed (Ramsden, 2005). According to this report: "New major roads cause the loss of local barn owl populations and the long-term absence of resident barn owls within at least 0.5 km either side [and] ... severe depletion of the population within 0.5-2.5 of the road."
(2) Another study, by researchers at Boise State University in Idaho in the U.S. during 2006, recorded 104 dead barn owls in one day's survey of the I-84 highway[1]. An estimate of the mortality rate in Idaho was 288-599 barn owls/100km/year (Boves, 2007 in Kociolek and Clevenger, 2009).
(3) In France, an (unverified[2]) estimate is that some 15,000 to 20,000 barn owls are killed on roads every year (LPO Ile-de-France, 2007). An estimate based on Baudevin (1997) would be 32 dead owls/100km/year.
(4) In a study in the Netherlands (de Bruijn, 1994), it was concluded that:

"In Liemers, productivity was too low to compensate for the high mortality in which road deaths took a heavy toll. This district proved to be a 'sink area', where the barn owl population persists only due to continuous net imports of owls."

Mitigation and mortality monitoring

In addition to tree and scrub planting recommended by Ramsden (2003), allowing natural plant recolonization and development of low bushes along roadside grassy slopes is recommended (LPO Ile-de-France, 2007). This is also a motorway margin maintenance issue.

In Florida State Park, 122 3-m long silver-coloured metal poles 5.1 cm diameter, were attached vertically 3.7m apart on both sides of a bridge, to encourage terns to fly higher when crossing the bridge (Bard *et al.*,

[1] http://news.opb.org/article/1274-mystery-dead-barn-owl/

[2] The orginal references (Goujon, 2007; Housset, 1992) have not been seen

2002). These effectively reduced mortality, and this concept was recommended (by Jacobsen, 2005) to reduce road mortality of barn owls.

There appears to be very little scientific data available on the design and effectiveness of mitigation measures to reduce barn owl mortality on major roads. One recent review (Glista *et al.*, 2009) concluded that:
"Although many studies have reported on the use of various structures for reducing road mortality, relatively few have measured the success of such structures. ... the efficiency of road mortality mitigation approaches should be determined via a post-implementation monitoring program."

A recent review of owl road mortality in Portugal (Gomes *et al.*, 2008) stated:
"Because it is not financially feasible for most governments to create roadkill management strategies along the total length of all roads, it is necessary to choose locations where application of these measures will be most effective and efficient; in other words to optimize the number of lives saved at as low a cost as possible. All of this makes clear how relevant identification of the Strigiformes road fatality 'hot-spots' is."

This review recommended a method of analysis (Malo's method) of actual owl road kill data to identify hot-spots which are above random. In the Portuguese study, this translated as 2 or more casualties per 500m of road over a 2 year period.

Kindly forward any further information relating to this case to manager.dau@ahg.gov.ie.

Is mise le meas,

Michael Murphy

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A SURVEY FOR THE FRESHWATER PEARL MUSSEL
***MARGARITIFERA MARGARITIFERA* (L., 1758)**
IN THE RIVER FEALE AND TRIBUTARIES AT LISTOWEL, COUNTY KERRY

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June 2013

1.0 Background & Introduction

The proposed N69 Listowel bypass consists of a bypass of Listowel Town, including a new crossing of the River Feale. The proposed development is located on lands surrounding Listowel Town, Co. Kerry. The on-line section of the proposed by-pass follows the entirety of the existing John B. Keane Road from its eastern end at the roundabout on the N69, to where it meets and follows the R553 northwards for c.200m at Curraghatoosane. The proposed development then goes off-line (Figure 1), following the route of the disused railway line before crossing over agricultural fields and the Forge and Grenville Roads to the River Feale crossing point at Scartleigh/Garryantanvally. It continues southwards from here across agricultural fields, crossing the R557 before joining back with the existing N69 at Coolnaleen Lower/Upper.

The River Feale forms part of the Lower Shannon Special Area of Conservation (SAC), site number 2165. The SAC site is selected for species listed in Annex II of the Habitats Directive which includes the freshwater pearl mussel (*Margaritifera margaritifera*). However, the River Feale is not a designated site for the pearl mussel.

There are records of the pearl mussel from the River Feale: in the main channel both upstream and downstream of Abbeyfeale, and also the Owveg tributary. Pearl Mussels are also known in the main channel of the River Feale near Wellesley Bridge (5km upstream of Abbeyfeale). The only record of this species from the lower River Feale is from just upstream of the N69 bridge at Q95526 33292 in 2007 (Republic of Ireland Molluscan Database).

A survey has been carried to determine if freshwater pearl mussels were present in the River Feale at the proposed crossing point downstream of Listowel and in associated courses along the proposed route. The field survey was carried out from 10-12 June 2013.

An update to the survey was carried out on 13th June 2015 to assess the areas downstream of an additional drainage outfall that drains to the Cashen River (and estuary) via the Gortcurreen and Derra West streams and the lower Galey River before entering the Cashen River.

2.0 Methodology and Survey Locations

The survey of the River Feale was carried out 3 surveyors, 2 of whom were in the water at all times with the other acting as 'bank manager'. The surveyors wore wetsuits to enable snorkelling as well as the standard survey techniques using glass bottomed viewing buckets (bathyscopes). The River Feale within the entire footprint of the potential impact zone of the proposed works was surveyed, but for survey purposes, it was sub-divided into 8 survey sections. See Figure 2 for section breaks and Table 1 for locations, habitat descriptions and photographs.

Brief assessments were also made in the main River Feale at Finuge Bridge, downstream of the proposed crossing point, and in Listowel, upstream of the proposed crossing point (Table 2).

Five associated watercourses along the proposed route were surveyed upstream and downstream of proposed crossing points (this was carried out by one surveyor on foot as the watercourses were found to be very narrow and shallow). The locations are shown in Figures 2 and 3. Tables 3-7 give habitat descriptions and photographs.

The 2015 stream survey was carried out by walking the bank and entering water courses where there was any potential habitat and surveying using a viewing bucket.

3.0 Results and Discussion

No pearl mussels were found in the River Feale at the proposed crossing point or within the wider impact zone. This section of river has already been heavily modified with extensive rock armouring and a long concrete wall. There is very little potentially suitable pearl mussel habitat – the substrate comprises mostly coarse cobble with boulders from collapsed revetments, particularly along the left bank. The substrate throughout the survey section was heavily silted and covered with dense growths of filamentous algae, resulting from erosion, run-off from agricultural land and elevated levels of nutrients.

There was no evidence of pearl mussels and only very little potentially suitable habitat at sites both upstream and downstream of the proposed crossing site.

All of the small watercourses were very shallow and narrow, most were overgrown, some had been deeply dredged, and had elevated nutrient levels. None of these watercourses could support pearl mussels.

The freshwater pearl mussel is known from the River Feale upstream of the survey area, and the species requires a co-existing population of salmonid fish as larval mussels spend the first months of their life attached to the fish gills of either salmon or trout (depending on the population), or occasionally both. The host fish of the Feale mussel population is as yet unknown.

The Gortcurreen and Derra West streams were small, slow streams with no potential habitat for pearl mussels. The Galey River has records of both *Margaritifera margaritifera* and the threatened *Anodonta anatina* much further upstream. The nearest recorded sites for these species are approximately 10km upstream of the confluence of the Galey with the Derra West Stream for *A. anatina* (E. Ross record, 2008, Republic of Ireland Molluscan Database) and a further 4 km upstream (14km total) for *M. Margaritifera* (J. Lucey record, c. 1987, Republic of Ireland Molluscan Database). The Galey River downstream of the confluence with the Derra West and Gortcurreen Streams is a large, lowland, modified slow river, with no potential for freshwater pearl mussel habitat. Like the River Feale, as pearl mussels may still occur upstream of any developmental works influence, they rely on salmonid fish to host their larvae and thus protection measures should be designed to be protective of salmonids in the Galey River. The specific host fish of the Galey mussel population is also unknown.

Both the Galey and Feale Rivers flow into the Cashen River and then the sea. The Cashen River is tidal below the confluences of both rivers, so there is no potential for the Cashen to support pearl mussels. The need to protect migratory salmonids remains a requirement.

4.0 Recommendations

There are no specific measures needed for the freshwater pearl mussel in the context of this proposed development. Care needs to be taken to protect the salmon and trout populations in the area. The protection of the salmonid species is important for the protection of the fish populations in their own right, but also as a host for the freshwater pearl mussels upstream. Standard protection measures for salmonids are well documented (NRA, 2006; Goldman et al., 1986; Murphy, 2004; Environment Agency, 1996).

5.0 References

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Appendix 1: Maps

Figure 1: Map showing route of the off-line section of the proposed road (in red)

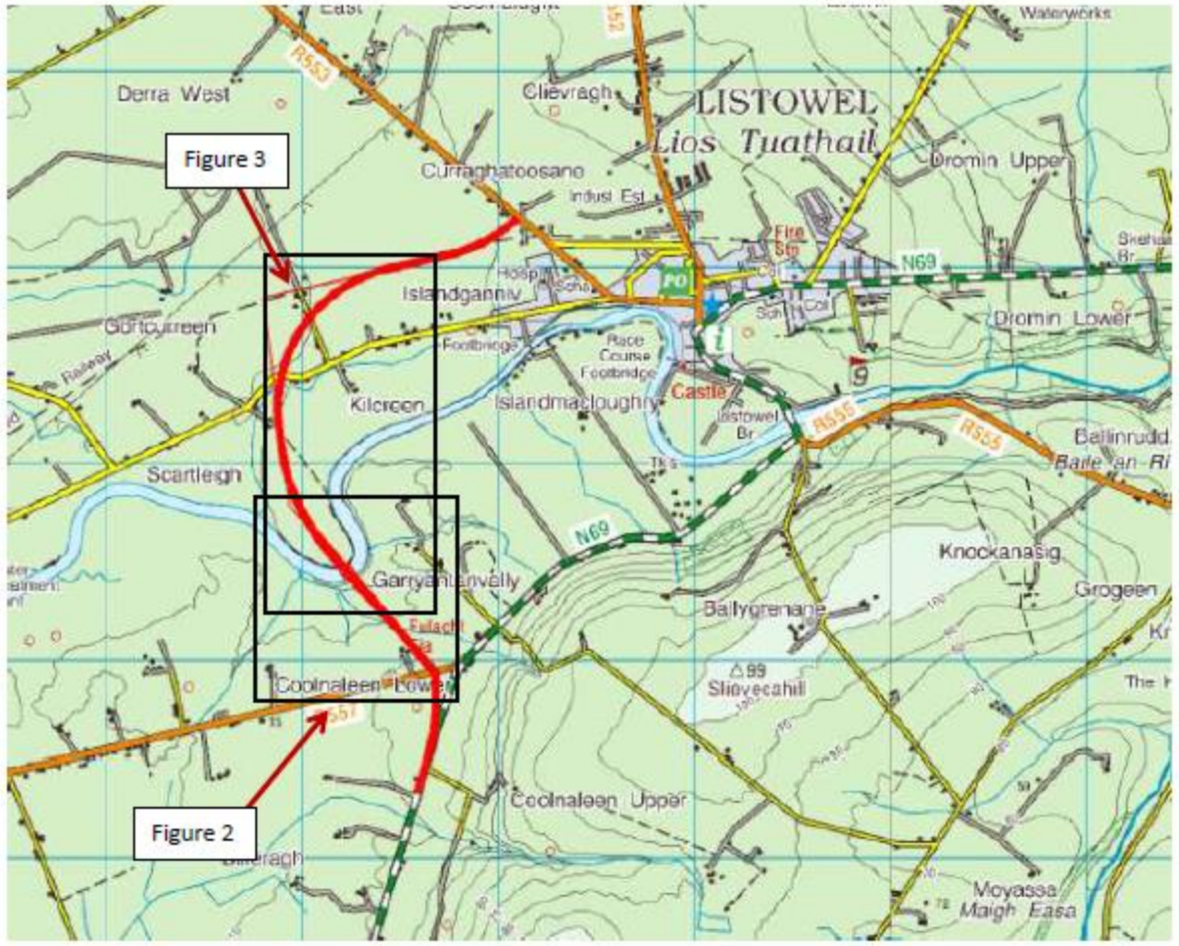

Figure 2: Survey locations at the proposed crossing point over the River Feale and associated tributaries

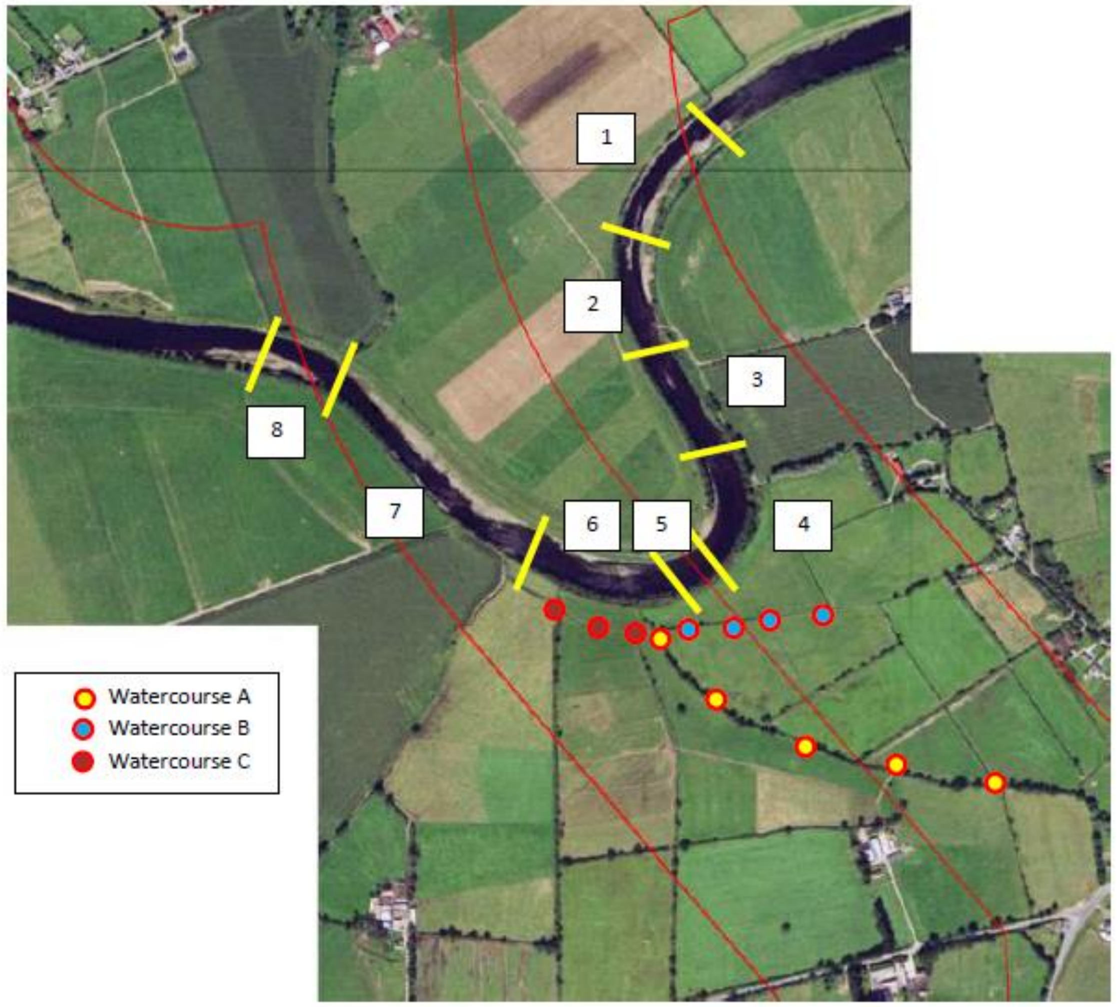

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Figure 3: Survey locations at the proposed crossing point over tributaries on the north side of the River Feale

7

Appendix 2: Survey section details and photographs

Table 1: Survey sections for the River Feale at proposed impact site

Section	Grid References	Description
1	Q97132 32958 d/s to 97167 32743	Section runs along length of concrete wall along right bank. Deep channel along right bank with coarse cobble and boulder substrate. Very shallow cobble and gravel along left bank which dries out in low flows (photo 1).
2	d/s to Q97223 32646	Mostly tree-lined along right bank (photo 2). Still deep along right bank with boulders, cobble and eroding clay. Very shallow cobble and gravel along left bank which dries out in low flows (photo 2). Further downstream the river channel becomes shallow along both banks, deeper in centre. Some pockets of potentially suitable cobble and gravels along right bank but substrate highly silted with at least 50% cover of filamentous algae. Substrate more scoured and rounded in mid-channel.
3	d/s to Q97289 32524	More open along right bank, as above, but a bit more riffley, shallow along both banks, deeper in centre. Some pockets of potentially suitable cobble and gravels along right bank but substrate highly silted with at least 50% cover of filamentous algae. Substrate more scoured and rounded in mid-channel.
4	To proposed crossing point	Section running round upstream part of bend. Collapsed revetment along outside of bend (left bank) and extensive 'beach' around inside of bend (photos 6 & 7). Heavily silted substrate around right bank with total algal cover (photo 8). Mostly boulders on left bank, but heavily silted all of the way round.
5	At proposed crossing point (+/- 25m) Q97207 32435	Collapsed revetment along outside of bend (left bank) and extensive 'beach' around inside of bend (photo 9). Mostly silted boulder substrate with algal cover.
6	d/s crossing point to Q97019 32488	Generally a more riffley section . Still rock armoured all along left bank (photo 10) with collapsed revetment in the river, high energy in places with scoured substrate but pockets of better gravel and cobble habitat but covered with silt and algae in shallower places.
7	d/s to confluence with ditch at Q96765 32732	Very similar to section 6
8	d/s to large tree on right bank at end of impact zone	Left bank with wide beach and grassland poached by cattle, shallow algal covered cobble along left half of river. Deep with clay and coarse cobble substrate along right bank.

1. Section 1: view from Left bank in very low flow looking upstream

2. Section 2: view from Left bank in very low flow looking downstream

3. Section 1: View u/s from d/s end

4. Section 2: view downstream from start point

5. Section 3: view upstream with surveyors

6. Section 4: view across channel

7. Section 4: view downstream towards crossing point

8. Section 4: algal-covered substrate

9. Section 5: proposed crossing point

10. Section 6: view downstream

11. Section 7: looking downstream

12. Section 8: the large tree on the right bank marks the end of the proposed impact zone

Table 2: River Feale sites outside of proposed crossing impact zone

Section	Grid References	Description
9	Q98543 33739	Very high energy riffle section, no suitable mussel habitat (photo 13)
10	Q38900 33542	Adjacent to racecourse footbridge. Wide and generally shallow upstream of bridge with patches of *Ranunculus*, some patches of potentially suitable mussel habitat. Photo 14.
11	Q98791 33282 u/s to 98834 33099	Adjacent to and d/s of creamery (photos 15 & 16). Shallow cobble margins along right bank and steep tree-lined and partially armoured left bank. Outfall from creamery, in stream boulders in places. Very little suitable mussel habitat.
12	Finuge Bridge Q95166 32124	Wide glide section, upstream limit of tide, downstream of water tr4eatment works. Substrate covered in algae, unlikely to have potential to support mussels.

13. Feale in Listowel, across from racecourse

14. Feale in Listowel, upstream of castle

15. Feale in Listowel, downstream of creamery

16. Feale in Listowel, upstream towards creamery (and

	outfall)
	
17. Feale downstream of proposed works downstream of Finuge Bridge	18. Feale downstream of proposed works upstream of Finuge Bridge

Table 3: Watercourse A

This is a very narrow and shallow flowing ditch running through heavily stocked cattle pasture. The banks are densely overgrown with trees and hedges, and tall *Oenanthe* is present towards the downstream (Feale) end. This is not pearl mussel habitat.

	
19. Shallow, narrow watercourse	20. Cattle crossing, the proposed road crossing point is just downstream of here
	
21. Densely overgrown	22. Tall *Oenanthe*

Table 4: Watercourse B

This watercourse joins Watercourse A a few metres from the Feale. It comprises an east/west agricultural ditch which has been deepened and has steep muddy banks. The substrate is muddy and covered (in more open areas) with a thick mat of filamentous algae. This is not pearl mussel habitat.

	
23. Gap with mud and slurry run-off	24. Muddy banks and filamentous algae
	
25. Dredged channel with algae	26. Deeply dredged channel

Table 5: Watercourse C

This channel is the continuation of Watercourse B to the west of the confluence with Watercourse A (see Figure 2). It is deepened and densely overgrown with *Oenanthe*. This is not pearl mussel habitat.

	
27. View looking east with dense *Oenanthe*	28. View looking west with dense *Oenanthe*

Table 6: Watercourse D

This is a very narrow and shallow flowing ditch running alongside a road, through cropfields and through heavily stocked cattle pasture. The ditch is densely overgrown throughout. This is not pearl mussel habitat.

	
29. Shallow channel, heavily shaded (near crossing point)	30. Densely overgrown with nettles alongside potato field
	
31. Densely overgrown near confluence with Feale	32. Confluence with Feale

Table 7: Watercourse E

This is a densely overgrown narrow and shallow flowing ditch. This is not pearl mussel habitat.

		
33. At crossing point over old railway	34. On north side of old railway	35. Downstream of road

Table 8: 2015 updated survey

Water course	Grid reference	Description
Gortcurreen	Q 9478 3372	Small disturbed stream, dark and overgrown in places. No potential mussel habitat.
Derra West Stream	Q 957 332	Very slow stream. No potential mussel habitat.
Derra West Stream	Q935 334	Very slow, modified drained stream. No potential mussel habitat.
Galey River	Q 926 337	Large, lowland river. Modified through past drainage with little gradient or flow. No potential mussel habitat.
Galey River	Q 925 335	River becomes wider and remains slow throughout towards confluence with Cashen River. No potential mussel habitat.

Appendix 6.3 List of Birds Observed on Bird Survey

Common Name	Scientific Name	Conservation Importance	
		Annex I	BoCCI
Barn owl	*Tyto alba*	-	Red List
Blackbird	*Turdus merula*	-	Green List
Blackcap	*Sylvia atricapilla*	-	Green List
Blue tit	*Parus caerulea*	-	Green List
Chaffinch	*Fringilla coelebs*	-	Green List
Chiffchaff	*Phylloscopus collybyta*	-	Green List
Coal Tit	*Periparus ater*	-	Green List
Cormorant	*Phalacrocorax carbo*	-	Amber List
Dunnock	*Prunella modularis*	-	Green List
Goldcrest	*Regulus regulus*	-	Amber List
Goldfinch	*Carduelis carduelis*	-	Green List
Great tit	*Parus major*	-	Green List
Greenfinch	*Carduelis chloris*	-	Amber List
Grey heron	*Ardea cinerea*	-	Green List
Hooded Crow	*Corvus corone*	-	Green List
House martin	*Delichon urbica*	-	Amber List
House sparrow	*Passer domesticus*	-	Amber List
Jackdaw	*Corvus monedula*	-	Green List
Kestrel	*Falco tinnunculus*	-	Amber List
Lesser redpoll	*Carduelis flammea cabaret*	-	Green List
Linnet	*Carduelis cannabina*	-	Amber List
Long-tailed tit	*Aegithalos caudatus*	-	Green List
Magpie	*Pica pica*	-	Green List
Mallard	*Anas platyrhynchos*	-	Green List
Meadow pipit	*Anthus pratensis*	-	Red List

Common Name	Scientific Name	Conservation Importance	
		Annex I	BoCCI
Moorhen	*Gallinula chloropus*	-	Green List
Pheasant	*Phasianus colchicius*	-	Green List
Pied wagtail	*Motacilla alba*	-	Green List
Reed bunting	*Emberiza schoeniclus*	-	Green List
Robin	*Erithacus rubecula*	-	Amber List
Rook	*Corvus frugilegus*	-	Green List
Sand martin	*Riparia riparia*	-	Amber List
Sedge warbler	*Acrocephalus choenobaenus*	-	Green List
Short-eared owl	*Asio flammeus*	✓	Amber List
Skylark	*Alauda arvensis*	-	Amber List
Snipe	*Gallinago gallinago*	-	Amber List
Song Thrush	*Corvus monedula*	-	Green List
Starling	*Sturnus vulgaris*	-	Amber List
Stock dove	*Columba oenas*	-	Amber List
Swallow	*Hirundo rustica*	-	Amber List
Swift	*Apus apus*	-	Amber List
Whitethroat	*Sylvia communis*	-	Green List
Willow Warbler	*Phylloscopus trochilus*	-	Green List
Wood Pigeon	*Columba palumbus*	-	Green List
Wren	*Troglodytes troglodytes*	-	Green List

NOTE: The NIS is reproduced here in support of the EIS but the NIS is available as a high resolution standalone document

NATURA IMPACT STATEMENT

PROVISION OF INFORMATION FOR AN APPROPRIATE ASSESSMENT OF THE PROPOSED

N69 LISTOWEL BYPASS, CO. KERRY

Prepared for Jacobs

Rev.	Status	Author	Reviewed By	Approved By	Issue Date
R0A	Final	AS/CC	CC/AC	AC	27/04/2017

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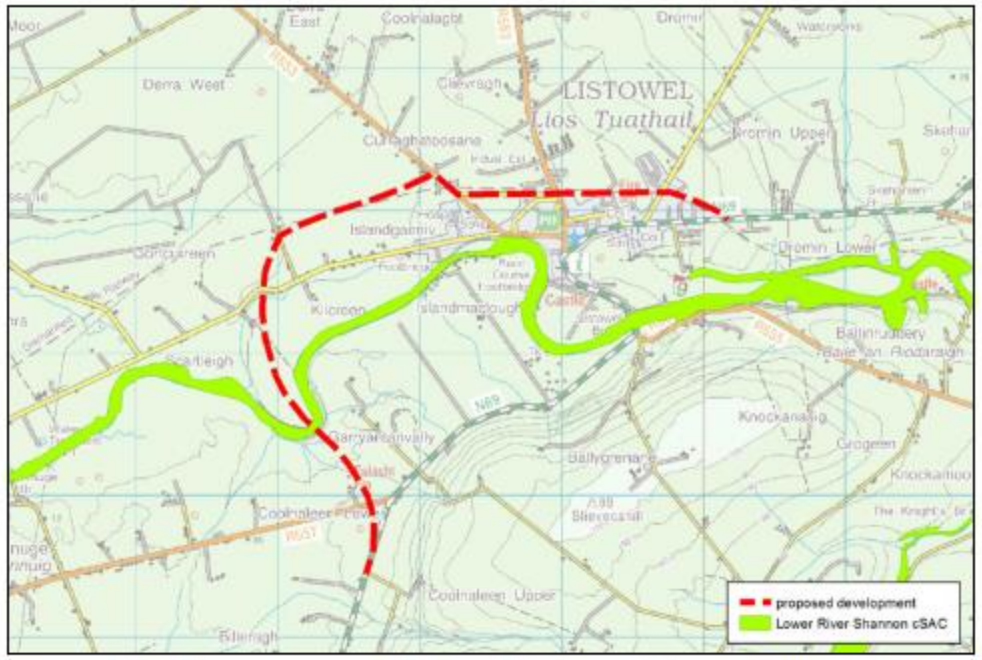
LIST OF FIGURES

1 Introduction

This report, which contains information required for the competent authority (in this instance An Bord Pleanála) to undertake an Appropriate Assessment (AA), has been prepared by Scott Cawley Ltd. for Jacobs Engineering Ireland Ltd. ('Jacobs') on behalf of their client, Kerry National Road Design Office (NRDO). It provides information on, and assesses the potential for, the proposed N69 Listowel Bypass (the proposed development, see Figure 1) to have significant impacts on Natura 2000 sites (hereafter referred to as European sites)[1] and furthermore assesses whether the proposed development would impact on the integrity of any European site.

Figure 1: Location of the N69 Listowel Bypass (the proposed development)



It is necessary that the decision to permit the proposed development has regard to Article 6 of the *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora* (as amended) (hereafter referred to as the Habitats Directive). This is transposed in Ireland primarily by *S.I. No. 477 of 2011, European Communities (Birds and Natural Habitats) Regulations 2011* (hereafter referred to as the Birds and Habitats Regulations) and by the *Planning and Development (Amendment) Act 2010,* as amended (hereafter referred to as the Planning Acts).

The information in this report forms part of, and should be read in conjunction with, the documentation being submitted to the competent authority in connection with the proposed road development, in particular the EIS which this report forms a part of.

[1] Natura 2000 sites are defined under the Habitats Directive (Article 3) as a European ecological network of special areas of conservation composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II. The aim of the network is to aid the long-term survival of Europe's most valuable and threatened species and habitats. In Ireland these sites are designated as *European sites* - defined under the Planning Acts and/or Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special area of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as candidate Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs)

2 Methodology

2.1 Guidance and Approach

This report has been prepared with regard to the following guidance documents where relevant:

- *Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities.* (Department of Environment, Heritage and Local Government, 2010 revision);
- *Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities.* Circular NPW 1/10 & PSSP 2/10;
- *Assessment of Plans and Projects Significantly Affecting Natura 2000 sites: Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC* (European Commission Environment Directorate-General, 2001); hereafter referred to as the EC Article 6 Guidance Document. The guidance within this document provides a non-mandatory methodology for carrying out assessments required under Article 6(3) and (4) of the Habitats Directive;
- *Managing Natura 2000 Sites: The Provisions of Article 6 of the Habitat's Directive 92/43/EEC (European Commission, 2000 and updated draft April 2015).*
- *Guidance Document on Article 6(4) of the Habitats Directive 92/43/EEC. Clarification of the Concepts of Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence.* Opinion of the European Commission (European Commission, January 2007);
- *Communication from the Commission on the precautionary principle.* European Commission (2000).

Guidance which has been followed in determining magnitude and significance of impacts as well as in proposing mitigation measures, in relation to European sites, include:

- *Guidelines for Ecological Impact Assessment in the UK and Ireland (2nd Edn)* (Chartered Institute of Ecology and Environmental Assessment, 2016);
- *Guidelines on the Information to be contained in Environmental Impact Statements* (Environmental Protection Agency, 2002 and Revised Draft 2015a)
- *Advice Notes for Preparing Environmental Impact Statements* (Environmental Protection Agency, 2003 and Revised Draft 2015b)
- *Environmental Guidelines Series for Planning and Construction of National Roads* (National Roads Authority, 2005-2009); and
- *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (National Road Authority, 2008a);

2.2 Desktop Study

The sources of desktop data relied upon are listed below:

- Online data available on European sites as held by the National Parks and Wildlife Service (NPWS) from www.npws.ie;
- Information on water quality in the area available from www.epa.ie, and from the applicant's design team;
- Information on the Shannon International River Basin District from www.wfdireland.ie;
- Ordnance Survey of Ireland mapping and aerial photography available from www.osi.ie;
- Aerial photography available online at Google Maps <http://maps.google.com/> and Bing Maps <http://www.bing.com/maps/>;
- Information in the Route Corridor Selection (Kerry County Council, 2012);
- Liaising with Jacobs on the environmental assessments for the proposed development; and

- Information on the status of EU protected habitats in Ireland (National Parks & Wildlife Service, 2013a and 2013b).

The hydrogeological baseline assessment considered the following sources of information:

- Ordnance Survey of Ireland;
- N69 Listowel Bypass Constraints Report (Kerry County Council, August 2007);
- Online maps and data of the Geological Survey of Ireland (GSI) (consulted March-April 2014);
- Ground investigation data produced by Causeway Geotech Ltd. (April 2014);
- Land owner consultation on Private Water Supply followed by site surveys and sampling (2013); and
- *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (National Road Authority, 2009).

The information on ground and groundwater conditions for the proposed development was based on the findings of the ground investigation data produced by Causeway Geotech Ltd. (April 2014). This ground investigation comprised of:

- Thirteen percussion boreholes;
- Two percussion boreholes with rotary core follow on;
- Two rotary open hole boreholes (BH105AD and BH107AD);
- A standpipe installation in each borehole; and
- Forty-one trial pits.

Key cumulative impact assessment sources in relevant documents:

- Ireland's National Biodiversity Plan, 2011 – 2016 (Department of Arts, Heritage and the Gaeltacht, 2011);
- Kerry County Development Plan 2015 – 2021 (Kerry County Council, 2015);
- Listowel Town Development Plan, 2009 – 2015 (Listowel Town Council, 2009);
- Listowel/Ballybunion Functional Areas Local Area Plan 2013-2019 (Kerry County Council, 2013);
- Heritage and Biodiversity Plan, 2008 – 2012 (Kerry County Council, 2008b); and
- Biodiversity Actions 2008-2012 (Kerry County Council, 2008a).

2.3 Site Surveys

Habitats

Flora and habitats were surveyed over four visits: the first between the 3rd and 5th April 2013; the second over the 17th and 18th July 2013; the third on the 26th June 2014, and the fourth between 31st August and 2nd September 2016[2]. The habitats were surveyed using the methodology outlined in the guidance document *Best Practice Guidance for Habitat Survey and Mapping* (Smith *et al.*, 2011). All habitat types were identified and classified using the *Guide to Habitats in Ireland* (Fossitt, 2000). Guidance on European Annex I habitat classification was sought from the *Interpretation Manual of EU Habitats* (European Commission, 2013) and the most recent national interpretations of EU Habitats Directive Annex I Habitats, where available. Within each habitat dominant and abundant plant species, indicator species and/or species of conservation interest were recorded. More detailed botanical surveys were undertaken in July 2013 and June 2014 of habitats that were considered to be of a higher ecological value; including the lands within the boundary of the Lower River Shannon SAC at the proposed crossing point of the River Feale.

[2] Surveys between 3rd August and 2nd September 2016 involved ground truthing and updating of surveys undertaken in 2013 and 2014.

Plant nomenclature followed that of the *Checklist of the Flora of Britain & Ireland* (Botanical Society of Britain & Ireland, 2007 and updates), and bryophyte nomenclature follows the *Checklist of British and Irish Bryophytes* (British Bryological Society, 2009).

Otter

A corridor of approximately 500m was initially surveyed for otter *Lutra lutra* activity as part of the multi-disciplinary walkover survey between the 3rd and 5th April 2013. The status and activity of any otter holts was recorded along with any evidence of activity, including paths, tracks, feeding signs, sprainting sites or couches (otter resting places).

Additional survey work was then undertaken for otter activity and their breeding and resting places, having regard to the survey methodology set out in the Design Manual for Roads and Bridges (*HA 81/99 - Nature Conservation Advice in Relation to Otters*, Highways Agency, 2001). A further survey for otter was undertaken on the 11th June 2013 covering a distance of 600m either side of the proposed crossing point of the River Feale. In October 2013, January 2014 and April 2014, further otter surveys were undertaken on all watercourses crossed by the proposed development. These surveys covered a distance of c.2km upstream and downstream of proposed crossing points (where access allowed) in conjunction with spot checks of main bridge sites within a 5km radius for signs of otter presence/activity. Ground truthing and updating of these survey results were undertaken in August and September 2016.

Freshwater pearl mussel

A stage 1 (presence/absence) survey for the freshwater pearl mussel *Margaritifera margaritifera* was carried out by Evelyn Moorkens & Associates from 10th to 12th June 2013 (full report in Appendix 6.2 of the EIS). The survey of the River Feale was carried out by three surveyors; two of whom were in the water at all times, with the other acting as 'bank manager'. The surveyors wore wetsuits to enable snorkelling as well as the standard survey technique using glass bottomed viewing buckets (bathyscopes). The River Feale within the entire footprint of the potential impact zone of the proposed works was surveyed, and for survey purposes, was sub-divided into eight survey sections (see Figure 2).

Brief assessments were also made in the main River Feale channel at Finuge Bridge, downstream of the proposed crossing point, and in Listowel, upstream of the proposed crossing point. Five associated watercourses along the proposed route were surveyed upstream and downstream of proposed crossing points (this was carried out by one surveyor on foot as the watercourses were found to be very narrow and shallow). The survey extent and locations are shown in the *Freshwater Pearl Mussel Survey Report* in Appendix 6.2 of the EIS.

Wintering birds

Following consultation with BirdWatch Ireland, the Irish Whooper Swan Study Group and the NPWS, it was confirmed that an internationally important population of wintering Whooper swans is resident in the locality.

As a result, monthly whooper swan *Cygnus cygnus* surveys were carried out over the periods October 2013 to March 2014 and November 2016 to April 2017. During each survey visit over the winters of 2013/14 and 2016/17, the following sites were visited to record and count any whooper swans present: the known principal feeding site at Ballyouneen (c.6 km west of the proposed development); another known feeding sub-site at Finuge (Galvin's Farm, c.275 m west of the proposed River Feale crossing point); and all suitable agricultural fields within 400 m of the off-line section of the proposed development see Figures 6.13-6.18. Additional sites were also counted as information on the species distribution developed over the surveys, including: Lixnaw Canal, Ballynagare Bridge, Ardcullen Marshes, and Cloneen Causeway. Records were also made of any other wintering bird species present within 400 m of the off-line section of the proposed development.

Fish species

The River Feale is considered to be a nationally important river system for Atlantic salmon *Salmo salar* and brown trout *Salmo trutta*.

Previous studies undertaken in relation to the proposed development noted the presence of holding pools for Atlantic salmon in the vicinity of the proposed crossing point of the River Feale, and spawning and nursery areas were present throughout the lower River Feale in the locality (Mott MacDonald, 2009; Ryan Hanley, 2012). The

Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower (see Figures 7.1-7.6: Surface Water Features) were all noted as having low/moderate potential for juvenile salmonids and lamprey species with none of these species recorded at the proposed crossing points (Ryan Hanley Consulting Engineers, 2012).

Brook lamprey *Lampetra planeri*, river lamprey *L. fluviatilis*, and sea lamprey *Petromyzon marinus* are known from the River Feale with juvenile lamprey previously recorded at sampling stations at the Listowel Racecourse footbridge and upstream of the weir at Scartleigh (O'Connor, 2006). The larvae (or ammocoetes) of these species burrow into fine silts in areas of slack flow along the river bank; a habitat that is not present at the proposed crossing point.

2.4 Consultation

In addition to written correspondence, meetings were held with the NPWS's Divisional Ecologist on 2nd May 2013 and 24th October 2016, as well as an informal site meeting with the local NPWS conservation ranger on 11th June 2013 regarding the scope of the ecological field survey work, existing records of rare and protected species and the likely significant impacts of the proposed development . A data request was submitted to the NPWS on the 10th September 2013 requesting any records of protected species or habitats, and any habitat mapping/surveys undertaken in the vicinity of the proposed crossing point of the Lower River Shannon cSAC.

BirdWatch Ireland were consulted regarding known records for barn owl and other raptor species in the locality on the 19th March 2013 and the 17th October 2013; and in relation to whooper swan *Cygnus cygnus* and other wintering bird records (Olivia Crowe, 11th June 2013 and 26th April 2017). The Irish Whooper Swan Study Group was also consulted in relation to whooper swan records in the locality. Additional consultation was also undertaken with the NPWS on the 9th October 2013 in relation to hen harrier nesting sites within 10km of the proposed development.

The Senior Fisheries Environment Officer with Inland Fisheries Ireland (IFI) was consulted on the 10th September 2013 regarding the fisheries value of the watercourses crossed; and in relation to bridge and culvert design on the 23rd August 2013.

A summary of the consultation responses received is provided in Appendix 6.1 of the EIS.

3 Screening

3.1 Background

The previously referenced guidance documents set out a staged process for carrying out Appropriate Assessment, the first stage of which is referred to as screening. This stage identifies whether any significant impacts on European sites might arise as a result of a proposed development either alone or in combination with other plans and projects.

If the conclusions at the end of the screening exercise are that significant impacts on any European sites, as a result of the proposed development, either alone or in combination with other plans and projects, are likely, uncertain or unknown, then there is a requirement to proceed to subsequent stages of Appropriate Assessment. The findings of the AA must be clearly documented in order to provide transparency of decision-making, and to ensure the application of the 'precautionary principle'[3]. If however the conclusions at the end of the screening exercise are that significant impacts on any European sites, as a result of the proposed development, either alone or in combination with other plans and projects, can be ruled out, the need for Appropriate Assessment does not arise.

[3] One of the primary foundations of the precautionary principle, and globally accepted definitions, results from the work of the Rio Declaration. Principle #15 declaration notes:

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

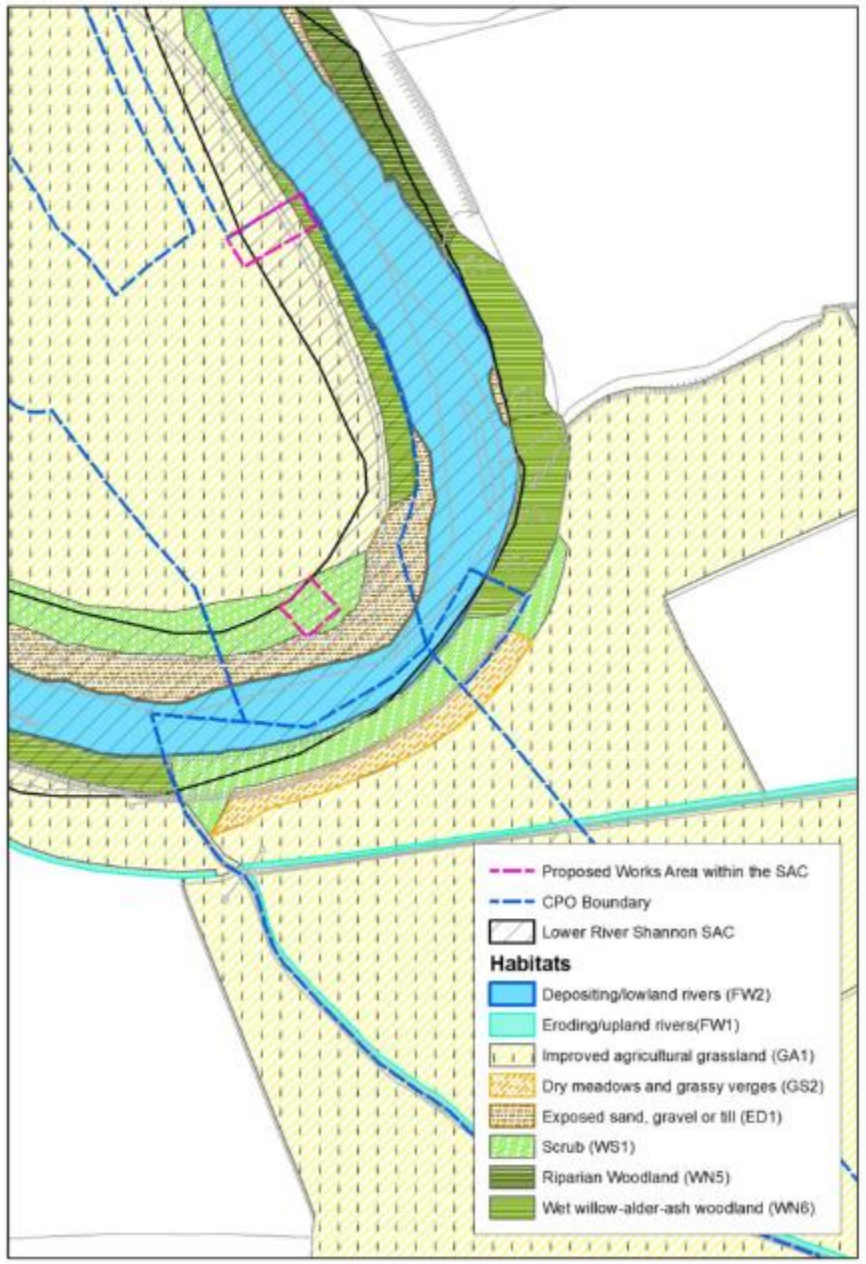
3.2 Overview of the Study Area and Receiving Environment

3.2.1 Site Description and Features of the Surrounding Environment

Habitats

The proposed crossing point of the Lower River Shannon cSAC consists of the following habitat types: mosaic of Exposed Sand, Gravel or Till/Reed and Large Sedge Swamps (ED1/FS1), Depositing/Lowland Rivers (FW2), Improved Agricultural Grassland (GA1), Scrub (WS1) and Wet Willow-Alder-Ash woodland (WN6) – see Figure 2: Habitat map of the proposed crossing point of the Lower River Shannon cSAC.

Figure 2: Habitat map of the proposed crossing point of the Lower River Shannon cSAC (River Feale)



Depositing/Lowland Rivers (FW2) - River Feale

The proposed crossing point of the River Feale is located approximately 3.8km downstream of Listowel Bridge. It is evident that this part of the river has been modified in the past with embankments along either side of the channel. Some rock armouring has been installed along the southern bank to prevent erosion. Similarly, for a stretch of approximately 360m along the northern bank a short distance upstream of the proposed crossing point, concrete reinforcement forms part of the riverbank. This appears to be a stabilisation/protection measure to minimise erosion of the riverbank.

The crossing point is at a shallow pool on a bend in the river. The width of the river at the time of the survey was approximately 20m. The flow regime in the river in the vicinity was a combination of pool, riffle and glide over a largely cobble based substrate.

At the proposed crossing point the southern bank of the river consists of a high, vertical bank (c.4/5m above the water level) of unconsolidated gravel and cobbles (see Plate 1 below). At the top of the bank is an area of dense bramble scrub with narrow bands of Alder *Alnus glutinosa* woodland to the west and east (described in more detail under the WN6 woodland classification below). At the proposed crossing point the northern bank of the river consists of an area of reed swamp on alluvial cobbles and gravels grading to an area of dense gorse scrub on the embankment separating the river channel from the agricultural field beyond. The habitats present on both banks are described in more detail under the relevant habitat classification categories in this section. Instream aquatic plant species were generally quite limited in extent and included Canadian pondweed *Elodea canadensis*, water-starwort spp. *Callitriche* spp. and *Fontinalis* spp.

Some water-crowfoot occurs to the east of the proposed crossing point (*c.*70 m upstream), the principal species of which is *Ranunculus penicillatus* var. *penicillatus*. This area of habitat (given that this species is characteristic) may correspond with the Annex I habitat type "water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation" [3260]. The European Commission definition of this habitat is broad (European Commission, 2013), and despite work undertaken by Kelleher (2011), there is no agreed definition of this habitat and its sub-types in Ireland (NPWS, 2013a). Based on the *Lower River Shannon SAC Conservation Objectives Supporting Document- Watercourses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation* (National Parks and Wildlife Service, 2012), this qualifying interest habitat within the Lower River Shannon cSAC includes three high conservation element sub-types to which the area of water crowfoot east of the bridge crossing does not correspond. This habitat therefore, irrespective of its classification, does not form part of the qualifying interest for the Lower River Shannon cSAC.

Exposed Sand, Gravel or Till/Reed and Large Sedge Swamps (ED1/FS1)

This habitat mosaic was present at the proposed crossing point of the River Feale. Along the southern bank there was a cliff face of unconsolidated alluvial deposits (coarse sands, gravels and cobble). This material was largely unvegetated save for sparse cover of reed canary-grass *Phalaris arundinacea*, creeping bent *Agrostis stolonifera* and occasional willow saplings along the waterside boulders (*e.g. Salix fragilis, S. cinerea*).

Plate 1: South bank of River Feale at the proposed crossing point

Along the northern bank of the River Feale, exposed gravels and cobbles are present in a transitional zone between the river and the more established scrub cover higher up the river bank (Plate 2). There is abundant growth of reed canary-grass within this band, of varying densities.

Plate 2: North bank of River Feale at the proposed crossing point

Where habitat conditions support emergent vegetation, the river is fringed by species in addition to reed canary-grass such as purple-loosestrife *Lythrum salicaria*, common nettle *Urtica dioica*, water forget-me-not *Myosotis scorpioides*, docks (*Rumex crispus, R. conglomeratus*), meadowsweet *Filipendula ulmaria*, great willowherb *Epilobium hirsutum*, hogweed *Heracleum sphondylium*, hemlock water-dropwort *Oenanthe crocata*, bittersweet *Solanum dulcamara*, water mint *Mentha aquatica*, branched bur-reed *Sparganium erectum*, wavy bitter-cress *Cardamine flexuosa*, fool's-water-cress *Apium nodiflorum*, water-cress *Rorippa nasturtium-aquaticum*, marsh

valerian *Valeriana dioica*, water horsetail *Equisetum fluviatile* and very occasionally common spike-rush *Eleocharis palustris*.

On the exposed cobbles, species such as procumbent pearlwort *Sagina procumbens*, clovers *Trifolium* spp., redshank *Persicaria maculosa* and water-pepper *Persicaria hydropiper* occur.

Other species present include willows *Salix* spp., colt's-foot *Tussilago farfara*, dandelion *Taraxacum* spp., daisy *Bellis perennis*, creeping buttercup *Ranunculus repens*, red clover *Trifolium pratense*, common nettle, and yarrow *Achillea millefolium*, with willow scrub, becoming more frequent on the upper shores of exposed alluvial material.

The invasive alien plant species Indian balsam (also known as Himalayan balsam) *Impatiens glandulifera* and Japanese knotweed *Fallopia japonica* are also present along the river bank at the proposed crossing point as well as both up and downstream.

Improved Agricultural Grassland (GA1)

A large proportion of the lands crossed by the proposed development corresponded to this habitat type. The majority of fields are subject to intensive grazing and/or regular cutting for silage, with others having been re-sown with agricultural grasses following a change in use from arable crops. Species composition is typically poor with grass species present including: rye-grasses *Lolium* spp., cock's-foot, Yorkshire fog *Holcus lanatus*, creeping bent, crested dog's-tail *Cynosurus cristatus*, meadow foxtail *Alopecurus pratensis* and meadow-grasses *Poa* spp. Herb species are generally limited to species such as creeping buttercup, meadow buttercup *Ranunculus acris*, ribwort plantain *Plantago lanceolata*, dandelion, white clover *Trifolium repens*, daisy, common mouse-ear *Cerastium fontanum*, docks *Rumex* spp. and thistles *Cirsium* spp. Some improved agricultural fields between the River Feale and the R557 and between the Forge Road and the R553 have abundant rush cover in places; soft-rush and jointed rush *Juncus articulatus*. These fields are included within the GA1 classification where rushes do not dominate the vegetation. Wetter patches (with some wet grassland characteristics) are present in the improved agricultural fields south of the River Feale. For example, some patches of yellow iris *Iris pseudacorus* are present in small isolated wet areas in some fields.

Dry Meadows and Grassy Verges (GS2)

The embankment at the southern crossing point of the River Feale is dominated by red fescue but is being overgrown by bramble scrub encroaching from the adjacent scrub habitat along the top of the river bank.

Plate 3: Southern bank – view from agricultural fields looking north

Riparian Woodland (WN5)

This woodland type occurs primarily in mosaic with Scrub WS1 habitat on the northern bank of the River Feale a short distance downstream of the proposed crossing point, on the lower portions of the slope transitioning to reed swamp and exposed cobble mosaic (Exposed Sand, Gravel or Till/Reed and Large Sedge Swamps ED1/FS1). The tree species present are willows (*Salix cinerea*, *S. fragilis* and occasional *Salix alba*) with ground flora supporting reed canary-grass, meadowsweet, rough meadow-grass, remote sedge *Carex remota* and opposite-leaved golden-saxifrage *Chrysosplenium oppositifolium*.

Another area of this habitat occurs on the southern bank of the River Feale a short distance upstream of the crossing point and is similar in nature except that it additionally contains occasional ash (Plate 3).

Detailed botanic surveys of these areas of woodland were undertaken on 26th June 2014. Neither of these areas correspond to the Annex I habitat "Alluvial forests with and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)" [*91E0]. A vegetation assessment undertaken, based on Perrin *et al*. (2008), indicated that although both areas of woodland support the three positive indicator tree species (ash, alder and grey willow), both areas failed all other criteria for meeting the Annex I habitat type *91E0; *i.e.* an absence of enough of the other positive indicator non-tree species, not meeting various criteria for habitat structure, inadequate representation of tree ages and size classes and presence of the negative indicator species sycamore *Acer pseudoplatanus*.

Plate 3: Woodland habitats upstream of the proposed crossing point of the River Feale (view looking south - proposed crossing point is around the bend in the river channel in the distance).

Wet Willow-Alder-Ash Woodland (WN6)

Along the banks of the River Feale on both the southern and northern banks there are a number of thin linear strips of alder dominated woodland. These wooded areas do not directly correspond to Wet Willow-Alder-Ash Woodland (WN6) as described by Fossitt but this is the closest habitat match in that classification system. The habitat most closely corresponds to the *Alnus glutinosa – Filipendula ulmaria* group (3b *Alnus glutinosa – Rubus fruticosus*) vegetation type as per Perrin *et. al.*, 2008. This habitat does not correspond to the Annex I habitat *Alluvial forests with *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*).

Detailed botanic surveys of these areas of woodland were undertaken on 26th June 2014. None of these areas corresponded to the Annex I habitat "alluvial forests with *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)" [*91E0]. A vegetation community assessment based on Perrin *et al*. (2008) indicated that although these areas of woodland support the three positive indicator tree species (ash, alder and grey willow), these woodland areas failed all other criteria for meeting the Annex I habitat type *91E0; *i.e.* an absence of the other positive

indicator non-tree species, not meeting various criteria for habitat structure, inadequate representation of tree ages and size classes and presence of the negative indicator species sycamore *Acer pseudoplatanus*.

The tree species present primarily include alder with occasional ash *Fraxinus excelsior*, willows (*Salix cinerea*, *S. fragilis* and occasional *Salix alba*) and sycamore *Acer pseudoplatanus*. The understory was represented by hawthorn and elder *Sambucus nigra* and the field layer was dominated by bramble *Rubus fruticosus* agg.

In drier stands the ground flora supports primrose *Primula vulgaris*, enchanter's-nightshade *Circaea lutetiana*, common Ivy *Hedera helix*, bramble, ramsons *Allium ursinum*, male-fern *Dryopteris filix-mas*, hogweed, lesser celandine *Ranunculus ficaria*, bluebells *Hyacinthoides non-scripta (L.)*, wood avens *Geum urbanum*, broad-leaved dock, wood anemone *Anemone nemorosa*, great woodrush *Luzula sylvatica*, alexanders *Smyrnium olusatrum*, red campion *Silene dioica*, common nettle, cleavers *Galium aparine*, hedge woundwort *Stachys sylvatica*, creeping buttercup, bittersweet and ground ivy *Glechoma hederacea*.

In more damp areas, the ground flora supports meadowsweet, rough meadow-grass *Poa trivialis*, remote sedge *Carex remota*, opposite-leaved golden-saxifrage *Chrysosplenium oppositifolium* and hemlock water-dropwort.

Scrub (WS1)

At the proposed crossing point of the River Feale there are substantial areas of scrub on both banks. Dense bramble cover is present along the embankment at the top of the southern river bank; there is complete cover on the north facing side with patches of bramble cover on the south facing side (and some gorse at the western end). An extensive area of gorse scrub is present along the northern riverbank at the proposed crossing point.

<u>Species</u>

Freshwater pearl mussel

There were no records, and no evidence from the survey, for this species downstream of the proposed development. There is very little suitable habitat upstream and downstream of the River Feale crossing point and the habitat in the smaller tributary streams is unsuitable.

Otter

Evidence of otter activity was recorded frequently along the banks of the River Feale and also on the Mill Stream Lower (as shown on Figures 6.6-6.12: Mammal Survey Results). No evidence of otter was recorded along any of the other watercourses crossed by the proposed development.

Three potential otter holts and an otter couch site were recorded within the area surveyed. Two of these sites are located more than 1.3km from the proposed development and will not be affected in any way as they are outside of the zone of influence (150m in relation to active natal holt sites according to National Roads Authority,2006, and Highways Agency, 2001). The remaining potential holt is located along the boundary of the proposed development at Garryantanvally. Although this burrow along the stream bank displayed the characteristics of an otter holt, no evidence of any otter activity was recorded in its vicinity throughout the survey period (in 2013, 2014 and 2016). It is included in the assessment, as it is deemed prudent to have it mapped and rechecked pre-construction to confirm that it is not in use by otter at that time.

Spot checks for evidence of otter activity were also undertaken at major bridge sites within a 5km radius of the proposed development: Drommurrin Bridge, Inch Bridge, Shrone Bridge, Finuge Bridge, Listowel Racecourse (Greenville Road), Listowel Racecourse (Listowel Town Centre), Listowel Bridge, The Knight's Bridge, and Kennelly's Bridge. All, aside from the Listowel Racecourse (Greenville Road) bridge site, had evidence of otter activity on one or more visits. For more details see Figures 6.6-6.12: Mammal Survey Results.

Invasive Plant Species

There are four invasive, non-native plant species listed in the Third Schedule of the *European Communities (Birds and Natural Habitats) Regulations, 2011* present within, or in close proximity to, the proposed development: Japanese knotweed *Fallopia japonica*, Indian balsam *Impatiens glandiflora*, Spanish bluebell & hybrids *Hyacinthoides hispanica* and *H. x massartiana* and three-cornered garlic *Allium triquetrum*. The locations of these invasive species are shown on Figures 6.1-6.5: Invasive Species Results.

Wintering Birds

Surveys to determine the usage of the fields within the zone of influence of the proposed development by whooper swans were carried out over two seasons: 2013-2014 and 2016-2017. The 2013-2014 season commenced in early November 2013 and finished in late March 2014, while surveys for the 2016-2017 season commenced in late November 2016 and ended in early April 2017. Both survey seasons encompassed six survey visits.

In both seasons, there were large flocks of whooper swans (maximum counts of 72 to 549 birds, with a mean of 226) feeding on improved agricultural fields at Ballyouneen (c. 6km west of the proposed River Feale crossing point). Whooper swans also fed on grassland in Finuge, c. 320m west of the River Feale crossing point, albeit in smaller numbers (counts ranging between 0 and 249, with a mean of 63). At Finuge, the date with the highest count of whooper swans corresponded to flooding of other favoured sites in the locality. Whooper swans were observed feeding at five other locations over the two survey seasons, although none of these locations were occupied by the species with the same regularity as Ballyouneen and Finuge. The lowest count of birds was recorded in early April 2014, which might be attributed to the migration of the species to its summering grounds in Iceland.

In addition to the feeding activity observed across the survey sites, whooper swans were observed night roosting within the River Feale, c. 320m west of the proposed development. The number of birds roosting here varied between seven and 59 birds.

With regards to other wetland bird species, a flock of c. 60 golden plover *Pluvialis apricaria* were recorded roosting in the agricultural field immediately to the north of the proposed crossing point of the River Feale in April 2013. A flock of c.170 golden plover were observed in December 2013 in the same area; occasionally settling in the same field between disturbance events. Flocks of up to 72 golden plover were observed overflying the Finuge whooper swan site on the 28th March 2014. In the 2016/17 survey season, 46 golden plover were recorded feeding at Finuge on 24th November 2016.

Snipe *Gallinago gallinago* were flushed from areas of rushy or rank grassland along the off-line section of the proposed development at Islandganniv, Garryantanvally and Coolnaleen Lower during the site surveys in April 2013, October 2013, December 2013, January 2014, February 2014, December 2016 and February 2017.

Flocks of mallard *Anas platyrhynchos* (up to 9 individuals) and teal *Anas crecca* (up to 26 individuals) were recorded along the River Feale in the vicinity of the proposed crossing point during the winter survey periods.

Black-headed gulls *Larus ridibundus* (in flocks of up to 50 birds) were routinely seen in many of the improved agricultural fields next to the River Feale over the course of the surveys; from Finuge Bridge to Listowel Racecourse, including the large field immediately north of the proposed crossing point.

Low numbers (*i.e.* 1-5) of oystercatcher *Haematopus ostralegus*, redshank *Tringa tetanus*, and greenshank *Tringa nebularia* were observed flying over the Finuge site in the 2016/17 survey season.

Pink-footed geese *Anser brachyrhynchus* (five individuals) and one barnacle goose *Branta leucopsis* overflew the Finuge site on the 17th February 2014, entering and leaving the area from the direction of the Cashen Estuary. Eleven greylag geese *Anser anser* were grazing in fields alongside whooper swans on 8th December 2016.

The Finuge whooper swan feeding area and the fields where snipe were recorded, are shown on Figures 6.13-6.18: Bird Survey Results.

Breeding Birds

The results of the breeding bird surveys are shown on Figures 6.13-6.18: Bird Survey Results and the full species list is included in Appendix 6.3 of the EIS.

Fish Species

The River Feale is considered to be a nationally important river system for Atlantic salmon and brown trout. Water quality in the River Feale is classified by the EPA as being of good status (Q4) *c*.1.7km upstream of the proposed crossing point (sampling station at Listowel Racecourse footbridge) and is classified as being of moderate status (Q3-4) at Scartleigh Weir, *c*.1.3km downstream of the proposed crossing point.

Previous studies undertaken in relation to the proposed development noted the presence of holding pools for Atlantic salmon in the vicinity of the proposed crossing point, and spawning and nursery areas were present throughout the lower River Feale in the locality (Mott MacDonald, 2009 and Ryan Hanley, 2012).

All three species of lamprey are known from the River Feale with juvenile lamprey previously recorded at sampling stations at the Listowel Racecourse footbridge and upstream of the weir at Scartleigh (O'Connor, 2006). The larvae (or ammocoetes) of these species burrow into fine silts in areas of slack flow along the river bank; a habitat that is not present at the proposed crossing point.

Baseline Water Quality monitoring results

Baseline water quality monitoring was undertaken in March and June 2013 at various locations along the River Feale and surrounding watercourses see Figures 7.1-7.6: Surface Water Features, in line with the NRA *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Scheme* (NRA, 2009) (see Appendix 6). Where available, these results are compared to the standards in the *European Communities Environmental Objective (Surface Water) Regulations, S.I. 272 of 2009.* Physico-chemical analysis results for the water samples show few exceedances of the guideline limits and there is no indication of pollution within the watercourses. Suspended solids results are were all under the 25 mg/l guideline value for salmonid waters.

3.2.2 Description of the Proposed Development

The proposed development is a combination of new road construction and upgrades to existing roads. It includes new road construction through greenfield lands around the west of the town and the upgrade of the existing John B. Keane Road along the northern fringe of the town as well as side road realignments, junction upgrades and the provision of new pedestrian and cycle infrastructure. The proposed development comprises approximately 7 km of construction between the existing N69 at Billeragh, south of Listowel Town and the existing N69 in Ballygowloge (refer to Figure 1.1 for the proposed development terminus locations). It consists of approximately 3.8 km of new greenfield road construction, 1.2 km upgrade/realignment of existing road, and 2 km of upgrade to the John B. Keane Road and provision of new shared cycle and pedestrian facilities.

The proposed development commences on the existing N69 in the townland of Billeragh approximately 0.7 km south of its junction with the R557 to Finuge and continues along the N69 for a distance of approximately 0.25 km. It then leaves the existing road alignment and proceeds north as greenfield construction through the townland of Coolnaleen and Garryantanvally, intersecting the R557 to Finuge at a new roundabout, then continuing north. It crosses two streams, the Ballygrenane Stream and the Garryantanvally Stream, before crossing the River Feale by means of a river bridge. Continuing northwards, it crosses the Mill Stream Lower and then intersects Local Road, known locally as Greenville Road, at a new roundabout. The mainline then turns northeast, intersecting Local Road L10112, known locally as Forge Road. Access to the northern section of the L10112 will be provided by means of a 'T' junction onto the proposed development, while the section of the L10112 to the south of the proposed development will become a cul-de-sac, accessed via the Greenville Road. The proposed development continues northeast, and turns east following the line of the disused railway for approximately 0.6 km before turning northeast to avoid an existing cluster of dwellings.

The proposed development then intersects the R553 to Ballybunnion at a new roundabout. The John B. Keane Road will be re-designated as N69 National Secondary Road. The John B. Keane Road is currently designated as N69 from the junction with the R552 Ballylongford Road. The existing junction with the R552 Ballylongford Road is a small urban roundabout. As part of the proposed development, this will be upgraded to include traffic signals, in place of the existing roundabout, incorporating pedestrian crossing facilities. The entire length of the John B. Keane Road will be upgraded to include a new shared pedestrian and cyclist facility on its northern side which will generally be constructed within the existing road boundary to minimise adverse impact.

Description of the River Feale Crossing

The proposed River Feale Bridge spans the river and is located within the townland of Garryantanvally. The structure crosses perpendicular to the river and is a two span arrangement with an intermediate support located within the Lower River Shannon SAC, but outside of the high water channel. The south abutment is set-back, with the intermediate pier set-back from the northern edge of the high water channel. The pier set-back allows for a natural bank path to be maintained for future access for maintenance and fishing and includes an allowance for the curvature of the river. The northern back span has been sized to minimise the overall length of the structure while preventing uplift at the abutment bearings. The length of the main span is approximately 69 m with a back span of 45 m.

Drainage and Attenuation

There are a number of different types of drainage system which were adopted for the carriageway drainage system:

- Sealed Drainage: This drainage system collects, conveys and discharges carriageway runoff via sealed (impervious) conduits. An example of this type of drainage system is the kerb and gully drain. Typically, this type of drainage system is used where footways are provided or on high embankments (> 6 metres).
- Grassed Surface Water Channels: Grassed Surface Water Channels are a development of swales for use as road edge channels. The function of the channel is to collect and convey rainwater runoff from the road surface. At suitable points along the channel, water is discharged into a separate carrier pipe or carrier drain. Where Grassed Surface Water Channels are used a Fin Drain will be provided to ensure any percolation through the channel is intercepted before reaching the unbound pavement layers.
- Over the Edge Drainage (Open Channels): These drains are used to drain over the edge carriageway runoff on smaller embankments (<6 metres high) and to act as interceptor drains for water from adjoining properties at the top of cut slopes and at the toe of embankments. They are generally trapezoidal in shape, 1 metre wide at the base with 1:1 side slopes. They can be unlined or concrete lined, depending on ground conditions.

It is proposed, as part of the drainage design for the proposed development, to construct retention ponds (also known as attenuation ponds) which will reduce the likelihood of flooding in the catchment.

Pollution Control measures from the proposed development are designed in accordance with HD 33/06, HA 103/06, HA 216/06 of the DMRB.

The proposed road drainage system will primarily incorporate grassed surface water channels, kerb and gully, over the edge drainage, sealed pipes, carrier drains, interceptor ditches, culverts, attenuation areas and pollution control as required in accordance with the above design standards.

Pollution control will be achieved during the conveyance of the road runoff to the attenuation features, including a forebay and wetlands at each outfall location, and both grassed surface water channels within the intermediate verges and the over-the-edge drainage to grassed swales/carrier drains where the drainage is allowed filter through the vegetation.

3.2.3 Other development nearby which could lead to cumulative impacts upon local ecology

The River Feale in the vicinity of Listowel is classified as being "at risk of not achieving good status" under the Water Framework Directive Risk Scores (Environmental Protection Agency, 2017). In the absence of the proposed development, potential impacts to water quality, along with any flood relief measures or similar works that may affect the hydrological or flood regime of the River Feale and its tributaries into the future, have the potential to result in negative impacts to the aquatic environment and associated habitats. These include existing IPC licenced discharges, discharges from Listowel Waste Water Treatment Plant (which according to *the Listowel Waste Water Treatment Plant Annual Environmental Report 2012* is operating within capacity, is compliant with the Environmental Limit Values set in the wastewater discharge licence and the discharge does not have an observable negative impact on either water quality or on Water Framework Directive status) and existing storm water overflows from the waste water network which discharge to the River Feale. If the proposed development were to affect the existing hydrological regime or affect existing water quality within the River Feale system there would be the potential for significant adverse "in-combination" effects to result.

The *Shannon River Basin Management Plan 2009-2015* lists the following pressures on water quality within the district, many of which could have *potential* "in-combination" effects with other proposed plans and projects: diffuse pollution risks, such as nutrient enrichment, from agriculture, forestry, peatland and urban land uses; wastewater and industrial discharges; wastewater from unsewered properties; landfills, quarries, mines and

contaminated lands; physical modifications and damage; water abstractions; aquaculture; invasive species; leisure activities; and dangerous substances. A road development has the potential to affect water quality in receiving watercourses at some geographic level and therefore act "in-combination" with some of the pressures listed above.

The key objectives of *Ireland's National Biodiversity Plan 2011 – 2016* are: to mainstream biodiversity in the decision making process across all sectors; to substantially strengthen the knowledge base for conservation, management and sustainable use of biodiversity; to increase awareness and appreciation of biodiversity and ecosystems services; to conserve and restore biodiversity and ecosystem services in the wider countryside and the marine environment; to expand and improve on the management of protected areas and legally protected species; and, to substantially strengthen the effectiveness of international governance for biodiversity and ecosystem services. No risk of significant adverse "in-combination" effects with the proposed development were identified at the strategic level from this plan.

Similarly, Kerry County Council's *Biodiversity Actions 2008-2012* plan and its *Heritage and Biodiversity Plan 2008 – 2012* pose no risk of significant adverse "in-combination" effects with the proposed development as they seek to enhance and protect the county's biodiversity resource.

There is potential for "in-combination" effects of projects undertaken within the scope of the *Kerry County Development Plan 2015 – 2021*, the *Listowel Town Development Plan 2009 – 2015*, and the *Listowel/Ballybunion Functional Areas Local Area Plan 2013-2019*. All of these plans have objectives to protect biodiversity, to comply with the requirements of the EU Habitats Directive, and not to permit development likely to have a significant adverse effect on the integrity of European sites. The Natura Impact Report (NIR) for the *Kerry County Development Plan 2015 – 2021* concluded that *"the Kerry County Development Plan is not likely to have significant effects on a Natura 2000 site, either by itself or in combination with other plans or projects and that adverse impacts on the integrity of Natura 2000 sites are not likely to occur"*. The Findings of No Significant Effects (FONSE) report prepared for the *Listowel/Ballybunion Functional Areas Local Area Plan 2013-2019* concluded that the "*Listowel/Ballybunion Functional Areas Local Area Plan (FALAP) (2013-2019) and the related 10th variation to the Kerry County Development Plan 2009-2015, would not have significant effects on Natura 2000 sites. It is therefore considered that an appropriate assessment is not required*". Therefore, no significant adverse "in-combination" effects are predicted to result from these plans in combination with the proposed development.

A planning application was submitted to Kerry County Council to construct a 10 turbine wind farm in the townlands of Lissahane/Ballyhorgan, *c.*2.8km south-west of the proposed development. Planning permission was refused by Kerry County Council in October of 2014 but permission was granted on appeal to An Bórd Pleanála in July 2016. As this area is hydrologically connected to the Lower River Shannon cSAC by way of the existing field drainage network, there is the potential for pollution events during construction to effect water quality in the River Feale. During operation, the most significant of the likely effects are impacts to bird species. An NIS was submitted with the planning application for the proposed wind farm development (McCarthy, Keville, O'Sullivan Ltd., 2014) which concluded that "*no significant or indeterminate impacts are likely as a result of the proposed project on the conservation objectives or overall integrity of any Natura 2000 site in the vicinity of the site of the proposed development*". Given that the proposed development alone was not predicted to result in any significant effects to qualifying interest bird species of the nearby SPAs, the proposed N69 Listowel Bypass will not have any in-combination effects with the proposed wind farm development.

The vast majority of other planning applications in the area relate to housing extensions/renovations or farm improvements (*e.g.* new sheds, roofing, livestock storage units and slurry tanks). The only likely significant effects that would arise in-combination with such developments is a reduction in water quality in receiving watercourses (*e.g.* the River Feale) that could result from septic tanks and/or contaminated run-off from agriculture (*e.g.* accidental discharge of slurry from farm yards).

3.2.4 Designated sites within 15km of the proposed development

Designated sites within 15km of the proposed development are shown in Figure 3 European sites within potential zone of influence of the Proposed Development. Two cSACs and three SPAs are located within this 15km zone; outside of which, there are no other European sites within the zone of influence of the proposed development. Table 1 below outlines the qualifying interests for each European site and identifies whether there are any potential source-pathway-receptor links via which adverse effects to the sites' qualifying interests and conservation objectives could potentially occur. This was vital to identify any potential adverse effects from the proposed development on the qualifying interests of these European sites, or cumulatively with other developments, that may result.

European sites are considered relevant where a source-pathway-receptor link exists between the proposed development and the European Sites. In order for an impact to occur there must be a risk enabled by having a 'source' (*e.g.* waste water discharge), a 'receptor' (*e.g.* a SAC or other ecologically sensitive feature), and a pathway between the source and the receptor (*i.e.* a watercourse or drainage system which connects the proposed development site to the SAC). The risk of the impact does not automatically mean it will occur, or that it will be significant. However, identification of the risk does mean that there is a possibility of ecological or environmental damage occurring, with the level and significance of the impact depending upon the nature and exposure to the risk and the characteristics of the receptor.

Where a source-pathway-receptor link is identified between the proposed development and a European Site which has the potential to result in adverse effects to the sites' qualifying interests and conservation objectives, each of the qualifying interests are assessed in Table 2 to identify which species or habitats are at risk.

Figure 3: European sites within the potential zone of influence of the proposed development

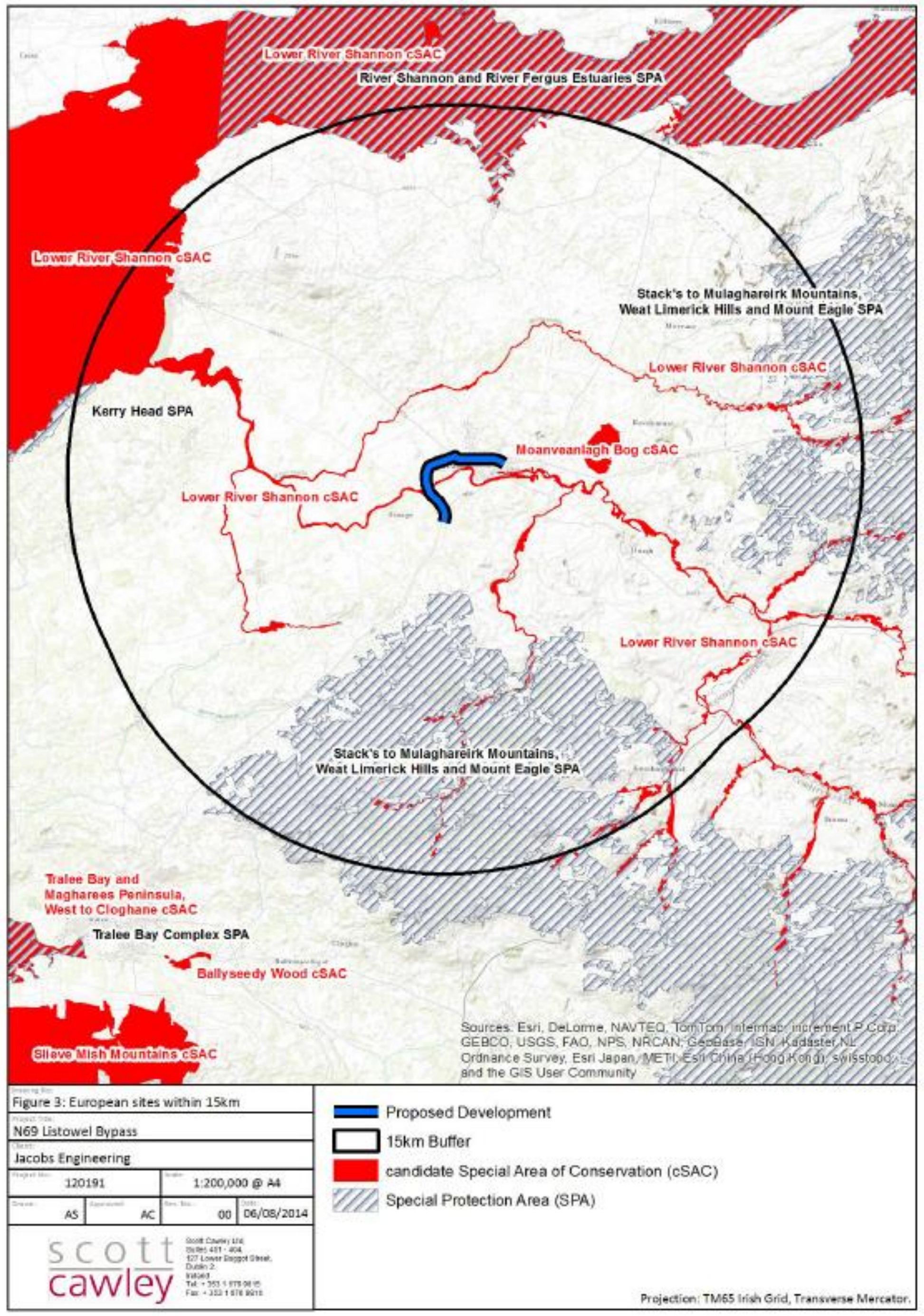


Table 1 **Identification of European sites and their Relevance to the Proposed Development** (European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.			
Site Name & Code	**Distance from Development** (approximate)	**Qualifying Interests (QIs) / Special Conservation Interests (SCIs)** (*Priority Annex I Habitats)	**Do any potential receptor-pathway-source links exist between the proposed development and the European site?**
candidate Special Areas of Conservation (cSACs)			
Lower River Shannon cSAC [002165]	The proposed development crosses the cSAC	▪ Freshwater pearl mussel *Margaritifera margaritifera* [1029] ▪ Sea lamprey *Petromyzon marinus* [1095] ▪ Brook lamprey *Lampetra planeri* [1096] ▪ River lamprey *Lampetra fluviatilis* [1099] ▪ Atlantic salmon *Salmo salar* [1106] ▪ Sandbanks which are slightly covered by sea water all the time [1110] ▪ Estuaries [1130] ▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ *Coastal lagoons [1150] ▪ Large shallow inlets and bays [1160] ▪ Reefs [1170] ▪ Perennial vegetation of stony banks [1220] ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts [1230] ▪ *Salicornia* and other annuals colonizing mud and sand [1310] ▪ Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] ▪ Bottle-nosed dolphin *Tursiops truncatus* [1349] ▪ Otter *Lutra lutra* [1355]	Yes, as the proposed development crosses the Lower River Shannon cSAC via a proposed new bridge over the River Feale, and drainage outfalls from the proposed road development will discharge to the cSAC. The following are the potential impact sources that have been identified: *Habitat Loss* The construction of the proposed new River Feale Bridge will result in the loss of habitat from within the boundary of the cSAC; none of which is Annex I or Qualifying Interest habitat. *Habitat Degradation* Invasive plant species (*e.g.* Japanese knotweed *Fallopia japonica* and Indian balsam *Impatiens glandulifera*) are present at the crossing point of the River Feale and at locations along some of its tributaries, which are also proposed to be crossed. Construction works in these areas will disturb soils contaminated by these invasive plant species. Therefore, there is a risk that contaminated soils and plant material would be washed downstream to the lower reaches of the River Feale and Cashen Estuary, spreading invasive plant species to uninfested areas within the cSAC, with the potential to result in indirect impacts on downatream Annex I habitat types present. A reduction in air quality could also lead to habitat degradation within the cSAC, influencing plant growth rates and species composition, diversity, and abundance.

[4] In ecological and environmental impact assessment, for an impact to occur there must be a risk enabled by having a 'source' (e.g. construction works at a proposed development site), a 'receptor' (e.g. a SAC or other ecologically sensitive feature), and a pathway between the source and the receptor (i.e. a watercourse which connects the proposed development site to the SAC). The risk of the impact does not automatically mean it will occur, or that it will be significant. However, identification of the risk does mean that there is a possibility of ecological or environmental damage occurring, with the level and significance of the impact depending upon the nature and exposure to the risk and the characteristics of the receptor.

Table 1 Identification of European sites and their Relevance to the Proposed Development (European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.			
Site Name & Code	**Distance from Development** (approximate)	**Qualifying Interests (QIs) / Special Conservation Interests (SCIs)** (*Priority Annex I Habitats)	**Do any potential receptor-pathway-source links exist between the proposed development and the European site?**
		▪ Mediterranean salt meadows (*Juncetalia maritimi*) [1410] ▪ Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] ▪ *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [6410] ▪ *Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] Source: NPWS (2012) Conservation Objectives: Lower River Shannon SAC 002165. Version 1.0. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.	*Disturbance during Construction* Although there will be no instream works, and therefore no direct disturbance, construction works in the vicinity of the River Feale have the potential to result in indirect disturbance (and associated displacement effects) to aquatic species in the river. *Reduction in Water Quality* As all drainage outfalls from the proposed development will ultimately discharge to the River Feale, or to other surface water features connected to the River Feale/River Cashen system, the construction and operation of the proposed development has the potential to adversely affect water quality in the cSAC and result in associated indirect effects on aquatic qualifying interest Annex I habitats and Annex II species. *Barrier Effect* The proposed clear span bridge design will ensure that that neither the construction nor operation of the proposed development will result in any barrier effect to aquatic species along the River Feale corridor. *Effects on the existing hydrological regime and floodplain connectivity along the River Feale* The clear span bridge design proposed will maintain the existing channel profile and substrate, and the existing flow regime of the river. Hydraulic modelling has been carried out to understand the impact of the road crossing on the flow of the watercourse in normal and flood flow. To consider this the 50% and 1% plus climate change annual exceedance, probability flows were run through the hydraulic model. In both scenarios there is no predicted headloss at the proposed bridge therefore the structure is not providing a restriction to in channel flow. However in the 1% plus climate change event, where the road crosses the floodplain, restriction to flow across the floodplain flow was

Table 1 Identification of European sites and their Relevance to the Proposed Development

(European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.

Site Name & Code	Distance from Development (approximate)	Qualifying Interests (QIs) / Special Conservation Interests (SCIs) (*Priority Annex I Habitats)	Do any potential receptor-pathway-source links exist between the proposed development and the European site?
			predicted by the hydraulic modelling (see Figure C2-3 in Appendix 8.2 of the EIS the Flood Risk Assessment - post proposed development with mitigation measures flood risk during 1% AEP plus climate change). This would result in increased retention of water on the floodplain for a period after a 1% plus climate change flood event. Given that the hydraulic modelling did not predict any restriction to in channel flow, and that any such flooding events are likely to be rare (1%) and temporary in nature, none of the aquatic qualifying interest species will be adversely affected. Similarly no significant effects are likely with respect to the estuarine or coastal habitats downstream. Any areas of the Annex I priority habitat Alluvial forests [*91E0] are also unlikely to be significantly affected as this habitat type requires periodic flooding (see Table 4). Nevertheless, effects to the functioning of a floodplain need to be minimised both quantitatively and with respect to the extent of any predicted effects and mitigation measures have been proposed (see Section 5.1.4).
Moanveanlagh Bog SAC [002351]	3.2km east	▪ Active raised bogs [7110] ▪ Degraded raised bogs still capable of natural regeneration [7120] ▪ Depressions on peat substrates of the *Rhynchosporion* [7150] Source: NPWS (2015) Conservation objectives for Moanveanlagh Bog SAC [002351]. Version 1.0. Department of Arts, Heritage & the Gaeltacht.	No, due to the distance of the SAC from the proposed development and the absence of any pathway by which the hydrology of the bog could be affected.
Special Protection Areas (SPAs)			
River Shannon and River Fergus Estuaries SPA [004077]	10.7km north	▪ Cormorant *Phalacrocorax carbo* [A017] ▪ Whooper Swan *Cygnus cygnus* [A038] ▪ Light-bellied Brent Goose *Branta bernicla hrota* [A046]	No. The proposed development will not result in any significant direct or indirect impacts to the SPA. The proposed development sits within the River Feale catchment, a catchment which does not drain directly to this European site. In

Table 1 Identification of European sites and their Relevance to the Proposed Development (European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.			
Site Name & Code	**Distance from Development** (approximate)	**Qualifying Interests (QIs) / Special Conservation Interests (SCIs)** (*Priority Annex I Habitats)	**Do any potential receptor-pathway-source links exist between the proposed development and the European site?**
		▪ Shelduck *Tadorna tadorna* [A048] ▪ Wigeon *Anas penelope* [A050] ▪ Teal *Anas crecca* [A052] ▪ Pintail *Anas acuta* [A054] ▪ Shoveler *Anas clypeata* [A056] ▪ Scaup *Aythya marila* [A062] ▪ Ringed Plover *Charadrius hiaticula* [A137] ▪ Golden Plover *Pluvialis apricaria* [A140] ▪ Grey Plover *Pluvialis squatarola* [A141] ▪ Lapwing *Vanellus vanellus* [A142] ▪ Knot *Calidris canutus* [A143] ▪ Dunlin *Calidris alpina* [A149] ▪ Black-tailed Godwit *Limosa limosa* [A156] ▪ Bar-tailed Godwit *Limosa lapponica* [A157] ▪ Curlew *Numenius* arquata [A160] ▪ Redshank *Tringa totanus* [A162] ▪ Greenshank *Tringa nebularia* [A164] ▪ Black-headed Gull *Chroicocephalus ridibundus* [A179] ▪ Wetlands [A999]	theory it could be argued that there is an indirect linkage from the proposed development site to this European site, via drainage through the River Feale catchment to the mouth of the Shannon Estuary which itself is connected back to this European site via tidal movements. However in reality this pathway via freshwater and marine water bodies is so long (approximately 29 km), circuitous and indirect that even if any potential impacts would have travelled this pathway, they would have been fully dissipated and assimilated by the capacity of the wider marine environment so as not to be felt within this SPA. This 29km indirect pathway will not pose a risk of spread of invasive species arising from construction works to the SPA. This is based both on the length and circuitous nature of the pathway as well as the fact that at least *c.* 15km of the final stages of this pathway is via brackish and marine water bodies in which the relevant invasive species (primarily Japanese knotweed and Indian balsalm) would not survive the saline conditions. Due to the approximate 10.7km overland distance from the proposed development site to this SPA, there is no potential for any other impact pathways (*e.g.* due to noise or other airborne impacts). Of the bird species recorded during the course of the ecology surveys undertaken in the preparation of the NIS (Appendix 6.3 of the EIS and Figures 6.13-6.18: Bird Survey Results), only the following species listed as qualifying interests of the SPA were present within the zone of influence of the proposed development: golden plover, whooper swan,

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Site Name & Code	Distance from Development (approximate)	Qualifying Interests (QIs) / Special Conservation Interests (SCIs) (*Priority Annex I Habitats)	Do any potential receptor-pathway-source links exist between the proposed development and the European site?
		Source: NPWS (2012) Conservation Objectives: River Shannon and River Fergus Estuaries SPA 004077. Version 1.0. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.	teal, black-headed gull, and cormorant. However, those birds recorded in Listowel are most likely from Cashen Estuary flocks[5] given the relatively close proximity of the estuary to Listowel and the River Cashen/River Feale corridor that connects the estuary with the proposed development site. Even if the SCI bird species recorded were to be from the River Fergus/Shannon Estuaries, displacement of the species would not result in a significant population level impact. This is because there are large areas of suitable foraging habitat of similar quality within the locality which have the capacity to absorb any displaced birds, and as the closest foraging site for whooper swans (Finuge) regularly sustains a relatively small proportion of the Cashen Estuary flock. Therefore, the proposed development will not result in any adverse effects on the River Shannon and River Fergus Estuaries SPA's SCI bird species.

[5] In the case of whooper swan, the birds recorded in the Listowel area were considered as being from the Cashen Estuary flock based on observations during the field surveys and consultation with the Irish Whooper Swan Study Group.

Table 1 Identification of European sites and their Relevance to the Proposed Development

(European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.

Site Name & Code	Distance from Development (approximate)	Qualifying Interests (QIs) / Special Conservation Interests (SCIs) (*Priority Annex I Habitats)	Do any potential receptor-pathway-source links exist between the proposed development and the European site?
Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA [004161]	3km south	▪ Hen Harrier *Circus cyaneus* [A082] Source: NPWS (2016) Conservation objectives for Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA [004161]. Generic Version 5.0. Department of Arts, Heritage & the Gaeltacht	No. This European site is not directly impacted. The SPA is located approximately 3km from the proposed development. Hen harrier may therefore range within the Listowel area, as male birds can feed as far as 10km from the nest site and the species is known to range widely during the winter (Hardy *et al.*, 2009). However, given the distance from the known nest sites (there are no known nests within 6km) and the low probability of the species to forage within the zone of influence of any construction disturbance due to the low suitability of the habitats impacted, habitat loss and general construction disturbance associated with the proposed development will not result in any significant effects on this species. Given the distance of the proposed development from the known hen harrier nest sites (there are no known nest sites within 6km), and the low susceptibility of the species to impacts from road traffic, the operation of the proposed development will not result in any significant effects on this species.

Table 1 Identification of European sites and their Relevance to the Proposed Development

(European sites are considered relevant where a receptor -pathway-source link[4] exists between the proposed development and the European Site.

Site Name & Code	Distance from Development (approximate)	Qualifying Interests (QIs) / Special Conservation Interests (SCIs) (*Priority Annex I Habitats)	Do any potential receptor-pathway-source links exist between the proposed development and the European site?
Kerry Head SPA [004189]	14.2km west	▪ Fulmar *Fulmarus glacialis* [A009] ▪ Chough *Pyrrhocorax pyrrhocorax* [A346] Source: NPWS (2016) Conservation objectives for Kerry Head SPA [004189]. Generic Version 5.0. Department of Arts, Heritage & the Gaeltacht.	No. Fulmar is a species which breeds along the Irish coast and winters at sea or at coastal sites. As such, this species will not be affected in any way given the distance separating the proposed development from the SPA and its coastline. Similarly, Chough are also a coastal bird with 95% of breeding sites recorded on islands or within 1km of the coastline (Gray *et al.*, 2003). As such, this species will not be affected in any way given the distance separating the proposed development from the SPA and its coastline. Therefore, the proposed development will not result in any significant effects on the SCI bird species.

Identification of European sites and their Relevance to the Proposed Development Conclusion

Of the five European sites located within the potential zone of influence of the proposed development, only the Lower River Shannon SAC has a source-receptor-pathway link with the proposed development and as such significant effects on this site cannot be ruled out in the absence of mitigation. The proposed development has the potential to affect the Lower River Shannon SAC as a result of: habitat loss at the site of the proposed new bridge over the River Feale; habitat degradation from the spread of invasive plant species, and a reduction in air quality; a reduction in water quality during construction and operation; and, effects on the existing hydrological regime and floodplain connectivity along the River Feale. These potential impacts are further assessed in Table 2 below.

Table 2	Detailed Screening Assessment in relation to the qualifying interests of the Lower River Shannon SAC [002165]
Qualifying Interests (*Priority Annex I Habitats for Conservation)	**Are any of the identified receptor-pathway-source links between the proposed development and the Natura 2000 site likely to have a significant effect on one or more of the qualifying interest habitats or species?**
Atlantic salmon *Salmo salar* [1106] Sea lamprey *Petromyzon marinus* [1095] Brook lamprey *Lampetra planeri* [1096] River lamprey *Lampetra fluviatilis* [1099]	Atlantic salmon and lamprey species are considered together as the potential for the proposed development to affect these species relates to the same factors: habitat loss, habitat degradation, the risk of a reduction in water quality and the risk of a barrier effect associated with the installation of bridges and other structures on watercourses. The potential for the proposed development to affect the existing hydrological regime and floodplain connectivity has been ruled out (see Table 1). *Habitat loss/habitat degradation* The use of a clear span bridge design over the River Feale, with no construction works within the river channel (during normal flow conditions), avoids any loss of river substrate habitat that would affect these aquatic species. The removal of bankside vegetation at this location will also not result in any direct significant effects on Atlantic salmon or lamprey species. This vegetation is all above the normal water channel level and does not provide shelter or refuge opportunities for these species. Therefore its removal will not affect the ability for these species to continue to use the river habitat. Habitat degradation in relation to these aquatic species is only possible as a result of significant/prolonged pollution and/or siltation events during construction if this were to occur. The risk of pollution events occurring during construction is discussed in more detail below under *Reduction in Water Quality*. Although not within the Lower River Shannon cSAC boundary, habitat loss associated with the installation of structures on the tributary streams (the Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower) is considered here also, as there is the potential for negative effects to occur to cSAC populations if they use these channels. However, in this case the Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower were all noted as low/moderate potential for juvenile salmonids and lamprey species with none of these species recorded at the proposed crossing points (Ryan Hanley Consulting Engineers, 2012). Therefore, works for the installation of structures on these watercourses are not predicted to result in any significant effect to Atlantic salmon or lamprey populations in the Lower River Shannon cSAC. *Disturbance to fish species during construction* Any disturbance due to increased human presence, and noise and vibration associated with the construction works (including the installation of the temporary piles required to construct the bridge abutments in isolation from the river) is not predicted to result in any significant disturbance to aquatic species principally due to the absence of any in-stream works on the River Feale but also in consideration of the temporary nature of any vibration associated with the pile driving, and the short-term nature of general construction works (which will be of a limited duration each day *i.e.* confined to normal working hours). *Reduction in Water Quality* During construction, contaminated surface water runoff and/or an accidental spillage or pollution event affecting any surface water feature has the potential to have significant negative impacts on water quality and may consequently impact on fish species present downstream; significant reductions in water quality can cause stress or mortality in adult and juvenile fish. The effects of frequent and/or prolonged siltation or pollution events in a river system have the potential to be extensive and far-reaching and can have significant impacts *e.g.* prolonged siltation events can damage spawning habitat present downstream by clogging up the interstitial spaces in gravel beds.

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	In the unlikely instance that a pollution event of such a magnitude occurred during construction, given that the proposed development is within the lower reaches of the catchment this therefore would not have far-reaching effects within the River Feale system. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts during construction, and mitigation measures are proposed to minimise the risk of the proposed development having any perceptible effect on water quality. There will be six new outfall points to surface water features from the road drainage network during operation. During routine operation pollutants (for example oils and hydrocarbons from fuel combustion and salts or herbicides from road maintenance) will be deposited on the road surfaces. The implications for water quality relate to the potential for these pollutants to be transported in surface run-off and enter the water environment via the road drainage system. The impact will depend on the volume and type of traffic using the road, the provision of pollution control measures, and the sensitivity of the receiving watercourse. A Highways Agency Water Risk Assessment Tool (HAWRAT) assessment has been undertaken to assess the carriageway runoff from the proposed development on the receiving watercourses. Full details of this assessment are presented in Chapter 8 and Appendix 8.3 of the EIS but the key relevant findings are presented here. The toxicity thresholds which are used by the tool, have been designed to prevent adverse ecological effects in receiving waters. Equally, in artificial and heavily modified water bodies, the thresholds have been designed to prevent adverse effects on ecological potential. The thresholds are consistent with the requirements of the Water Framework Directive. During the operation of the development, surface water runoff will be passed through a three stage train system of petrol/oil interceptor, attenuation pond, and constructed wetland prior to discharge (as described in Section 3.2.2). The design of the treatment system has taken account of the size of the catchment drained, and the types of contaminants (grit, heavy metals, and hydrocarbons). The results of the HAWRAT assessment show the % removal of pollutants required to achieve required water quality objectives and whether the proposed drainage designs achieve these removals. In each case it can be seen that the proposed drainage designs are adequate and that no additional measures are required. The HAWRAT results indicate that impacts to water quality in all receiving watercourses as a result of the operational phase would be considered to be either imperceptible, or neutral to negligible, due to the pollutant removal ability of the proposed drainage system. The outputs (annual average concentrations for soluble pollutants, dissolved copper and dissolved zinc) were also compared against the Environmental Quality Standards (EQS) in the *European Communities Environmental Objective (Surface Water) Regulations 2009* and in all cases levels are significantly below the annual average (AA-EQS). Based on the HAWRAT assessment, and given the drainage design proposed (a three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, as described in Section 3.2.2) the operating water quality of the drainage outfalls will not have any perceptible impact on water quality in the receiving watercourses. Extreme flood events may temporarily affect the functioning of the attenuation and wetland elements of the treatment chain, but the petrol interceptor would continue to function as designed. However, given the increased dilution factor and flow rates associated with such events the predicted impact on water quality is predicted to be imperceptible. A risk of hydrocarbon and other dangerous substance contamination exists as a result of accidental spillage by vehicles using the proposed development during the operational phase of the proposed development. The Highways Agency (HA) considers that in "*circumstances where an outfall discharges within close proximity to (i.e. within 1 km) a protected area for conservation, or could affect important drinking water supplies or other important abstractions, a higher standard of protection will be required such that the risk of a serious pollution incident has an annual probability of less than 0.5%.*". As is demonstrated in Chapter 8 of the EIS (Section 8.2.7 (b) ii) and Appendix 8.4 of the EIS, the probability of accidental spillage occurring has been calculated as being less

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	than 0.5% in all cases. Therefore, the likelihood of a serous pollution incident is so low that it is not deemed necessary in accordance with the Highways Agency's guidance to further reduce the risk of a serious pollution incident through other measures. Given that all surface water run-off from the proposed development will be captured by the three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, in the extremely unlikely event of an accidental spillage any hydrocarbons or other potential pollutants would pass through this system offering some level of protection to the receiving watercourses. Given the extremely low likelihood and level of protection available through the design of the drainage system significant effects are not predicted. *Barrier Effect* The use of a clear span bridge design over the River Feale avoids the potential for the proposed development to result in any barrier effect to fish passage. It was noted during the field surveys that existing flood prevention measures on the tributaries crossed by the proposed development (Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower) are likely to result in a degree of barrier effect on these watercourses due to the presence of flap valves and, in the case of the Ballygrenane and Garryantanvally Streams, an outfall pipe which is elevated from the River Feale. Given the design of the structures proposed for the Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower (Figure 5: Culvert Typical Arrangement) the proposed development will not pose a risk of any significant effects on these species as a result of barrier effects in the supporting tributary network.
Freshwater pearl mussel *Margaritifera margaritifera* [1029]	The freshwater pearl mussel conservation objectives for the Lower River Shannon cSAC relate specifically to the Cloon River population in County Clare and given the absence of any hydrological connection between the proposed development and this river catchment, there is no potential for the proposed development to result in any direct effects on this population. Although there are no freshwater pearl mussel populations present within the zone of influence of the proposed development (at, or downstream of, the proposed River Feale Bridge or the proposed drainage outfalls), there are records of populations in the catchment, 23km upstream of Listowel (Ross, 2009). The freshwater pearl mussel will not be affected in any way by habitat loss or habitat degradation. There is however, a potential pathway by which the proposed development could have indirect impacts on this species within the River Feale catchment by virtue of the fact that the larval stage of the species' life-cycle relies upon salmonid fish as a host species; any potential effects on salmonid fish species could therefore also potentially affect freshwater pearl mussel recruitment in the catchment. The potential for the proposed development to result in any significant effects on salmonid fish species has already been discussed above in relation to Atlantic salmon.

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Qualifying Interests (*Priority Annex I Habitats for Conservation)	**Are any of the identified receptor-pathway-source links between the proposed development and the Natura 2000 site likely to have a significant effect on one or more of the qualifying interest habitats or species?**
Sandbanks which are slightly covered by sea water all the time [1110]	This habitat type is present in the Shannon Estuary between Ballybunion, Loop Head and Carrigaholt (National Parks & Wildlife Service, 2012a, map 3); separated from the proposed development by *c.*18.5km of river channel and a *c.*4km marine open water buffer. Given the scale of the proposed development and its distance from the location of this habitat type within the cSAC, and the assimilative capacity of the River Feale in its lower reaches and the Shannon Estuary itself, it is not predicted that a pollution event would occur during construction, or operation, of a magnitude or duration that would result in any perceptible change in water quality in the Shannon Estuary. Therefore, the proposed development does not pose a risk of any significant effects on this Annex I habitat within the Lower River Shannon cSAC.
*Coastal lagoons [1150]	The Annex I habitat **Coastal lagoons* is limited to four sites within the Shannon Estuary (National Parks & Wildlife Service, 2012); the closest of which is Cloonconeen Pool, *c.*11.5km from the Cashen Estuary. Given the substantial distance of river channel and open marine water that separates the proposed development site from the locations of this habitat type within the SAC the proposed development does not pose a risk of any significant effects on this Annex I habitat within the Lower River Shannon cSAC.
Large shallow inlets and bays [1160]	This habitat type is associated with the Shannon Estuary *c.*18.5km downstream of the proposed development (National Parks & Wildlife Service, 2012a, map 7). Given the scale of the proposed development and its distance from the location of this habitat type within the SAC, and the assimilative capacity of the River Feale in its lower reaches and the Shannon Estuary itself, it is not predicted that a pollution event would occur during construction, or operation, of a magnitude or duration that would result in any perceptible change in water quality in the Shannon Estuary. Therefore, the proposed development does not pose a risk of any significant effects on this Annex I habitat within the Lower River Shannon cSAC.
Reefs [1170]	This habitat type is associated with the Shannon Estuary *c.*18.5km downstream of the proposed development (National Parks & Wildlife Service, 2012a, map 8). Given the scale of the proposed development and its distance from the location of this habitat type within the cSAC, and the assimilative capacity of the River Feale in its lower reaches and the Shannon Estuary themselves, it is not predicted that a pollution event would occur during construction, or operation, of a magnitude or duration that would result in any perceptible change in water quality in the Shannon Estuary. Therefore, the proposed development does not pose a risk of any significant effects on this Annex I habitat within the Lower River Shannon cSAC.
Perennial vegetation of stony banks [1220]	The nearest location of this habitat type to the proposed development is along the Shannon Estuary coastline at Ballybunion (National Parks & Wildlife Service, 2012a, map 10); *c.*18.5km downstream of the proposed development and north along the coastline. Given that this is a terrestrial habitat type with no surface water pathway by which the proposed development could impact on it, the proposed development does not pose a risk of any significant effects on this Annex I habitat within the Lower River Shannon cSAC.

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Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	The nearest locations of this habitat type to the proposed development are along the Shannon Estuary coastline south of the Cashen Estuary and north of Ballybunion (National Parks & Wildlife Service, 2012a, map 11); *c.*18.5km downstream of the proposed development, and north and south along the coastline. Given that this is a terrestrial habitat type with no surface water pathway by which the proposed development could impact on it, the proposed development does not pose a risk of any significant effects on of this Annex I habitat within the Lower River Shannon cSAC.
Estuaries [1130] Mudflats and sandflats not covered by seawater at low tide [1140] *Salicornia* and other annuals colonizing mud and sand [1310] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	The extent of the Cashen River Estuary is mapped from the coastline south of Ballybunion to the Finuge Bridge, *c.*2.5km downstream of the proposed development (National Parks & Wildlife Service, 2012a, map 3). As estuaries are ecological units encompassing the aquatic and coastal habitat types associated with the zone of tidal influence in the lower reaches of a river system, those Annex I coastal habitats either known or likely to occur within the Cashen River Estuary are discussed here also (National Parks & Wildlife Service, 2012a, map 12). In relation to the proposed development, the estuarine system and habitats are only likely to be affected either by a reduction in water quality or through the introduction of invasive plant species. *Potential for a Significant Reduction in Water Quality During Construction* During construction, contaminated surface water runoff and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently an impact on the estuarine habitats present downstream. The effects of frequent and/or a prolonged pollution events in an estuarine system can have the potential to be extensive and far-reaching and can have potentially significant long-term effects. In the unlikely instance that a pollution event of such a magnitude would occur during construction, given that the proposed development is within the lower reaches of the catchment this therefore would not have far-reaching effects within the River Feale system. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts during construction and mitigation measures are proposed to minimise the risk of the proposed development having any perceptible effect on water quality. *Potential for a Significant Reduction in Water Quality During Operation* There will be six new outfall points to surface water features from the road drainage network during operation. As described in detail above for salmon and lamprey, the HAWRAT assessment indicates that impacts to water quality in all receiving watercourses as a result of the operational phase would be considered to be either imperceptible, or neutral to negligible, due to the pollutant removal ability of the proposed drainage system. The outputs (annual average concentrations for soluble pollutants, dissolved copper and dissolved zinc) were also compared against the Environmental Quality Standards (EQS) in the *European Communities Environmental Objective (Surface Water) Regulations 2009* and in all cases levels are significantly below the annual average (AA-EQS). Based on the HAWRAT assessment and given the drainage design proposed (a three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, as described in Section 3.2.2) the operating water quality of the drainage outfalls will not have any perceptible impact on water quality in the receiving watercourses. Extreme flood events may temporarily affect the functioning of the attenuation and wetland elements of the

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	treatment chain, but the petrol interceptor would continue to function as designed. However, given the increased dilution factor and flow rates associated with such events the predicted impact on water quality will likely be imperceptible. A risk of hydrocarbon and other dangerous substance contamination exists as a result of accidental spillage by vehicles using the proposed development during the operational phase of the proposed development. The Highways Agency (HA) considers that in *"circumstances where an outfall discharges within close proximity to (i.e. within 1 km) a protected area for conservation, or could affect important drinking water supplies or other important abstractions, a higher standard of protection will be required such that the risk of a serious pollution incident has an annual probability of less than 0.5%."*. As is demonstrated in Chapter 8 of the EIS (Section 8.2.7 (b) ii) and Appendix 8.4 of the EIS, the probability of accidental spillage occurring has been calculated as being less than 0.5% in all cases. Therefore, the likelihood of a serous pollution incident is so low that it is not deemed necessary in accordance with the Highways Agency's guidance to further reduce the risk of a serious pollution incident through additional measures. Given that all surface water run-off from the proposed development will be captured by the three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, in the extremely unlikely event of an accidental spillage any hydrocarbons or other potential pollutants would pass through this system offering some level of protection to the receiving watercourses. Given the extremely low likelihood and level of protection available through the design of the drainage system significant effects are not predicted. *Potential for Introducing/Spreading Invasive Plant Species* Invasive plant species are present at the crossing point of the River Feale and along some of its tributaries. Construction works in these areas will disturb soils contaminated by these plant species. Therefore, there is a risk that contaminated soils or plant material will be washed downstream to the lower reaches of the River Feale and Cashen Estuary and result in indirect impacts on the habitats there. The impact of spreading these species within the cSAC could potentially be long-term, and significant at a local level. Given the abundance of invasive plant species cover in the vicinity of the proposed development, there is a high probability that these species will recolonize the vegetated areas within the CPO fence line post-construction (particularly Japanese knotweed along the River Feale corridor and along the disused rail line embankments). As such, there is a risk that routine maintenance works may inadvertently spread contaminated vegetation cuttings to the estuary via the River Feale or other surface water features crossed by the proposed development.
Bottle-nosed dolphin *Tursiops truncatus* [1349]	The Bottle-nosed dolphin is associated with the Shannon Estuary *c.*18.5km downstream of the proposed development (National Parks & Wildlife Service, 2012a, map 16). Given the scale of the proposed development and its distance from the Shannon Estuary, and the assimilative capacity of the River Feale in its lower reaches and the Shannon and Cashen Estuaries themselves, it is not predicted that a pollution event would occur during construction, or operation, of a magnitude or duration that would result in any perceptible change in water quality in the Shannon Estuary. Therefore, the proposed development does not pose a risk of any significant effects on this Annex II species within the Lower River Shannon cSAC.
Otter *Lutra lutra* [1355]	The results of the otter survey show that the species is present throughout the study area, regularly using the River Feale corridor in the vicinity of the proposed New River Feale Bridge (see Figures 6.6 - 6.12: Mammal Survey Results). Although not within the Lower River Shannon cSAC boundary, impacts associated with tributary streams (the Ballygrenane Stream, Garryantanvally Stream, and the Mill Stream Lower) are considered here also, as

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	it is likely that the otters using these streams are part of the cSAC population. *Disturbance to breeding or resting places during construction* There are no confirmed and active otter breeding or resting places directly impacted by the proposed development. There is one potential otter holt along the proposed development boundary at Coolnaleen Lower/Garryantanvally (H4). Although this burrow along the stream bank displays the characteristics of an otter holt, no evidence of any otter activity has been recorded in its vicinity throughout the survey periods. Given the distance that the active holt and couch sites are from the proposed development site, and the absence of any other confirmed breeding or resting places within the zone of influence of the proposed development (150m based on current guidance - National Roads Authority 2008, NIEA 2011 and Highways Agency 2001), it is not predicted that construction works in the vicinity of these features will result in any disturbance to otter breeding or resting places. *Disturbance to Otter during construction* Any disturbance due to increased human presence, and noise and vibration associated with the construction works (including the installation of the temporary piles required to construct the bridge abutments in isolation from the river) is not predicted to result in any significant disturbance to otter using the watercourses crossed by the proposed development as; the species is generally nocturnal in habit and therefore, will not be affected by works during normal daylight working hours; and, otter are known to tolerate human disturbance under certain circumstances (Bailey & Rochford 2006, The Environment Agency 2010, Irish Wildlife Trust 2012, and also as evidenced by the presence of otter signs along the River Feale in Listowel Town) and the species would be expected to habituate to the presence of construction activities. *Habitat loss/severance during construction* As there were no active and/or confirmed holts or couch sites within the footprint of the proposed development there will be no decline in the number of available holt or couch sites within the cSAC. The use of a clear span bridge design over the River Feale will ensure that the proposed development will not result in any reduction in the extent of freshwater (river) habitat for otter within the cSAC. The construction of the proposed New River Feale Bridge will result in the loss of c.477m^2 of bankside vegetation within the cSAC boundary at two locations; on the north bank of the river at the proposed crossing point (c.409m^2 of scrub), and at the outfall for proposed Pond A3 (c.68m^2 of woodland). In the context of river systems, the *Threat Response Plan - Otter Lutra lutra 2009-2011* document (Department of the Environment, Heritage and the Gaeltacht, 2011) defines otter habitat as a 10m zone of riparian habitat along the river banks. On the south bank the riparian zone consists of a c.5m high cliff face of unconsolidated alluvial material topped with a bramble scrub covered earth bank. Given that otter activity was restricted to the boulders lining the base of the cliff in this area, the absence of any existing substantial vegetation cover in this zone, and the clear span bridge design proposed, the vegetation loss in this area is not predicted to result in any significant decline in the extent of the available terrestrial habitat; as evidenced by the continued use by otter of areas under bridge structures in the surrounding area. On the north bank of the river at the proposed crossing point the riparian zone consists of a band of exposed gravels, cobbles, and reed canary grass

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	with a band of more established scrub cover higher up the river bank. Given the clear span bridge design proposed, the vegetation loss in this area is not predicted to result in any significant decline in the extent of the available terrestrial habitat; as evidenced by the continued use by otter of areas under bridge structures in the surrounding area. At the outfall for proposed Pond A3 the riparian zone consists of a narrow band of woodland. Given the modified nature of the river bank immediately to the north of this location (concrete bank reinforcement works have been carried out in the past) which is still used by otter based on the evidence of the field surveys, the removal of the vegetation required to install the outfall and associated headwall is not predicted to result in any significant decline in the extent of the available terrestrial habitat for the species. As a result of the construction works, it is probable that the physical disturbance to the existing landscape in constructing the watercourse crossings will result in some initial severance along watercourses used by otter. However otter would be expected to habituate to the modified landscape quite quickly and therefore, habitat severance during construction will be temporary and is not predicted to result in any significant effects to the local otter population. *Reduction in Water Quality* During construction, contaminated surface water runoff and/or an accidental spillage or pollution event into any surface water feature has the potential to have a significant negative impact on water quality and consequently an impact on otter; either directly or indirectly (*e.g.* a reduction in water quality can cause stress or mortality in adult and juvenile fish, a key prey species of otter). The effects of frequent and/or prolonged pollution events in a river system have the potential to be extensive and far-reaching and can have potentially significant long-term effects. In the unlikely instance that a pollution event of such a magnitude would occur during construction, given that the proposed development is within the lower reaches of the catchment, this therefore would not have far-reaching effects within the River Feale system. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are proposed to further minimise the risk of the proposed development having any perceptible effect on water quality during construction. There will be six new outfall points to surface water features from the road drainage network during operation. As described in detail above for salmon and lamprey, the HAWRAT assessment indicates that impacts to water quality in all receiving watercourses as a result of the operational phase would be considered to be either imperceptible, or neutral to negligible, due to the pollutant removal ability of the proposed drainage system. The outputs (annual average concentrations for soluble pollutants, dissolved copper and dissolved zinc) were also compared against the Environmental Quality Standards (EQS) in the *European Communities Environmental Objective (Surface Water) Regulations 2009* and in all cases levels are significantly below the Annual Average AA-EQS. Based on the HAWRAT assessment and given the drainage design proposed (a three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, as described in Section 3.2.2) the operating water quality of the drainage outfalls will not have any perceptible impact on water quality in the receiving watercourses. Extreme flood events may temporarily affect the functioning of the attenuation and wetland elements of the treatment chain, but the petrol interceptor would continue to function as designed. However, given the increased dilution factor and flow rates associated with such events the predicted impact on water quality will likely be imperceptible.

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	A risk of hydrocarbon and other dangerous substance contamination exists as a result of accidental spillage by vehicles using the proposed development during the operational phase of the proposed development. The Highways Agency (HA) considers that in "*circumstances where an outfall discharges within close proximity to (i.e. within 1 km) a protected area for conservation, or could affect important drinking water supplies or other important abstractions, a higher standard of protection will be required such that the risk of a serious pollution incident has an annual probability of less than 0.5%.*". As is demonstrated in Chapter 8 of the EIS (Section 8.2.7 (b) ii) and Appendix 8.4 of the EIS, the probability of accidental spillage occurring has been calculated as being less than 0.5% in all cases. Therefore, the likelihood of a serous pollution incident is so low that it is not deemed necessary in accordance with the Highways Agency's guidance to further reduce the risk of a serious pollution incident through additional measures. Given that all surface water run-off from the proposed development will be captured by the three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, in the extremely unlikely event of an accidental spillage any hydrocarbons or other potential pollutants would pass through this system offering some level of protection to the receiving watercourses. Given the extremely low likelihood and level of protection available through the design of the drainage system significant effects are not predicted. *Habitat severance/barrier effect during operation* The clear span bridge design over the River Feale will ensure that there is no physical severance along this river corridor during operation. However, the installation of the structures on minor tributaries of the River Feale has the potential to result in a permanent barrier impact to otter using these watercourses (which given the relatively small catchments of these tributary streams, are likely to be used by the cSAC otter population); particularly during periods of high water levels when passage through drainage pipes and structures is more difficult for aquatic species. *Road Traffic Collisions* The introduction of new bridges and structures along watercourses crossed by the proposed development will increase the risk of road traffic collisions with otter. *Light Spill* Nocturnal mammals, such as the otter, are likely to be disturbed by the introduction of artificial light into established breeding and foraging areas (Rich & Longcore, 2005). Lighting is not proposed, including specifically for any of the watercourse crossings along the proposed development, and none of the potential holt locations will be affected by increased background light levels. The lighting design for the proposed development does however, include for lighting to extend for 60m from each junction. The Mill Stream Lower is the only watercourse which is used by otter that falls within the zone of influence of this lighting. As the lighting proposed will be confined to lighting the road surface and not the watercourse beneath it is not predicted that it would result in any displacement effect in relation to otter movement along that watercourse.
Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]	Some water-crowfoot occurs to the east of the proposed crossing point (*c.*70 m upstream), the principal species of which is *Ranunculus penicillatus* var. *penicillatus*. This area of habitat (given that this species is characteristic) may correspond with the Annex I habitat type "water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation" [3260]. The European Commission definition of this habitat is broad (European Commission, 2013), and despite work undertaken by Kelleher (2011), there is no agreed definition of this habitat and its sub-types in Ireland (NPWS, 2013a). Based on the *Lower River Shannon SAC Conservation Objectives Supporting Document- Watercourses of plain to montane*

Table 2	Detailed Screening Assessment in relation to the qualifying interests of the Lower River Shannon SAC [002165]
Qualifying Interests (*Priority Annex I Habitats for Conservation)	**Are any of the identified receptor-pathway-source links between the proposed development and the Natura 2000 site likely to have a significant effect on one or more of the qualifying interest habitats or species?**
	levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (National Parks and Wildlife Service, 2012), this qualifying interest habitat within the Lower River Shannon cSAC includes three high conservation element sub-types to which the area of water crowfoot east of the bridge crossing does not correspond. This habitat therefore, irrespective of its classification, does not form part of the qualifying interest for the Lower River Shannon cSAC. In any case, the habitat is located upstream of the proposed New River Feale Bridge location and consequently will not be directly impacted. However, the outfall from the constructed wetland located on the north side of the River Feale discharges to the river *c.*130m upstream of the aquatic vegetation and there is therefore a risk of indirect impacts from a reduction in water quality as a result of construction works. In the unlikely instance that a pollution event would occur of a magnitude that would have any perceptible effect on instream aquatic vegetation, given that the proposed development is within the lower reaches of the catchment, this therefore would not have far-reaching effects within the River Feale system. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are proposed to further minimise the risk of the proposed development having any perceptible effect on water quality during construction. There will be a new outfall point from the road drainage network during operation to the River Feale upstream of this area of habitat near the proposed River Feale crossing point. As described in detail above for Salmon and lamprey, the HAWRAT assessment indicates that impacts to water quality in all the receiving River Feale as a result of the operational phase is be considered to be imperceptible, due to the pollutant removal ability of the proposed drainage system. The outputs (annual average concentrations for soluble pollutants, dissolved copper and dissolved zinc) were also compared against the Environmental Quality Standards (EQS) in the *European Communities Environmental Objective (Surface Water) Regulations 2009* and in all cases levels are significantly below the annual average (AA-EQS). Based on the HAWRAT assessment and given the drainage design proposed (a three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, as described in Section 3.2.2) the operating water quality of the drainage outfall will not have any perceptible impact on water quality in the River Feale. Extreme flood events may temporarily affect the functioning of the attenuation and wetland elements of the treatment chain, but the petrol interceptor would continue to function as designed. However, given the increased dilution factor and flow rates associated with such events the predicted impact on water quality will likely be imperceptible. A risk of hydrocarbon and other dangerous substance contamination exists as a result of accidental spillage by vehicles using the proposed development during the operational phase of the proposed development. The Highways Agency (HA) considers that in "*circumstances where an outfall discharges within close proximity to (i.e. within 1 km) a protected area for conservation, or could affect important drinking water supplies or other important abstractions, a higher standard of protection will be required such that the risk of a serious pollution incident has an annual probability of less than 0.5%.*". As is demonstrated in Chapter 8 of the EIS (Section 8.2.7 (b) ii) and Appendix 8.4 of the EIS, the probability of accidental spillage occurring has been calculated as being less than 0.5% in all cases. Therefore, the likelihood of a serous pollution incident is so low that it is not deemed necessary in accordance with the Highways Agency's guidance to further reduce the risk of a serious pollution incident through additional measures. Given that all surface water run-off from the proposed development will be captured by the three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, in the extremely unlikely event of an accidental spillage any hydrocarbons or other potential pollutants would pass through this system offering some level of protection to the receiving watercourses. Given the extremely low likelihood and

Table 2	Detailed Screening Assessment in relation to the qualifying interests of the Lower River Shannon SAC [002165]
Qualifying Interests (*Priority Annex I Habitats for Conservation)	**Are any of the identified receptor-pathway-source links between the proposed development and the Natura 2000 site likely to have a significant effect on one or more of the qualifying interest habitats or species?**
	level of protection available through the design of the drainage system significant effects are not predicted.
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [6410]	The Annex I habitat *Molinia meadows on calcareous, peaty or clayey-silt-laden soils* (*Molinion caeruleae*) is not present within, or near, the boundary of the proposed development and is not known from the downstream section of the cSAC (National Parks & Wildlife Service, 2012a). As such, this habitat type will not be impacted in any way by the proposed development.
*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]	None of the habitats within the zone of influence of the proposed development corresponds with the Annex I habitat type Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*). The only area of this habitat type shown in the conservation objectives document (National Parks & Wildlife Service, 2012a,map 14) is near Toornafulla; more than 25km upstream of the proposed development. However, there may be as yet unknown areas of this habitat type at a distance downstream of the proposed development; and if present could be at risk of indirect impacts from a reduction in water quality as a result of construction works or the spread of invasive plant species. *Reduction in Water Quality* In the unlikely instance that a pollution event would occur of a magnitude that would have any perceptible effect on riparian woodland habitats, given that the proposed development is within the lower reaches of the catchment, this therefore would not have far-reaching effects within the River Feale system. Nevertheless, a precautionary approach is being taken in assuming a level of risk of water quality impacts and detailed mitigation measures are proposed to further minimise the risk of the proposed development having any perceptible effect on water quality during construction. There will be six new outfall points to surface water features from the road drainage network during operation. As described in detail above for Salmon and lamprey, the HAWRAT assessment indicates that impacts to water quality in all receiving watercourses as a result of the operational phase would be considered to be either imperceptible, or neutral to negligible, due to the pollutant removal ability of the proposed drainage system. The outputs (annual average concentrations for soluble pollutants, dissolved copper and dissolved zinc) were also compared against the Environmental Quality Standards (EQS) in the *European Communities Environmental Objective (Surface Water) Regulations 2009* and in all cases levels are significantly below the annual average (AA-EQS). Based on the HAWRAT assessment and given the drainage design proposed (a three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, as described in Section 3.2.2) the operating water quality of the drainage outfalls will not have any perceptible impact on water quality in the receiving watercourses. Extreme flood events may temporarily affect the functioning of the attenuation and wetland elements of the treatment chain, but the petrol interceptor would continue to function as designed. However, given the increased dilution factor and flow rates associated with such events the predicted impact on water quality will likely be imperceptible. A risk of hydrocarbon and other dangerous substance contamination exists as a result of accidental spillage by vehicles using the proposed development during the operational phase of the proposed development. The Highways Agency (HA) considers that in "*circumstances where an outfall discharges within close proximity to (i.e. within 1 km) a protected area for conservation, or could affect important drinking water supplies or other important abstractions, a higher standard of protection will be required such that the risk of a serious pollution incident has an annual*

Table 2	Detailed Screening Assessment in relation to the qualifying interests of the Lower River Shannon SAC [002165]
Qualifying Interests (*Priority Annex I Habitats for Conservation)	**Are any of the identified receptor-pathway-source links between the proposed development and the Natura 2000 site likely to have a significant effect on one or more of the qualifying interest habitats or species?**
	probability of less than 0.5%.". As is demonstrated in Chapter 8 of the EIS (Section 8.2.7 (b) ii) and Appendix 8.4 of the EIS, the probability of accidental spillage occurring has been calculated as being less than 0.5% in all cases. Therefore, the likelihood of a serous pollution incident is so low that it is not deemed necessary in accordance with the Highways Agency's guidance to further reduce the risk of a serious pollution incident through additional measures. Given that all surface water run-off from the proposed development will be captured by the three stage system of petrol/oil interceptor, attenuation pond and constructed wetland, in the extremely unlikely event of an accidental spillage any hydrocarbons or other potential pollutants would pass through this system offering some level of protection to the receiving watercourses. Given the extremely low likelihood and level of protection available through the design of the drainage system significant effects are not predicted. *Potential for Introducing/Spreading Invasive Plant Species* Invasive plant species are present at the crossing point of the River Feale and along some of its tributaries. Construction works in these areas will disturb soils contaminated by these plant species. Therefore, there is a risk that contaminated soils or plant material will be washed downstream to the lower reaches of the River Feale and Cashen Estuary and result in indirect impacts on the habitats there. The impact of spreading these species within the cSAC could potentially be long-term, and significant at a local level. Given the abundance of invasive plant species cover in the vicinity of the proposed development, there is a high probability that these species will recolonize the vegetated areas within the CPO fence line post-construction (particularly Japanese knotweed along the River Feale corridor and along the disused rail line embankments). As such, there is a risk that routine maintenance works may inadvertently spread contaminated vegetation cuttings to the estuary via the River Feale or other surface water features crossed by the proposed development.

4 Conclusions of Information for Appropriate Assessment Screening Process

Following an examination, analysis and evaluation of the relevant information, including in particular the nature of the proposed development and its potential relationship with European sites, as well as considering other plans and projects, it is possible to rule out significant impacts on all European sites except for the Lower River Shannon cSAC. For all other European sites there is no likelihood of any significant impacts arising.

In the case of the Lower River Shannon cSAC for which the possibility of significant impacts could not be ruled out, the only potentially significant risks (in the absence of mitigation) were identified as arising from:

- A reduction in water quality in receiving watercourses during construction which has the potential to result in significant adverse effects on Qualifying Interest aquatic habitats and species either directly, or indirectly as a result of habitat degradation.
- The potential for invasive plant species to spread to the habitats downstream during construction and operation.
- The installation of structures on minor tributaries of the River Feale which has the potential to result in permanent barrier impacts to otters using these watercourses.
- The introduction of a new road into a rural landscape, and the associated bridges and structures along watercourses crossed by the proposed development, which will increase the risk of road traffic collisions with otter.

5 Stage Two: Provision of information for an Appropriate Assessment

Within this stage of the assessment, the potential impact of the proposed development on the integrity of the Lower River Shannon cSAC is examined with respect to the site's conservation objectives and to their general structure and function.

This report also sets out the specific mitigation measures that will be in place to ensure that any potential effects of the proposed development on the site's conservation objectives will not result in any adverse effect on the integrity of this European site.

5.1 Lower River Shannon cSAC

5.1.1 Conservation objectives

- The conservation objectives for the Lower River Shannon cSAC are set out in a site specific conservation objectives document (National Parks & Wildlife Service, 2012a) and these objectives, as they relate to qualifying interests that have been assessed as being at risk of significant adverse effects from elements of the proposed development, are summarised in Table 4, Section 5.1.6.

5.1.2 Condition of site and management

The NPWS reports on the status of EU protected habitats and species in Ireland (NPWS, 20013a and 2013b) note that the conservation status of qualifying Annex I habitats within the cSAC are generally in the unfavourable-inadequate category (see Table 3 overleaf). As all the QI habitats and species at risk from the proposed development are aquatic (or strongly associated with the aquatic environment as in the case of otter) or estuarine, the primary pressures and threats are related to water quality, habitat degradation, barriers to species movement and the spread of invasive plant species.

The known threats for the Lower River Shannon cSAC (as noted in the Natura 2000 Standard Data Form) that are related to the potential risks associated with the proposed development are water pollution, derived from both domestic/industrial and agricultural sources and the spread of invasive plant species (although the Natura 2000 Standard Data Form relates this solely to the spread of *Spartina*).

5.1.3 Qualifying Interest potentially exposed to risk

The cSAC was designated for a range of habitats and species, not all of which occur within the zone of influence of any potential effects from the proposed development, and not all of which would be vulnerable to those effects. Table 3 below lists only those qualifying interests of the Lower River Shannon cSAC which fall within the zone of influence of the proposed scheme and are deemed to be potentially at risk from elements of the proposed development.

Table 3 Qualifying interests of the Lower River Shannon SAC which are potentially at risk from elements of the proposed development

Qualifying Interests and current conservation status[6] (*Priority Annex I Habitats for Conservation)	Potential impact source (note that all other possible impact sources have been ruled out as demonstrated in Table 2)
Atlantic salmon Salmo salar [1106] Sea lamprey Petromyzon marinus [1095] Brook lamprey Lampetra planeri [1096] River lamprey Lampetra fluviatilis [1099]	A reduction in water quality in receiving watercourses during construction has the potential to result in significant effects on aquatic species directly, or indirectly as a result of habitat degradation.
Freshwater pearl mussel *Margaritifera margaritifera* [1029]	A reduction in water quality in receiving watercourses during construction has the potential to result in significant indirect effects on the freshwater pearl mussel in the River Feale catchment as its host fish species may be affected. (Note that there are no freshwater pearl mussel populations present within the zone of influence of the proposed development and that the freshwater pearl mussel conservation objectives for the Lower River Shannon SAC relate specifically to the Cloon River population in County Clare to which there is no direct hydrological connection from the proposed development. The only potential risk to the species is by virtue of the fact that the larval stage of the mussel's life-cycle relies upon salmonid fish as a host species; any potential adverse effects on salmonid fish species could therefore potentially affect freshwater pearl mussel recruitment in wider the catchment.)
Estuaries [1130] Mudflats and sandflats not covered by seawater at low tide [1140] *Salicornia* and other annuals colonizing mud and sand [1310] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	A reduction in water quality in receiving watercourses during has the potential to result in significant effects on estuarine habitats. There is the potential for invasive plant species to spread to the estuarine habitats downstream during construction and operation which has the potential to result in significant effects on these estuarine habitats.
Otter *Lutra lutra* [1355]	A reduction in water quality in receiving watercourses during construction has the potential to result in significant effects on aquatic species directly, or indirectly as a result of a reduction in prey (fish species). The installation of the structures on minor tributaries of the River Feale has the potential to result in a permanent barrier impact to otter using these watercourses. The introduction of a new road into a rural landscape, and the associated bridges and structures along watercourses crossed by the proposed development, will increase the risk of road traffic collisions with otter.
Water courses of plain to montane levels with the *Ranunculion fluitantis* and	A reduction in water quality in receiving watercourses during construction has the potential to result in significant effects on aquatic habitats.

[6] Conservation status sourced from *The Status of EU Protected Habitats and Species in Ireland: Habitat Assessments, Volume 2* (NPWS, 2013a) and *The Status of EU Protected Habitats and Species in Ireland: Species Assessments, Volume 3* (NPWS, 2013b).
Favourable , Unfavourable-inadequate , Unfavourable , Unknown

Table 3	Qualifying interests of the Lower River Shannon SAC which are potentially at risk from elements of the proposed development
Qualifying Interests and current conservation status[6] (*Priority Annex I Habitats for Conservation)	Potential impact source (note that all other possible impact sources have been ruled out as demonstrated in Table 2)
Callitricho-Batrachion vegetation [3260] *Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]	There is the potential for invasive plant species to spread to riparian woodland habitats downstream during construction and operation which has the potential to result in significant effects on these aquatic habitats.

The construction of the proposed River Feale Bridge will result in the loss of 765m^2 of habitat within the cSAC boundary which is made up of 409m^2 of scrub (north bank), 68m^2 of non-Annex I woodland (which will be lost in association with the installation of the outfall to the River Feale from the attenuation pond on the north bank), and 288m^2 of improved agricultural grassland – see Figure 2. None of the habitats directly impacted by the proposed development within the boundary of the cSAC correspond with any of the Annex I habitats for which the Lower River Shannon cSAC is designated; specifically *Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*). The loss of the areas of habitat within the boundary of the cSAC does not represent an adverse effect on the integrity of the Lower River Shannon cSAC in consideration of the site's conservation objectives and qualifying interests (refer to Table 5 for detailed examination of these).

Emissions from car exhausts, and the deposition of particulate matter (PM) and heavy metals (HM) produced by engine, brake and tyre wear, can contribute to increased deposition of pollutants such as oxides of nitrogen (NO_x), particulate matter (PM) and heavy metals (HM) in the vicinity of the road carriageway. This can affect the ecosystems and vegetation present, influencing plant growth rates and species composition, diversity, and abundance.

In terms of NO_x, by 2032 it is predicted that at a distance of 10m from the road the proposed development will lead to an increase on NO_x concentration levels of at most 6.8µg/m^3, to a total concentration of 14.4 µg/m^3, which is still well below the limit value of 30 µg/m^3 for the protection of vegetation (National Roads Authority, 2011). Similarly the dry deposition rate predicted for the year 2032 at 10m from the road is predicted to be 0.35KG(N)/ha/yr, which is well below the critical load of 5 KG(N)/ha/yr defined for all habitat types in *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes* (National Roads Authority, 2011). These values drop off rapidly at increased distance from the road (Table 4).

Table 4 Air Quality Assessment of Ecosystems - proposed N69 Listowel Bypass. Assessment of Impact Along Transect from Proposed Road Through the Lower River Shannon cSAC at Islandganniv South[7]

Distance To Road (m)	NO_x Conc. (µg/m^3) - 2017			NO_x Conc. (µg/m^3) - 2032			NO_2 Dry Deposition Rate Impact (KG(N)/ha/yr)	
	Do Minimum	Do Something	Impact	Do Minimum	Do Something	Impact	2017	2032
10	12.8	17.49	4.7	7.6	14.4	6.8	0.25	0.35
20	12.8	16.35	3.6	7.6	12.7	5.1	0.19	0.27
30	12.8	15.53	2.7	7.6	11.5	3.9	0.15	0.21
40	12.8	14.92	2.1	7.6	10.7	3.1	0.12	0.16
50	12.8	14.47	1.7	7.6	10.0	2.4	0.09	0.13
60	12.8	14.11	1.3	7.6	9.5	1.9	0.07	0.10
70	12.8	13.84	1.0	7.6	9.1	1.5	0.06	0.08
80	12.8	13.61	0.8	7.6	8.8	1.2	0.04	0.06
90	12.8	13.44	0.6	7.6	8.5	0.9	0.04	0.05
100	12.8	13.30	0.5	7.6	8.3	0.7	0.03	0.04
110	12.8	13.19	0.4	7.6	8.2	0.6	0.02	0.03
120	12.8	13.10	0.3	7.6	8.0	0.4	0.02	0.02
130	12.8	13.04	0.2	7.6	7.9	0.3	0.01	0.02
140	12.8	12.99	0.2	7.6	7.9	0.3	0.01	0.01
150	12.8	12.96	0.2	7.6	7.8	0.2	0.01	0.01
160	12.8	12.95	0.1	7.6	7.8	0.2	0.01	0.01
170	12.8	12.94	0.1	7.6	7.8	0.2	0.01	0.01
180	12.8	12.92	0.1	7.6	7.8	0.2	0.01	0.01
190	12.8	12.89	0.1	7.6	7.7	0.1	0.01	0.01
200	12.8	12.9	0.1	7.6	7.7	0.1	0.00	0.01
Standards	30 µg/m^3	30 µg/m^3	-	30 µg/m^3	30 µg/m^3	-	5 – 10 (KG(N)/ha/yr)	

In terms of PM and HM, the predicted concentrations will be below the ambient air quality standards. There is likely to be some increases in soil concentrations of elements of PM and HM within the immediate vicinity of the road side that will result in some localised effects to vegetation. However, it is not predicted to result in any significant changes to species composition or diversity or to adversely effect on the integrity of the Lower River Shannon cSAC in consideration of the site's conservation objectives and qualifying interests, given the absence of any qualifying interest habitats in the immediate vicinity of the proposed development.

Dust emissions during construction are not predicted to result in any long-lasting permanent significant effects to any habitat types present within the Lower River Shannon cSAC.

5.1.4 Mitigation Measures to Ensure No Significant Effects on the Integrity of the Lower River Shannon cSAC

Measures to Minimise Habitat Loss within the cSAC

The minimum working area on the ground necessary to facilitate the construction of the intermediate pier of the proposed New River Feale Bridge, and proposed Outfall A3, will be used (2284m^2 – see Figure 2: Habitat map of the proposed crossing point of the Lower River Shannon cSAC and Figure 8: River Feale Temporary Works). This area will be clearly delineated and fenced off at the outset of works and maintained for the duration of the construction programme. No other on the ground works within the cSAC boundary will be undertaken outside of this zone.

Mitigation Measures to Reduce the Potential for Impacts to Water Quality in Receiving Watercourses

[7] Table 8.15 of the N69 Listowel Bypass Air Quality and Climate Chapter

Prior to commencement of construction, the contractor will implement the following measures through a detailed Erosion and Sediment Control Plan (dESCP) that forms part of the Environmental Operating Plan (EOP). These measures are based on the following best practice guidelines to ensure that water bodies are adequately protected during construction work:

- Construction Industry Research and Information Association CIRIA C648: Control of water pollution from linear construction projects: Technical guidance (Murnane *et al.* 2006a);
- CIRIA C649: Control of water pollution from linear construction projects: Site guide (Murnane *et al.* 2006b);
- DMRB HD33/06: Surface and sub-surface drainage systems for highways. Design Manual for Roads and Bridges. Volume 4:2, (The Highways Agency, 2006);
- Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes (National Roads Authority, 2005);
- Maintenance and Protection of the Inland Fisheries Resource during Road Construction and Improvement Works - Requirements of the Southern Regional Fisheries Board (Southern Regional Fisheries Board, 2007).

The construction contractor will implement the following mitigation measures, via the CMS, for control of sediment/silt:

- A temporary impervious barrier will be installed to ensure that all works associated with the bridge pier construction at the River Feale are protected against the 1:100 year return period flood event to ensure that there is no hydraulic connectivity between the temporary works and the River Feale during construction (see Figure 8: River Feale Temporary Works);
- Suite of measures to prevent the release of sediment over baseline conditions to the River Feale (or its tributaries) during the construction work. These measures will include but not be limited to silt fences, silt curtains, settlement lagoons, filter materials, and stockpile seeding;
- Suite of measures to minimise the release of sediment from the newly excavated attenuation and constructed wetland areas to the River Feale (or its tributaries). These measures will include but not be limited to silt fences, silt curtains, settlement lagoons, filter materials, and stockpile seeding;
- Suite of measures to minimise the displacement and subsequent erosion and release of soft sediment during bridge and structure installation works, including dewatering of excavations. These measures will include but not be limited to silt fences, silt curtains, settlement lagoons, filter materials, and stockpile seeding;
- Suite of measures to appropriately handle, store and re-use where feasible material removed from the bank of the River Feale in such a way that silt escape to watercourses is avoided or reduced to the minimum practicable;
- Provision of exclusion zones and barriers (sediment fences) between earthworks, stockpiles and temporary surfaces and watercourses to prevent sediment washing into watercourses, or into drainage features that are connected to watercourses;
- Temporary construction of surface drainage and sediment control measures will be in place before earthworks commence;
- Pouring of cement based materials for the works will be carried out in the dry and allowed to cure for 48 hours before re-flooding. Pumped concrete will be monitored to ensure no accidental discharges to watercourses, or to drainage features that are connected to watercourses. Mixer washings and excess concrete will not be discharged to any surface water or drainage features;
- No storage of hydrocarbons or any polluting chemicals will occur within 50m of a watercourse. Fuel storage tanks will be bunded to a capacity at least 110% of the volume of the storage tank. Re-fuelling of plant will not occur within 50 m of any watercourse and only in bunded refuelling areas;

- Emergency procedures and spillage kits will be available and construction staff will be familiar with emergency procedures;
- Implementation of measures to minimise waste and ensure correct handling, storage and disposal of waste (most notably wet concrete, pile arisings and asphalt);
- Response measures for potential pollution incidents;
- Methods to stabilise watercourse banks that have been cleared of vegetation;
- Maintenance of machinery to be used in-stream;
- Removal and replacement of stream bed material in diverted watercourses;

Monitoring During Construction to Reduce the Potential for Impacts to Water Quality in Receiving Watercourses

A monitoring programme will be required at the pre-construction and construction stage.

Pre-construction water quality monitoring will be undertaken once a week for a 6 month period, prior to the commencement of the construction works. Samples will be taken for total suspended solids (TSS), turbidity, pH, temperature, dissolved oxygen (DO) and hydrocarbons up and downstream of the proposed crossing points (River Feale, WF0, WF1, WF4 and WF5) to confirm the baseline water quality conditions prior to the construction. For turbidity, pH, DO and temperature samples will be taken *in situ*. Samples for suspended soilds and hydrocarbons will be sent to an accredited laboratory for analysis.

Weekly during construction the contractor will monitor the levels of TSS, turbidity, pH, temperature, DO and hydrocarbons at locations to be agreed with Kerry County Council upstream and downstream once a week for the duration of the following works:

- Site clearance works, earthworks movements and stockpiling;
- Excavations including those associated with the provision of drainage works;
- Construction of the River Feale Bridge; and
- Construction works within and adjacent to watercourses including provision of culverts and watercourse realignments.

The construction monitoring results will be compared with those results established in pre-construction monitoring. In the event of an elevation above pre-construction levels an investigation will be undertaken by the contractor and remediation measure will be put in place.

In addition, real-time telemetric monitoring will be used by the contractor to measure turbidity upstream and downstream of the River Feale Bridge. The turbidity level recorded downstream shall not exceed the upstream level by 10%. In the event of an exceedance, an investigation will be carried out to determine the cause and contact will be made with the Kerry Water Services and the Irish Water Environment Division immediately. These results will be compared by the contractor to the weekly turbidity results and reported to KCC.

In addition, daily visual inspections of the surface drainage and sediment control measures and the watercourses will be undertaken by the contractor and these inspections shall be recorded and reported to the EAO. Indicators that water pollution may have occurred include the following:

- Change in water colour;
- Change in water transparency;
- Increases in the level of silt in the water;
- Oily sheen to water surface;
- Floating detritus; or
- Scums and foams.

In the event that such indicators are observed in the River Feale and if the EAO directs works will cease, sampling will be immediately undertaken as described for the weekly monitoring and an investigation of the potential cause will be undertaken by the contractor.

Where the works are identified as the source of the exceedance the following will apply:

- Contact will be made with the Kerry Water Services and/ or Irish Water, the NPWS and IFI.
- Works capable of generating sediment into the watercourses shall be stopped immediately.
- The contractor will be required to take immediate action to implement measures to ensure that such discharges do not re-occur.

The above monitoring will alert the Contractor to any detrimental effects that particular construction activities may be having on water quality so that appropriate remedial action can be taken as quickly as possible; and allow the contractor to demonstrate the success of the mitigation measures employed in maintaining any sediment release within the trigger values established. Further requirements in relation to monitoring are outlined in the pESCP contained in Appendix 8.5 of the EIS.

Mitigation Measures to Control and Prevent the Spread of Invasive Plant Species

The mitigation strategy in relation to invasive plant species is based on the *Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads* (National Roads Authority, 2010) with the objectives of permanently removing all invasive plant species from the working area and preventing the spread of any established populations present within the boundary of the proposed development.

An Outline Invasive Species Management Plan has been prepared (refer to Appendix 6.8 of the EIS) and will be implemented sufficiently far in advance of the proposed construction works commencing so as to allow time to adequately control all invasive species populations within the zone of influence of the proposed development, having regard to the specific timing/seasonal constraints that apply in relation to each individual species. The Outline Invasive Species Management Plans will be revised and finalised by the appointed contractor once precise methods of control identified in the Outline Invasive Species Management Plan are determined. The final Invasive Species Management Plan will assist the construction contractor in implementing the specific mitigation measures required in relation to individual invasive plant species.

As species may spread, or their distribution change, between the habitat surveys carried out for this NIS and the commencement of construction works, the implementation of the final Invasive Species Management Plan will include a pre-construction re-survey within the CPO boundary. In accordance with the NRA guidance (NRA, 2010) this survey will include accurate 1:5,000 scale mapping for the precise location of invasive species. The pre-construction surveys will be undertaken by suitable experts with competence in identifying the species concerned.

Measures to Protect Otter

Otters use many of the watercourses crossed by the road development. To avoid otter road casualties, otter passage facilities (raised ledges within structures or separate dry 600mm pipes) will be provided at watercourses used by otter. Underpasses will be constructed in accordance with the Wildlife Fencing Design Guide (CIRIA No. 646). The locations where otter passage facilities will be provided are shown on the ecology mitigation measures drawings (Figures 6.19-6.23: Ecology Mitigation Measures).

Otter-resistant fencing will be required to guide otters to the underpasses and will be installed in accordance with the specification outlined in the NRA guidance (National Roads Authority, 2008) and at the request of the NPWS will include the 45-degree overhang specified by the UK Highways Agency, (2001).

In accordance with the recommendations described in the *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes* (National Roads Authority, 2008), quarterly monitoring of the effectiveness of the mitigation measures will be undertaken in the first year after the completion of construction works.

Mitigation Measures to Minimise the Effects of Flow Restriction across the Floodplain during Extreme Flood Events (1% plus climate change)

Flood relief culverts have been included in the road embankments leading up to the proposed River Feale Bridge to minimise the obstruction to floodplain flow and water levels in localised areas (Figures 4.1-4.5: Overall Scheme Plan).

5.1.5 In-combination effects of the Proposed Development with other Potential Sources.

The potential impact sources which pose a risk to the qualifying interests of the Lower River Shannon cSAC have been identified, as follows (see also Table 3): a reduction in water quality in receiving watercourses during construction; the potential for invasive plant species to spread to the estuarine habitats downstream during construction and operation; installation of the structures on tributaries of the River Feale has the potential to result in a permanent barrier impact to otter using these watercourses; increased risk of road traffic collisions with Otter.

Given the mitigation measures detailed in Section 5.1.4 of this report, it is unlikely that any of the identified potential impact sources would result in any adverse effects on the integrity of the Lower River Shannon cSAC and therefore, it is not predicted to result in any significant "in-combination" effects with any other plans or projects.

5.1.6 Potential risk to Conservation Objectives resulting from the Proposed Development

Tables 2 and 3 set out the potential risks to the qualifying interests of the Lower River Shannon cSAC and identify those qualifying interests likely to be at risk; Section 5.1.4 of this report then sets out the mitigation measures that will be implemented to ensure that the proposed development will not result in any significant effects on those qualifying interests. Table 5 below, presents the assessment of whether, with the mitigation measures proposed, the proposed development would affect the specific conservation attributes and targets set out for each of the qualifying interests deemed to be potentially at risk from the proposed development.

Table 5 **Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development**

1029 Freshwater pearl mussel *Margaritifera margaritifera*

To restore the favourable conservation condition of freshwater pearl mussel in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:
** note that this conservation objective applies to the Freshwater pearl mussel population in the Cloon River, Co. Clare only*

Attribute	Measure	Target	Is the proposed development likely to affect the conservation target?
Distribution	Kilometres	Maintain at 7km.	No, as these targets relate specifically to a catchment that is hydrologically isolated from the proposed development. Even if these targets were to be attributed to the River Feale catchment, there are no populations within the direct zone of influence of the proposed development that could be affected. Since there are not likely to be any significant effects on water quality or host fish species there is no risk to any populations upstream in the catchment and there are no predicted impacts on these targets.
Population size	Number of adult mussels	Restore to 10,000 adult mussels	
Population structure: recruitment	Percentage per size class	Restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length	
Population structure: adult mortality	Percentage	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution	
Habitat extent	Kilometres	Restore suitable habitat in more than 3.3km (see map 15) and any additional stretches necessary for salmonid spawning	
Water quality: macroinvertebrate and phytobenthos (diatoms)	Ecological quality ratio (EQR)	Restore water quality - macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93	
Substratum quality: filamentous algae	Percentage	Restore substratum quality - filamentous algae: absent	

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
(macroalgae), macrophytes (rooted higher plants)		or trace (<5%); macrophytes: absent or trace (<5%)	
Substratum quality: sediment	Occurrence	Restore substratum quality - stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	
Substratum quality: oxygen availability	Redox potential	Restore to no more than 20% decline from water column to 5cm depth in substrate	
Hydrological regime: flow variability	Metres per second	Restore appropriate hydrological regimes	
Host fish	Number	Maintain sufficient juvenile salmonids to host glochidial larvae	
1095 Sea lamprey Petromyzon marinus			
To restore the favourable conservation condition of sea lamprey in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Distribution: extent of anadromy	% of river accessible	Greater than 75% of main stem length of rivers accessible from estuary	Since the proposed development will not result in any barrier effect on watercourses, there is no predicted impact on this target.
Population structure of juveniles	Number of age/size groups	At least three age/size groups present	Since the proposed development will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target
Juvenile density in fine sediment	Juveniles/m²	Juvenile density at least 1/m²	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Extent and distribution of spawning habitat	m² and occurrence	No decline in extent and distribution of spawning beds	Since the proposed development will not impact on the river substrate within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Availability of juvenile habitat	Number of positive sites in 3rd order channels (and greater), downstream	More than 50% of sample sites positive	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
	of spawning areas		
1096 Brook lamprey *Lampetra planeri*			
To restore the favourable conservation condition of brook lamprey in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Distribution	% of river accessible	Access to all water courses down to first order streams	Since the proposed development will not result in any barrier effect on watercourses, there is no predicted impact on this target.
Population structure of juveniles	Number of age/size groups	At least three age/size groups of brook/river lamprey present	Since the proposed development will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Juvenile density in fine sediment	Juveniles/m²	Mean catchment juvenile density of brook/river lamprey at least 2/m²	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Extent and distribution of spawning habitat	m² and occurrence	No decline in extent and distribution of spawning beds	Since the proposed development will not impact on the river substrate within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Availability of juvenile habitat	Number of positive sites in 2nd order channels (and greater), downstream of spawning areas	More than 50% of sample sites positive	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
1096 River lamprey *Lampetra fluviatilis*			
To restore the favourable conservation condition of river lamprey in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Distribution	% of river accessible	Access to all watercourses down to first order streams	Since the proposed development will not result in any barrier effect on watercourses, there is no predicted impact on this target.
Population structure of juveniles	Number of age/size groups	At least three age/size groups of river/brook lamprey present	Since the proposed development will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Juvenile density in fine sediment	Juveniles/m²	Mean catchment juvenile density of brook/river lamprey at least 2/m²	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Extent and	m² and	No decline in extent and distribution	Since the proposed development will not impact

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
distribution of spawning habitat	occurrence	of spawning beds	on the river substrate within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Availability of juvenile habitat	Number of positive sites in 2nd order channels (and greater), downstream of spawning areas	More than 50% of sample sites positive	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
1106 Atlantic salmon *Salmo salar* (only in fresh water)			
To restore the favourable conservation condition of salmon in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Distribution: extent of anadromy	% of river accessible	100% of river channels down to second order accessible from estuary	Since the proposed development will not result in any barrier effect on watercourses, there is no predicted impact on this target.
Adult spawning fish	Number	Conservation Limit (CL) for each system consistently exceeded	Since the proposed development will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Salmon fry abundance	Number of fry/5 minutes electrofishing	Maintain or exceed 0+ fry mean catchment - wide abundance threshold value. Currently set at 17 salmon fry/5 min sampling	Since the proposed development will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Out - migrating smolt abundance	Number	No significant decline	Since the proposed development will not result in any barrier effect on watercourses and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Number and distribution of redds	Number and occurrence	No decline in number and distribution of spawning redds due to anthropogenic causes	Since the proposed development will not impact on any such habitat within the cSAC and will not significantly affect water quality or result in any aquatic habitat degradation, there is no predicted impact on this target.
Water quality	EPA Q value	At least Q4 at all sites sampled by EPA	Since the proposed development will not significantly affect water quality in receiving watercourses, there is no predicted impact on this target.
1130 Estuaries			
To restore the favourable conservation condition of estuaries in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Hectares	The permanent habitat area is stable or increasing, subject to natural processes.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
			plant species, there is no predicted impact on this target.
Community distribution	Hectares	Conserve the following community types in a natural condition: Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex; Estuarine subtidal muddy sand to mixed sediment with gammarids community complex; Subtidal sand to mixed sediment with *Nucula nucleus* community complex; Subtidal sand to mixed sediment with *Nephtys spp*. community complex; Fucoid - dominated intertidal reef community complex; Faunal turf - dominated subtidal reef community; and Anemone - dominated subtidal reef community.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
1140 Mudflats and sandflats not covered by seawater at low tide			
To restore the favourable conservation condition of mudflats and sandflats not covered by seawater at low tide in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Hectares	The permanent habitat area is stable or increasing, subject to natural processes.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Community distribution	Hectares	Conserve the following community types in a natural condition: Intertidal sand with *Scolelepis squamata* and *Pontocrates spp*. community; and Intertidal sand to mixed sediment with polychaetes, molluscs and crustaceans community complex.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
1310 *Salicornia* and other annuals colonizing mud and sand			
To restore the favourable conservation condition of *Salicornia* and other annuals colonizing mud and sand in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Habitat area	Area stable or increasing, subject to natural processes, including erosion and succession.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Habitat distribution	Occurrence	No decline, or change in habitat distribution, subject to natural processes.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.

Table 5 Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development

Physical structure: sediment supply	Presence/ absence of physical barriers	Maintain natural circulation of sediments and organic matter, without any physical obstructions	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Physical structure: creeks and pans	Occurrence	Maintain/restore creek and pan structure, subject to natural processes, including erosion and succession	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Physical structure: flooding regime	Hectares flooded; frequency	Maintain natural tidal regime	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Vegetation structure: zonation	Occurrence	Maintain the range of coastal habitats including transitional zones, subject to natural processes including erosion and succession	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation height	Centimetres	Maintain structural variation within sward	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation cover	Percentage cover at a representative sample of monitoring stops	Maintain more than 90% of area outside creeks vegetated	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation composition: typical species and sub - communities	Percentage cover	Maintain the presence of species - poor communities with typical species listed in Saltmarsh Monitoring Project (McCorry and Ryle, 2009)	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: negative indicator species - Spartina anglica	Hectares	No significant expansion of common cordgrass (*Spartina anglica*), with an annual spread of less than 1%	Since the proposed development will not result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)			
To restore the favourable conservation condition of Atlantic salt meadows (*Glauco - Puccinellietalia maritimae*) in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Hectares	Area stable or increasing, subject to natural processes, including erosion and succession.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target,
Habitat distribution	Occurrence	No decline or change in habitat distribution, subject to natural processes.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Physical structure:	Presence/	Maintain natural circulation of	Since the proposed development will not have

Table 5 Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development

sediment supply	absence of physical barriers	sediments and organic matter, without any physical obstructions	any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Physical structure: creeks and pans	Occurrence	Maintain creek and pan structure, subject to natural processes, including erosion and succession	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Physical structure: flooding regime	Hectares flooded; frequency	Maintain natural tidal regime	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Vegetation structure: zonation	Occurrence	Maintain the range of coastal habitats including transitional zones, subject to natural processes including erosion and succession	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation height	Centimetres	Maintain structural variation within sward	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation cover	Percentage cover at a representative sample of monitoring stops	Maintain more than 90% of the saltmarsh area vegetated	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation composition: typical species and sub - communities	Percentage cover at a representative sample of monitoring stops	Maintain range of sub - communities with typical species listed in Saltmarsh Monitoring Project (McCorry and Ryle, 2009)	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: negative indicator species - Spartina anglica	Hectares	No significant expansion of common cordgrass (*Spartina anglica*), with an annual spread of less than 1%	Since the proposed development will not result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
1410 Mediterranean salt meadows (*Juncetalia maritimi*)			
To restore the favourable conservation condition of Mediterranean salt meadows (*Juncetalia maritimi*) in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Hectares	Area increasing, subject to natural processes, including erosion and succession.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Habitat distribution	Occurrence	No decline, or change in habitat distribution, subject to natural processes.	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Physical structure: sediment supply	Presence/ absence of	Maintain natural circulation of sediments and organic matter,	Since the proposed development will not have any influence on the hydrological regime of the

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
	physical barriers	without any physical obstructions	estuary, there is no predicted impact on this target.
Physical structure: creeks and pans	Occurrence	Maintain creek and pan structure, subject to natural processes, including erosion and succession	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Physical structure: flooding regime	Hectares flooded; frequency	Maintain natural tidal regime	Since the proposed development will not have any influence on the hydrological regime of the estuary, there is no predicted impact on this target.
Vegetation structure: zonation	Occurrence	Maintain the range of coastal habitats including transitional zones, subject to natural processes including erosion and succession	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation height	Centimetres	Maintain structural variation within sward	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: vegetation cover	Percentage cover at a representative sample of monitoring stops	Maintain more than 90% of area outside creeks vegetated	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation composition: typical species	Percentage cover	Maintain range of sub - communities with typical species listed in Saltmarsh Monitoring Project (McCorry and Ryle, 2009)	Since the proposed development will not significantly affect water quality or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation structure: negative indicator species - Spartina anglica	Hectares	No significant expansion of common cordgrass (Spartina anglica), with an annual spread of less than 1%	Since the proposed development will not result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
1355 Otter *Lutra lutra*			
To restore the favourable conservation condition of Otter *Lutra lutra* in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Distribution	Percentage positive survey sites	No significant decline	Since the proposed development will not result in any significant habitat loss, disturbance, displacement, barrier effects or mortalities (*i.e.* provision of otter passage facilities at watercourses used by otter and otte-resistant fencing), there is no predicted impact on this target.
Extent of terrestrial habitat	Hectares	No significant decline. Area mapped and calculated as 596.8ha above high water mark (HWM); 958.9ha along river banks/ around ponds	Since the proposed development will not result in any significant loss, or degradation, of any terrestrial otter habitat within the cSAC, there is no predicted impact on this target.
Extent of marine	Hectares	No significant decline. Area	Since the proposed development will not result

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
habitat		mapped and calculated as 4,461.6ha	in the loss of any marine habitat within the cSAC, there is no predicted impact on this target.
Extent of freshwater (river) habitat	Kilometres	No significant decline. Length mapped and calculated as 500.1km	Since the proposed development will not result in any loss, or degradation, of any freshwater river habitat within the cSAC, there is no predicted impact on this target.
Extent of freshwater (lake/lagoon) habitat	Hectares	No significant decline. Area mapped and calculated as 125.6ha	Since the proposed development will not result in the loss of any lake/lagoon habitat within the cSAC, there is no predicted impact on this target.
Couching sites and holts	Number	No significant decline	Since the proposed development will not result in the loss of any confirmed holt/couch sites, there is no predicted impact on this target.
Fish biomass available	Kilograms	No significant decline	Since the proposed development will not result in any significant impacts to fish species, there is no predicted impact on this target.
Barriers to connectivity	Number	No significant increase.	Since the proposed development will not result in any barrier effect on watercourses (*i.e.* provision of otter passage facilities at watercourses used by otter), there is no predicted impact on this target.
3260 Water courses of plain to montane levels with the Ranunculion fluitantis and *Callitricho - Batrachion* vegetation			
To restore the favourable conservation condition of Water courses of plain to montane levels with the Ranunculion fluitantis and *Callitricho - Batrachion* vegetation in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Is the proposed development likely to affect the conservation target?**
Habitat area	Kilometres	Area stable or increasing, subject to natural processes	Since the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any aquatic habitat degradation, there is no predicted impact on this target.
Habitat distribution	Occurrence	No decline, subject to natural processes	Since the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any aquatic habitat degradation, there is no predicted impact on this target.
Hydrological regime: river flow	Metres per second	Maintain appropriate hydrological regimes	Since the proposed development will not have any significant influence on the hydrological regime of the River Feale, there is no predicted impact on this target.
Hydrological regime: tidal influence	Daily water level fluctuations - metres	Maintain natural tidal regime	Since the proposed development will not have any significant influence on the hydrological regime of the River Feale, there is no predicted impact on this target.
Hydrological regime: freshwater seepages	Metres per second	Maintain appropriate freshwater seepage regimes	Since the proposed development will not have any significant influence on the hydrological regime of the River Feale, there is no predicted impact on this target.
Substratum composition: particle size range	Millimetres	The substratum should be dominated by the particle size ranges, appropriate to the habitat sub - type (frequently	Since the proposed development will not have any significant influence on the hydrological regime of the River Feale, or result in any aquatic habitat degradation, there is no predicted

Table 5 Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development

		sands, gravels and cobbles)	impact on this target.
Water quality: nutrients	Milligrams per litre	The concentration of nutrients in the water column should be sufficiently low to prevent changes in species composition or habitat condition	Since the proposed development will not significantly affect water quality in receiving watercourses, result in any aquatic habitat degradation, there is no predicted impact on this target.
Vegetation composition: typical species	Occurrence	Typical species of the relevant habitat sub - type should be present and in good condition	Since the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any aquatic habitat degradation, there is no predicted impact on this target.
Floodplain connectivity	Area	The area of active floodplain at and upstream of the habitat should be maintained	Since the proposed development will not significantly affect the functioning of the floodplain, reduce the area of active floodplain at or upstream of the habitat, and flood relief culverts are proposed to minimise the effect of the 1% plus climate change flood event, there is no predicted impact on this target.
Riparian habitat	Area	The area of riparian woodland at and upstream of the bryophyte - rich sub - type should be maintained	Since there will be no riparian woodland removed from the vicinity of this habitat type upstream of the proposed development, there is no predicted impact on this target.
91E0 *Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)			
To restore the favourable conservation condition of Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) in the Lower River Shannon cSAC, which is defined by the following list of attributes and targets:			
Attribute	**Measure**	**Target**	**Notes**
Habitat area	Hectares	Area stable or increasing, subject to natural processes, at least c.8.5ha for sites surveyed. See map 14	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Habitat distribution	Occurrence	No decline. Surveyed locations shown on map 14	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland size	Hectares	Area stable or increasing. Where topographically possible, "large" woods at least 25ha in size and "small" woods at least 3ha in size	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland structure: cover and height	Percentage and metres	Diverse structure with a relatively closed canopy containing mature trees; sub canopy layer with semi - mature trees and	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any

Table 5 Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development

		shrubs; and well - developed herb layer	habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland structure: community diversity and extent	Hectares	Maintain diversity and extent of community types	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland structure: natural regeneration	Seedling: sapling: pole ratio	Seedlings, saplings and pole age - classes occur in adequate proportions to ensure survival of woodland canopy	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Hydrological regime: flooding depth/height of water table	Metres	Appropriate hydrological regime necessary for maintenance of alluvial vegetation	Since the proposed development will not have any significant influence on the hydrological regime of the River Feale, there is no predicted impact on this target.
Woodland structure: dead wood	m^3 per hectare; number per hectare	At least $30m^3$/ha of fallen timber greater than 10cm diameter; 30 snags/ha; both categories should include stems greater than 40cm diameter (greater than 20cm diameter in the case of alder)	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland structure: veteran trees	Number per hectare	No decline	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Woodland structure: indicators of local distinctiveness	Occurrence	No decline	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation composition: native tree cover	Percentage	No decline. Native tree cover not less than 95%	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.

Table 5	Site specific conservation objectives of the Qualifying Interests of the Lower River Shannon cSAC which are potentially at risk from elements of the proposed development		
Vegetation composition: typical species	Occurrence	A variety of typical native species present, depending on woodland type, including alder (*Alnus glutinosa*), willows (*Salix spp.*) and, locally, oak (*Quercus robur*) and ash (*Fraxinus excelsior*)	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.
Vegetation composition: negative indicator species	Occurrence	Negative indicator species, particularly non - native invasive species, absent or under control	Since there are no records of this habitat type within the zone of influence of the proposed development and the proposed development will not significantly affect water quality, the existing hydrological regime, or result in any habitat degradation from the spread of invasive plant species, there is no predicted impact on this target.

6 Conclusions of Information Provided for the Appropriate Assessment Process

In order to align with case law clarifying the application of the Habitats Directive and Part XAB of the Planning and Development Act 2000, an AA undertaken by the competent authority should include an examination, analysis, evaluation, findings, conclusions and a final determination. Information to enable the competent authority to perform its statutory function in this regard is presented within this report.

Following an examination, analysis and evaluation of the relevant information including, in particular, the nature of the proposed development and the potential relationship between the proposed development and relevant European sites and, applying the precautionary principle, it is the professional opinion of the authors of this report that there will be no adverse impact on the integrity of any European sites.

In the case of the only relevant European Site, the Lower River Shannon cSAC, the potentially significant impacts (in the absence of mitigation) arise from water quality, the spread of invasive plant species, installation of watercourse structures and the risk of road traffic collisions with wildlife. This report has identified the potential effects these elements could have on the qualifying interests of the Lower River Shannon cSAC and their conservation objectives, in the absence of mitigation. However, with the full implementation of the mitigation measures outlined in Section 5.1.4 of this report, these risks will be avoided or reduced such that there will be no significant affects on habitats or species that are listed as qualifying interests, nor the attainment of their specific conservation objectives, either alone or in-combination with other plans or projects.

Accordingly, in the professional opinion of the authors of this report, whilst it has been acknowledged that there is the potential in the absence of mitigation for the proposed development to have significant direct or indirect impacts on the Lower River Shannon cSAC, with the implementation of the detailed mitigation measures identified in this report, the integrity of this European site will not be adversely affected.

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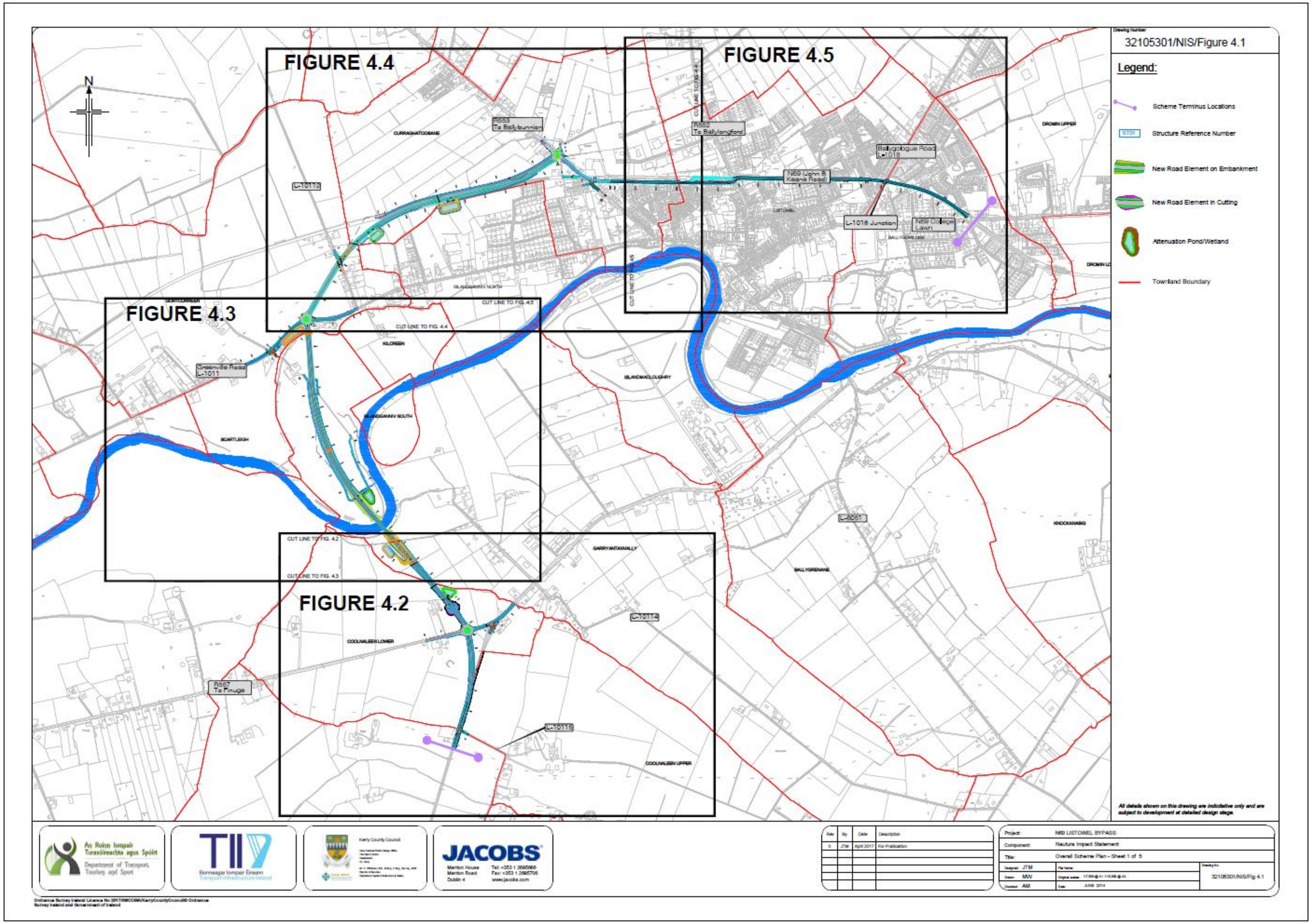
Figures

Figures 4.1 - 4.5: Overall Scheme Plan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Scheme Terminus Locations
Structure Reference Number
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Townland Boundary
FIGURE 4.4
FIGURE 4.5
FIGURE 4.3
FIGURE 4.2
R553 To Ballybunnion
R552 To Ballylongford
Ballygologue Road L-1018
N69 (John B Keane Road)
L-1018 Junction
N69 College Lawn
L-1011
Greenville Road L-1011
L-6051
L-1011
R557 To Finuge
L-1011
CURRAGHATOOSANE
DROMIN UPPER
LISTOWEL
KILCREEN
ISLANDGANNIV NORTH
ISLANDGANNIV SOUTH
ISLANDMACLOUGHRY
SCARTLEIGH
GARRYANTANVALLY
BALLYGRENANE
KNOCKANASIG
COOLNALEEN LOWER
COOLNALEEN UPPER
CUT LINE TO FIG. 4.3
CUT LINE TO FIG. 4.4
CUT LINE TO FIG. 4.2
CUT LINE TO FIG. 4.5
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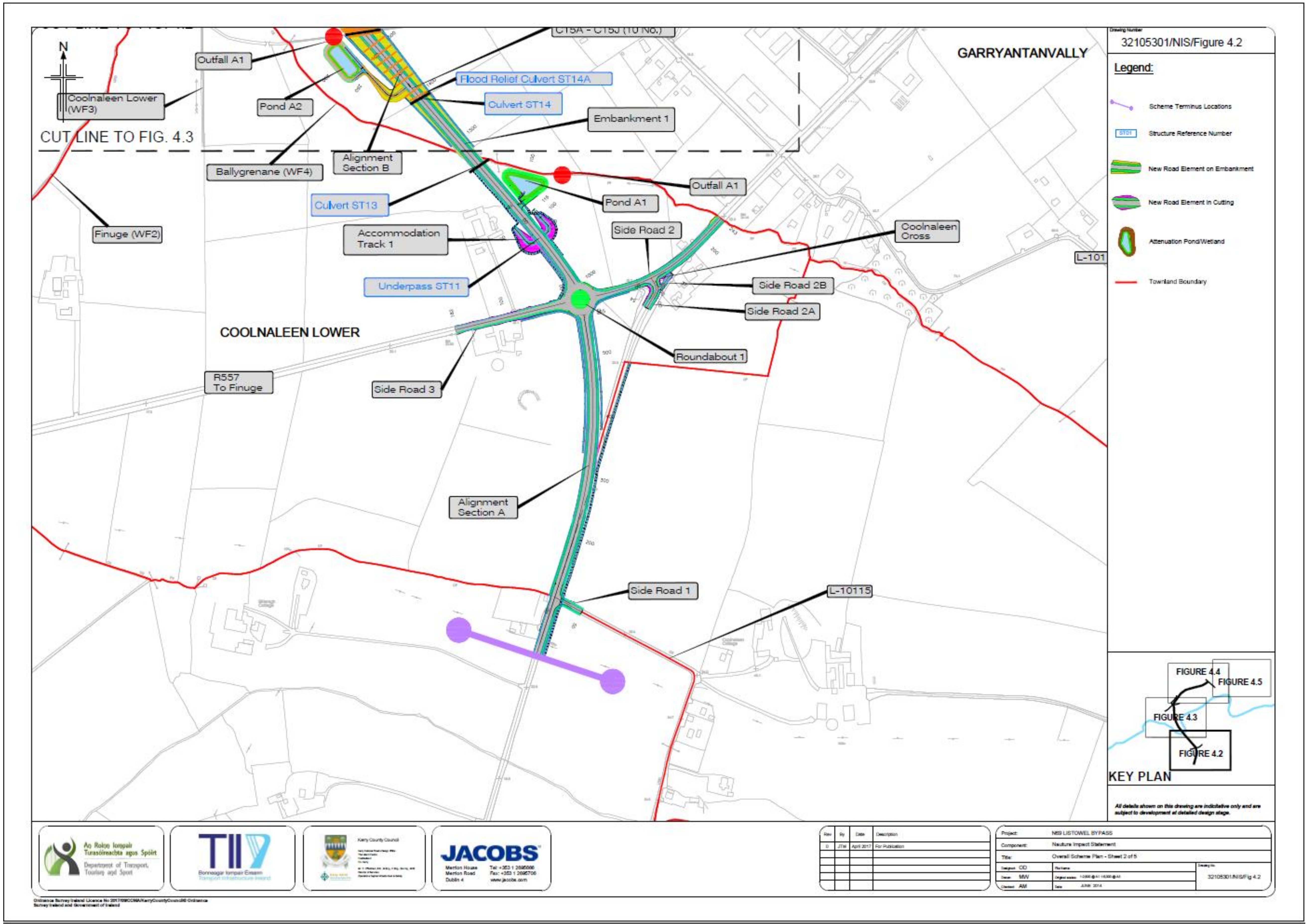
32105301/NIS/Fig 4.1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Structure Reference Number
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Townland Boundary
N
GARRYANTANVALLY
COOLNALEEN LOWER
CUT LINE TO FIG. 4.3
C15A - C15J (10 No.)
Outfall A1
Coolnaleen Lower (WF3)
Pond A2
Flood Relief Culvert ST14A
Culvert ST14
Embankment 1
Alignment Section B
Ballygrenane (WF4)
Outfall A1
Pond A1
Culvert ST13
Finuge (WF2)
Accommodation Track 1
Side Road 2
Coolnaleen Cross
L-101
Underpass ST11
Side Road 2B
Side Road 2A
Roundabout 1
R557 To Finuge
Side Road 3
Alignment Section A
Side Road 1
L-10115
FIGURE 4.4
FIGURE 4.5
FIGURE 4.3
FIGURE 4.2
KEY PLAN
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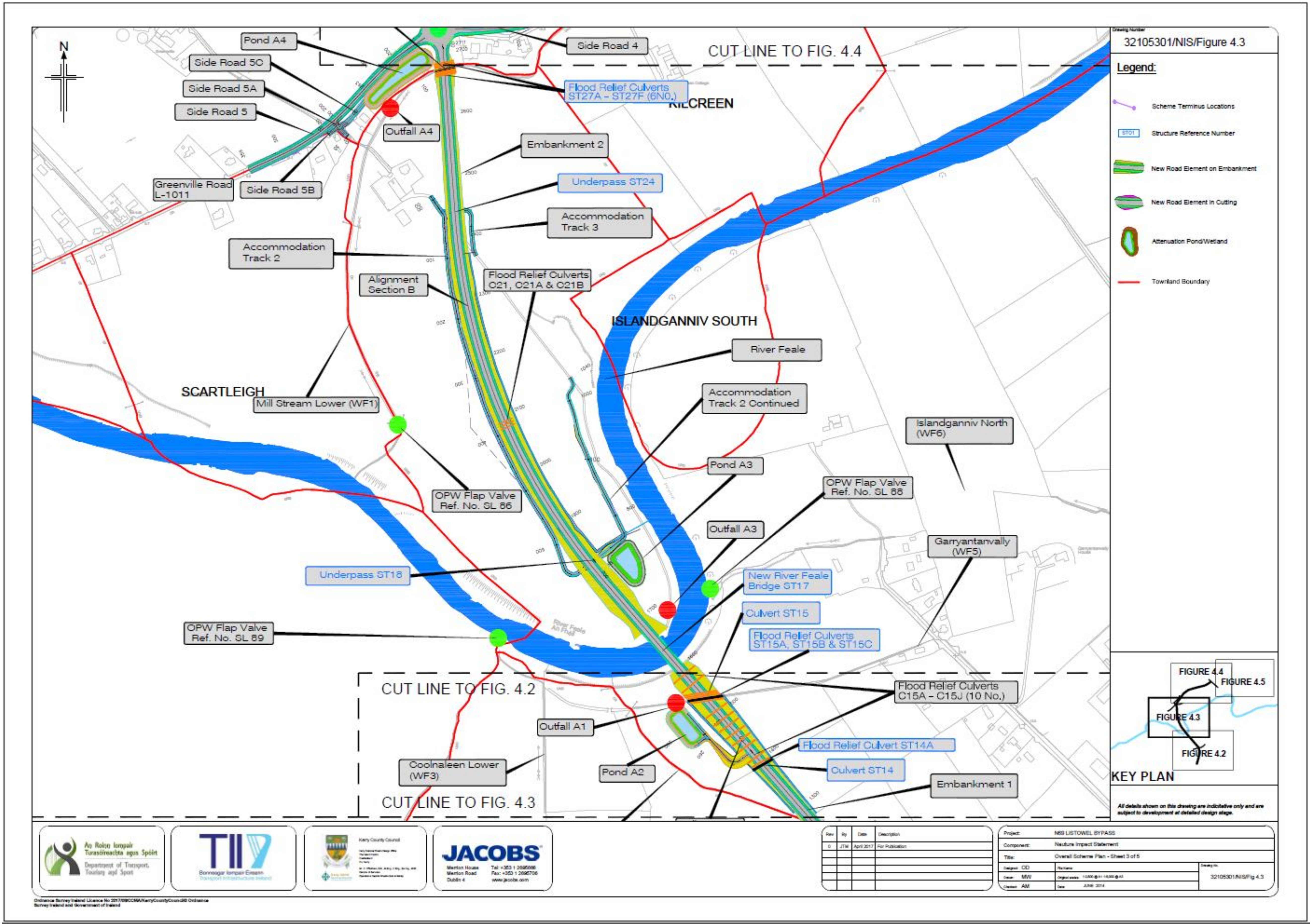
Overall Scheme Plan - Sheet 2 of 5
32105301/NIS/Fig 4.2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New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Townland Boundary
CUT LINE TO FIG. 4.4
CUT LINE TO FIG. 4.2
CUT LINE TO FIG. 4.3
Pond A4
Side Road 5C
Side Road 5A
Side Road 5
Side Road 4
Flood Relief Culverts ST27A - ST27F (6NO.)
KILCREEN
Outfall A4
Embankment 2
Underpass ST24
Greenville Road L-1011
Side Road 5B
Accommodation Track 3
Accommodation Track 2
Alignment Section B
Flood Relief Culverts C21, C21A & C21B
ISLANDGANNIV SOUTH
River Feale
SCARTLEIGH
Mill Stream Lower (WF1)
Accommodation Track 2 Continued
Islandganniv North (WF6)
Pond A3
OPW Flap Valve Ref. No. SL 88
OPW Flap Valve Ref. No. SL 86
Outfall A3
Garryantanvally (WF5)
Underpass ST18
New River Feale Bridge ST17
Culvert ST15
OPW Flap Valve Ref. No. SL 89
Flood Relief Culverts ST15A, ST15B & ST15C
Flood Relief Culverts C15A - C15J (10 No.)
Outfall A1
Coolnaleen Lower (WF3)
Pond A2
Flood Relief Culvert ST14A
Culvert ST14
Embankment 1
FIGURE 4.4
FIGURE 4.5
FIGURE 4.3
FIGURE 4.2
KEY PLAN
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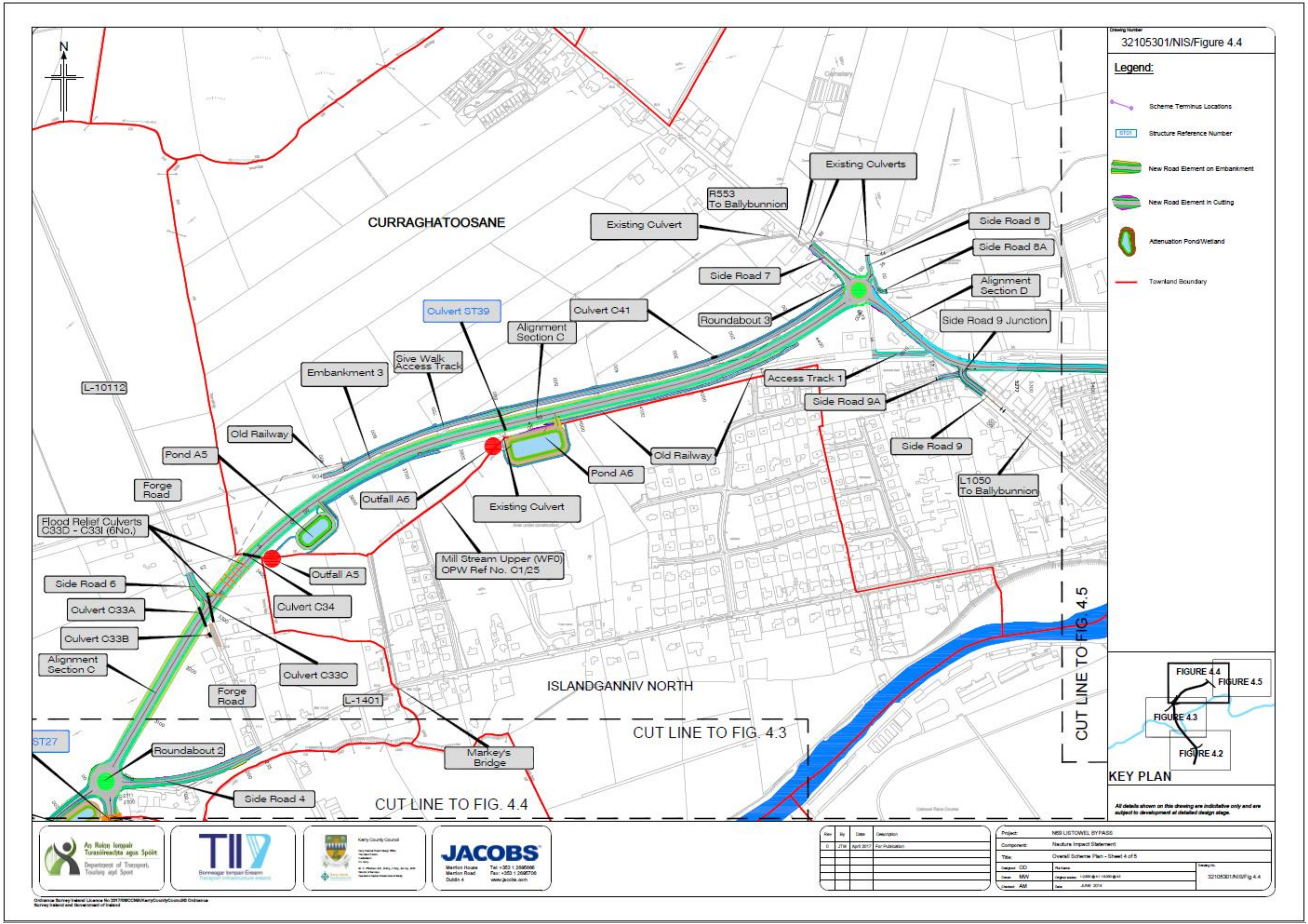
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New Road Element in Cutting
Attenuation Pond/Wetland
Townland Boundary
CURRAGHATOOSANE
ISLANDGANNIV NORTH
Existing Culverts
R553 To Ballybunnion
Existing Culvert
Side Road 8
Side Road 8A
Side Road 7
Alignment Section D
Culvert C41
Roundabout 3
Side Road 9 Junction
Culvert ST39
Alignment Section C
Sive Walk Access Track
Embankment 3
Access Track 1
Side Road 9A
L-10112
Old Railway
Side Road 9
Pond A5
Pond A6
L1050 To Ballybunnion
Forge Road
Outfall A6
Existing Culvert
Flood Relief Culverts C33D - C33I (6No.)
Mill Stream Upper (WF0) OPW Ref No. C1/25
Outfall A5
Side Road 6
Culvert C34
Culvert C33A
Culvert C33B
Alignment Section C
Culvert C33C
Forge Road
L-1401
CUT LINE TO FIG. 4.3
CUT LINE TO FIG. 4.5
ST27
Roundabout 2
Markey's Bridge
Side Road 4
CUT LINE TO FIG. 4.4
FIGURE 4.4
FIGURE 4.5
FIGURE 4.3
FIGURE 4.2
KEY PLAN
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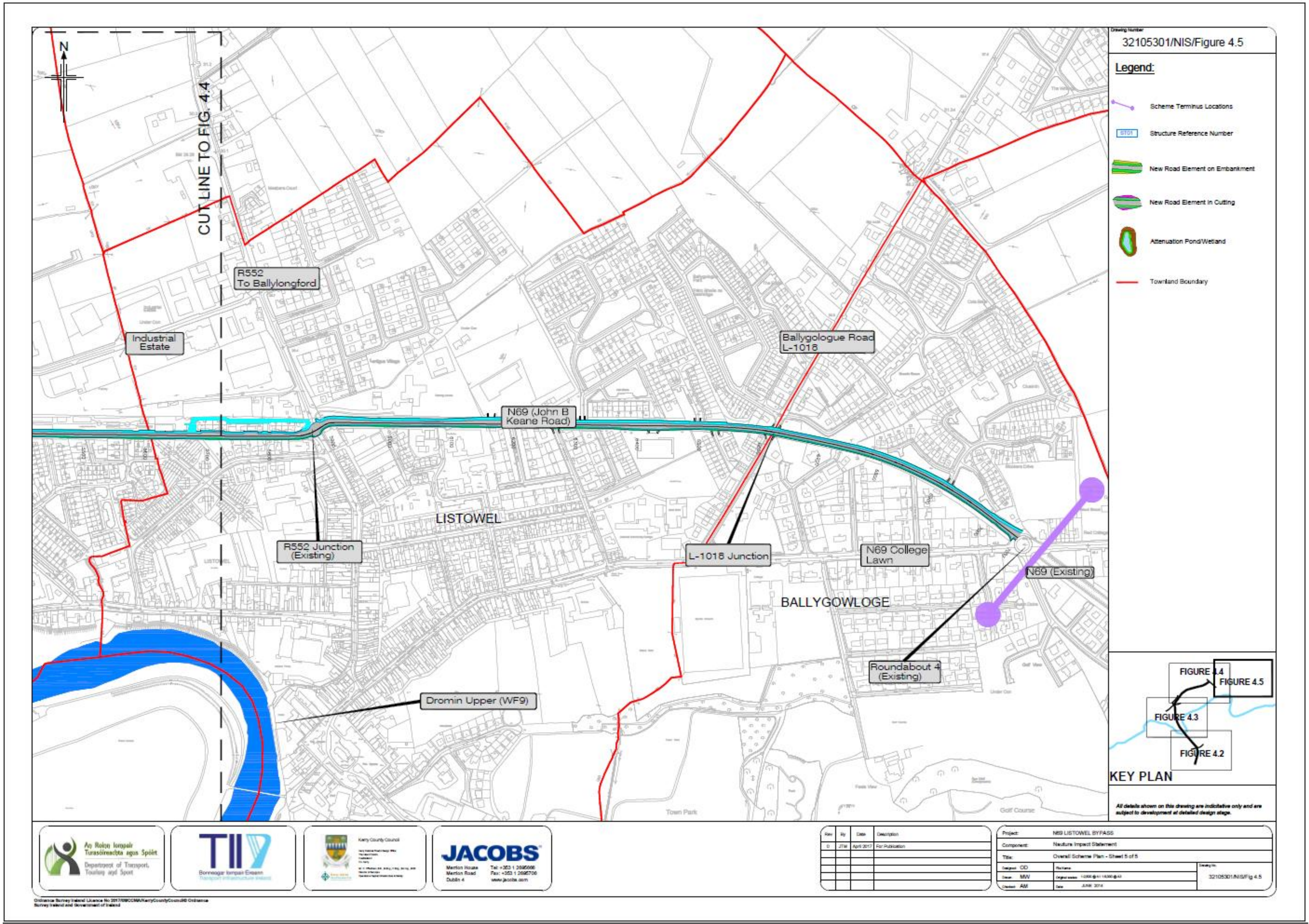

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Legend:
Scheme Terminus Locations
Structure Reference Number
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Townland Boundary
N
CUT LINE TO FIG. 4.4
R552 To Ballylongford
Industrial Estate
N69 (John B Keane Road)
Ballygologue Road L-1016
LISTOWEL
R552 Junction (Existing)
L-1016 Junction
N69 College Lawn
N69 (Existing)
BALLYGOWLOGE
Roundabout 4 (Existing)
Dromin Upper (WF9)
Town Park
Golf Course
FIGURE 4.4
FIGURE 4.5
FIGURE 4.3
FIGURE 4.2
KEY PLAN
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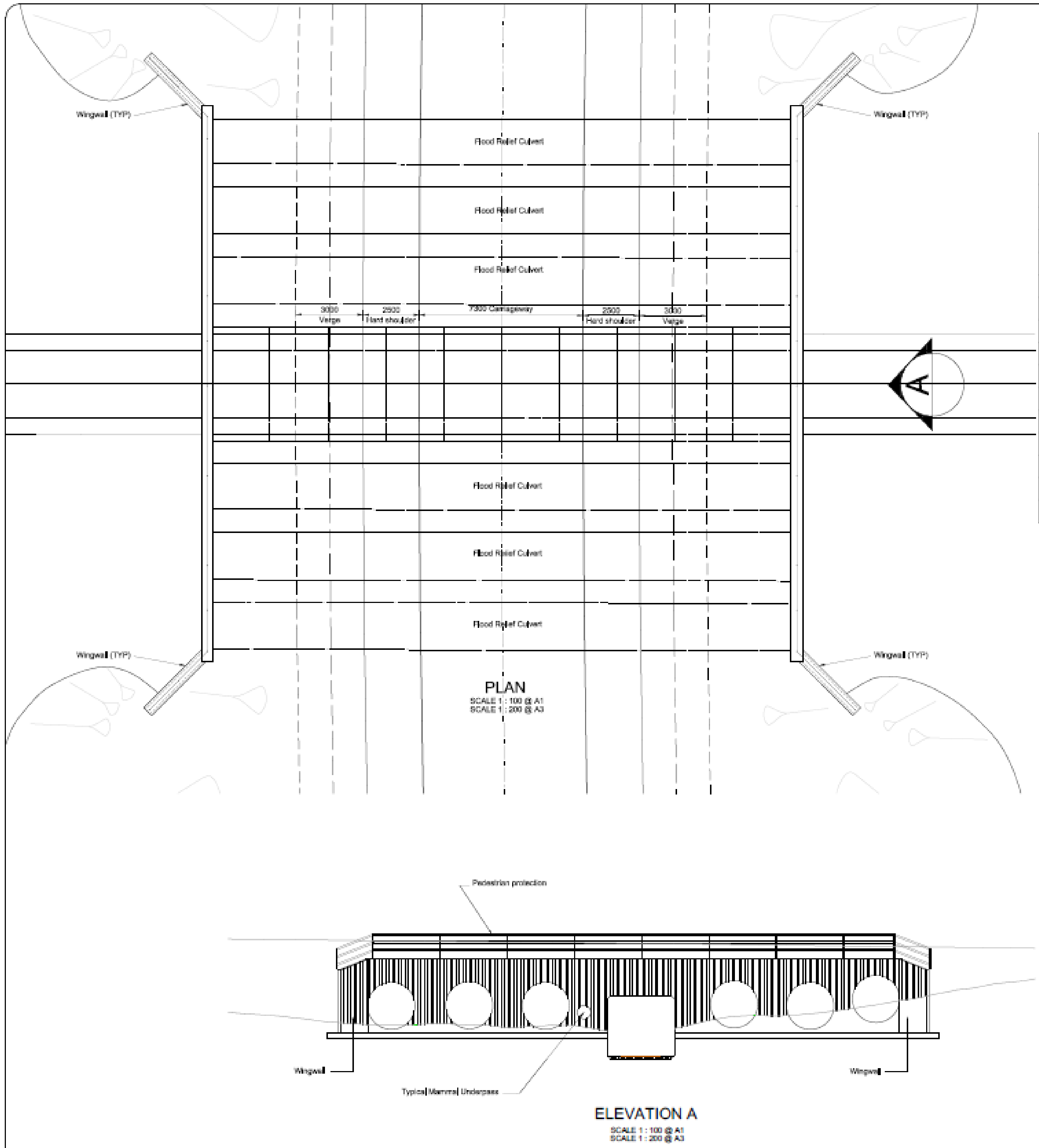
Component: Natura Impact Statement
Title: Overall Scheme Plan - Sheet 5 of 5
Designed: OD
Drawn: MW
Checked: AM
Date: JUNE 2014
32105301/NIS/Fig 4.5

Figure 5: Culvert Typical Design

32105301/NIS/Figure 5



Crossing	Structure Number	Approximate Mainline Chainage (m)	Dimensions (m)
Ballygrenane Stream	ST13	1,270	2.1Ø Pipe
Stream	ST14	1,390	2.1Ø Pipe
Flood Relief	ST14A	1,395	2.1Ø Pipe
Stream	ST15	1,525	2.1Ø Pipe
Flood Relief	ST15A	1,530	2.1Ø Pipe
Flood Relief	ST15B	1,535	2.1Ø Pipe
Flood Relief	ST15C	1,540	2.1Ø Pipe
Flood Relief	ST27A	2,660	2.1Ø Pipe
Flood Relief	ST27B	2,663	2.1Ø Pipe
Flood Relief	ST27C	2,668	2.1Ø Pipe
Mill Stream Lower	ST27	2,670	3.0 x 2.8 Box
Flood Relief	ST27D	2,672	2.1Ø Pipe
Flood Relief	ST27E	2,677	2.1Ø Pipe
Flood Relief	ST27F	2,680	2.1Ø Pipe
Mill Stream Upper	ST39	3,880	2.1 x 2.3 Box

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All levels and chainage in metres. All levels refer to Malin Head Datum.

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Project: N69 LISTOWEL BYPASS
Component: Nature Impact Statement
Title: Culvert Typical Arrangement
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Drawing No.: 32105301/NIS/Fig 5

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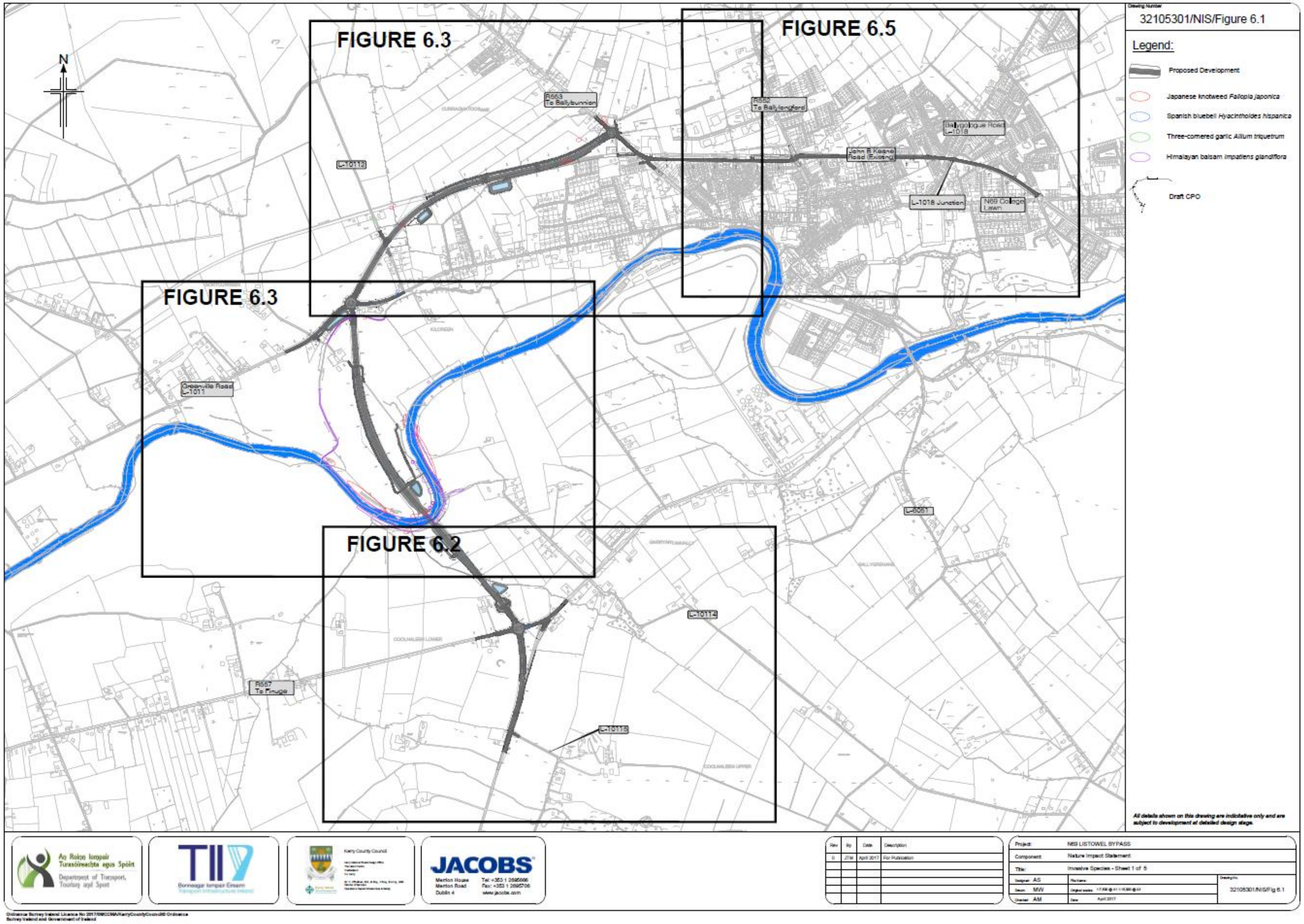
Figures 6.1 - 6.5: invasive Species Results



32105301/NIS/Figure 6.1
Legend:
Proposed Development
Japanese knotweed Fallopia japonica
Spanish bluebell Hyacinthoides hispanica
Three-cornered garlic Allium triquetrum
Himalayan balsam Impatiens glandiflora
Draft CPO
FIGURE 6.3
FIGURE 6.5
FIGURE 6.3
FIGURE 6.2
N
R553 To Ballybunnion
R552 To Ballylongford
Ballygologue Road L-1018
John B Keane Road (Existing)
L-1018 Junction
N69 College Lawn
L-1011
Greenville Road L-1011
L-6051
L-1011
R557 To Finuge
L-1011
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Component: Nature Impact Statement
Title: Invasive Species - Sheet 1 of 5
Designed: AS
Drawn: MW
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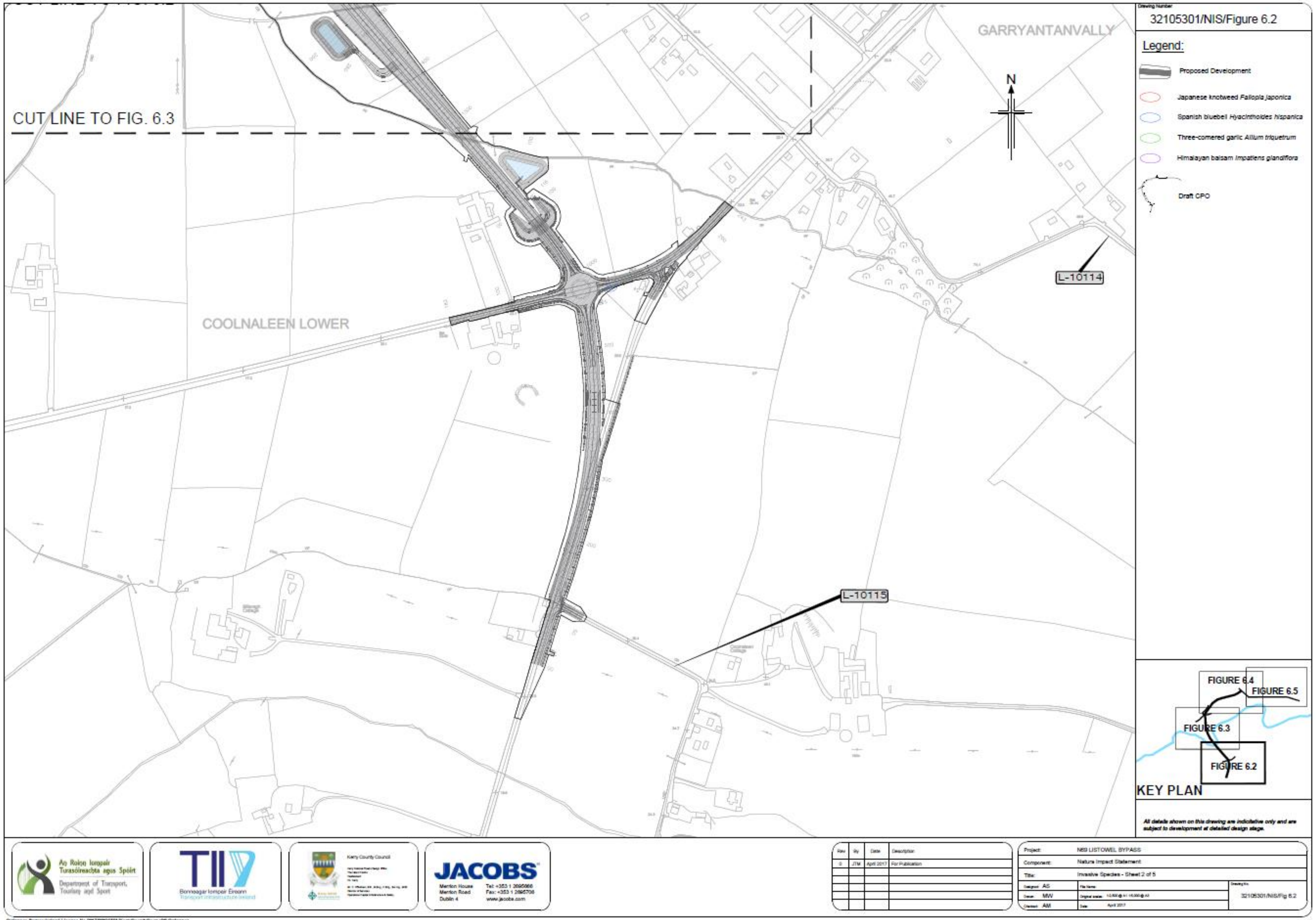
CUT LINE TO FIG. 6.3
GARRYANTANVALLY
COOLNALEEN LOWER
N
L-10114
L-10115
Drawing Number
32105301/NIS/Figure 6.2
Legend:
Proposed Development
Japanese knotweed Fallopia japonica
Spanish bluebell Hyacinthoides hispanica
Three-cornered garlic Allium triquetrum
Himalayan balsam Impatiens glandiflora
Draft CPO
FIGURE 6.4
FIGURE 6.5
FIGURE 6.3
FIGURE 6.2
KEY PLAN
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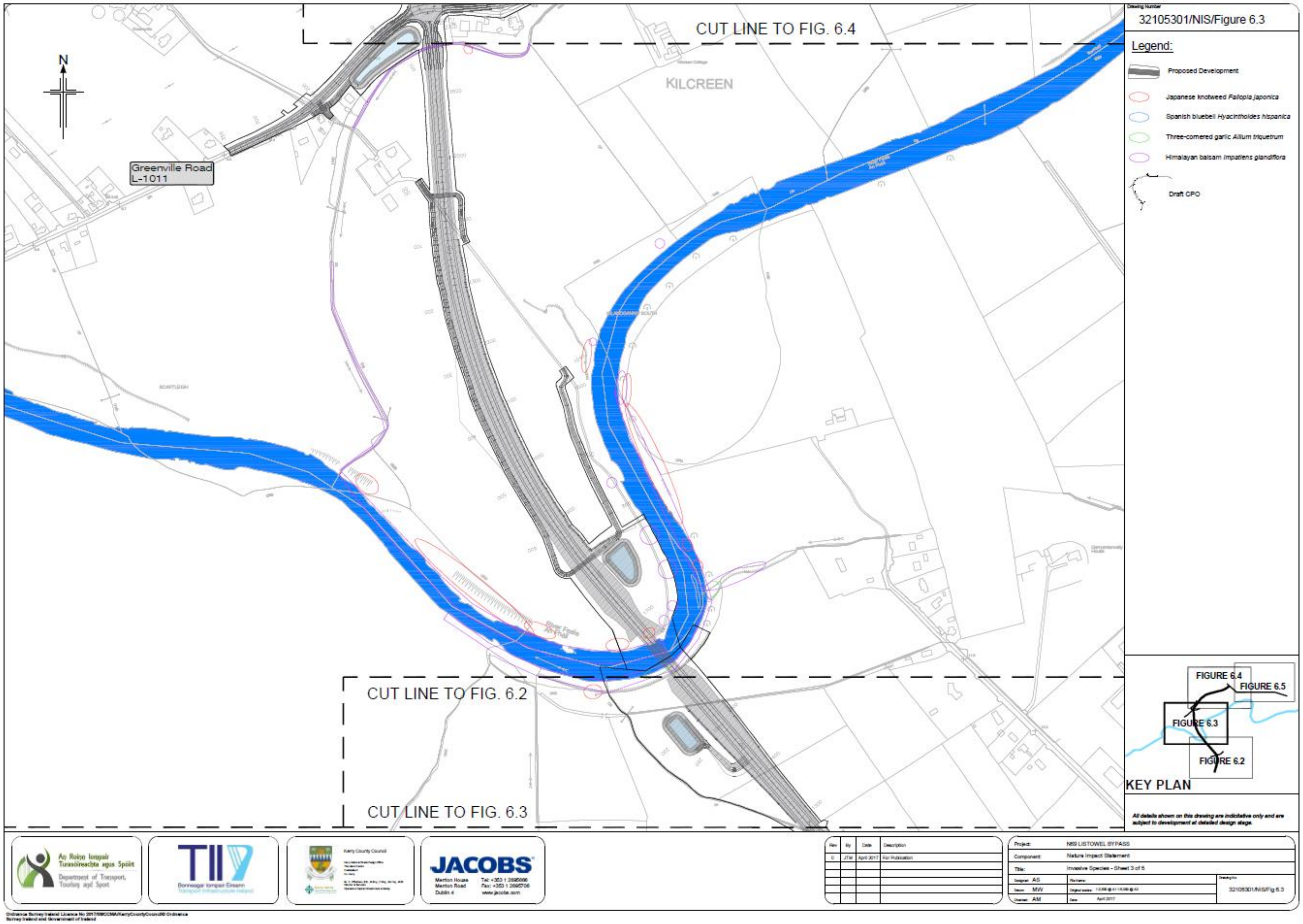
32105301/NIS/Fig 6.2



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32105301/NIS/Figure 6.3
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Japanese knotweed Fallopia japonica
Spanish bluebell Hyacinthoides hispanica
Three-cornered garlic Allium triquetrum
Himalayan balsam Impatiens glandiflora
Draft CPO
CUT LINE TO FIG. 6.4
KILCREEN
N
Greenville Road
L-1011
CUT LINE TO FIG. 6.2
CUT LINE TO FIG. 6.3
FIGURE 6.4
FIGURE 6.5
FIGURE 6.3
FIGURE 6.2
KEY PLAN
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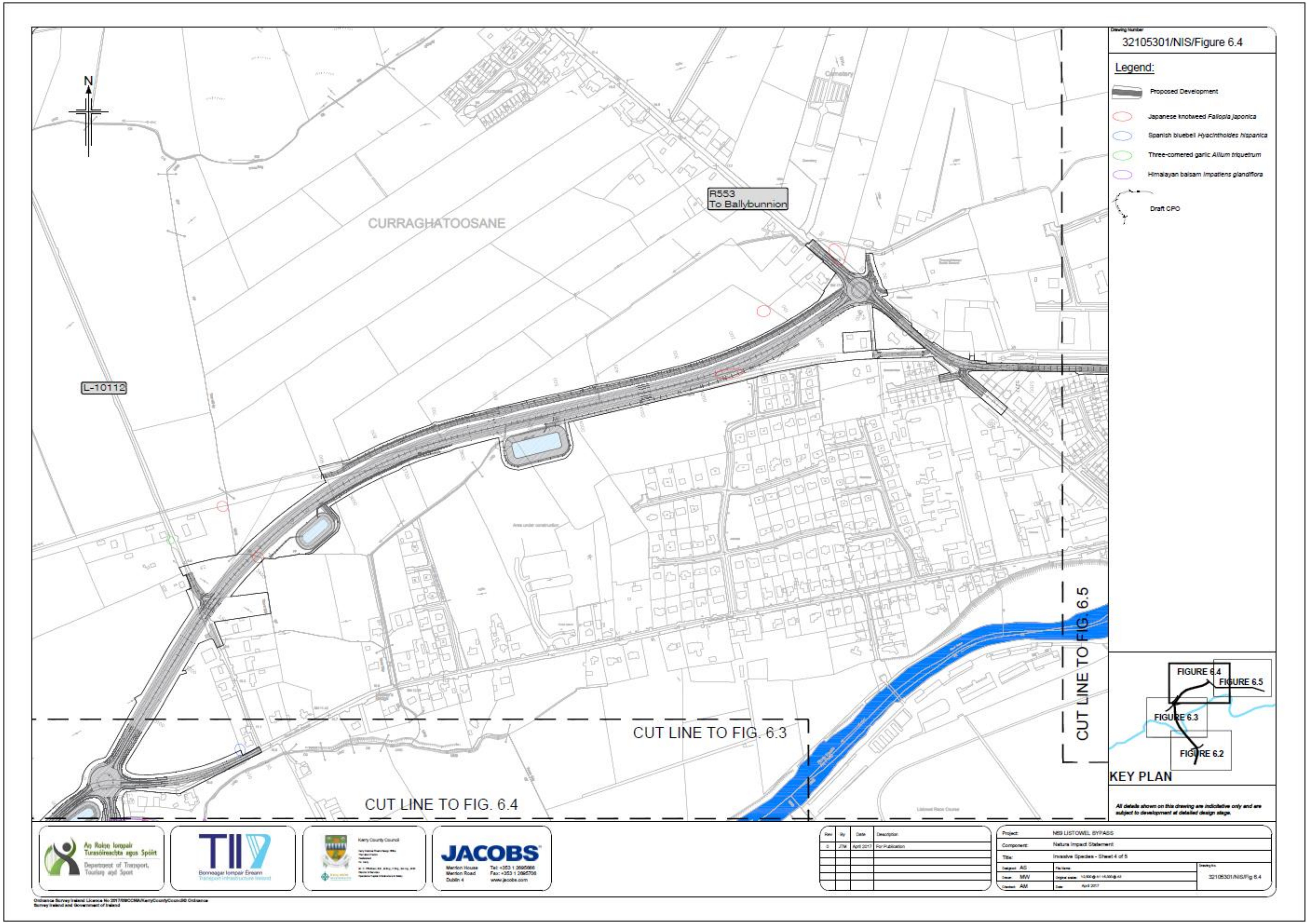
Component:
Nature Impact Statement
Title:
Invasive Species - Sheet 3 of 5
Designed: AS
Drawn: MW
Checked: AM
Date: April 2017
32105301/NIS/Fig 6.3


Drawing Number
32105301/NIS/Figure 6.4
Legend:
Proposed Development
Japanese knotweed Fallopia japonica
Spanish bluebell Hyacinthoides hispanica
Three-cornered garlic Allium triquetrum
Himalayan balsam Impatiens glandiflora
Draft CPO
N
CURRAGHATOOSANE
R553
To Ballybunnion
L-10112
CUT LINE TO FIG. 6.3
CUT LINE TO FIG. 6.4
CUT LINE TO FIG. 6.5
FIGURE 6.4
FIGURE 6.5
FIGURE 6.3
FIGURE 6.2
KEY PLAN
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Title: Invasive Species - Sheet 4 of 5
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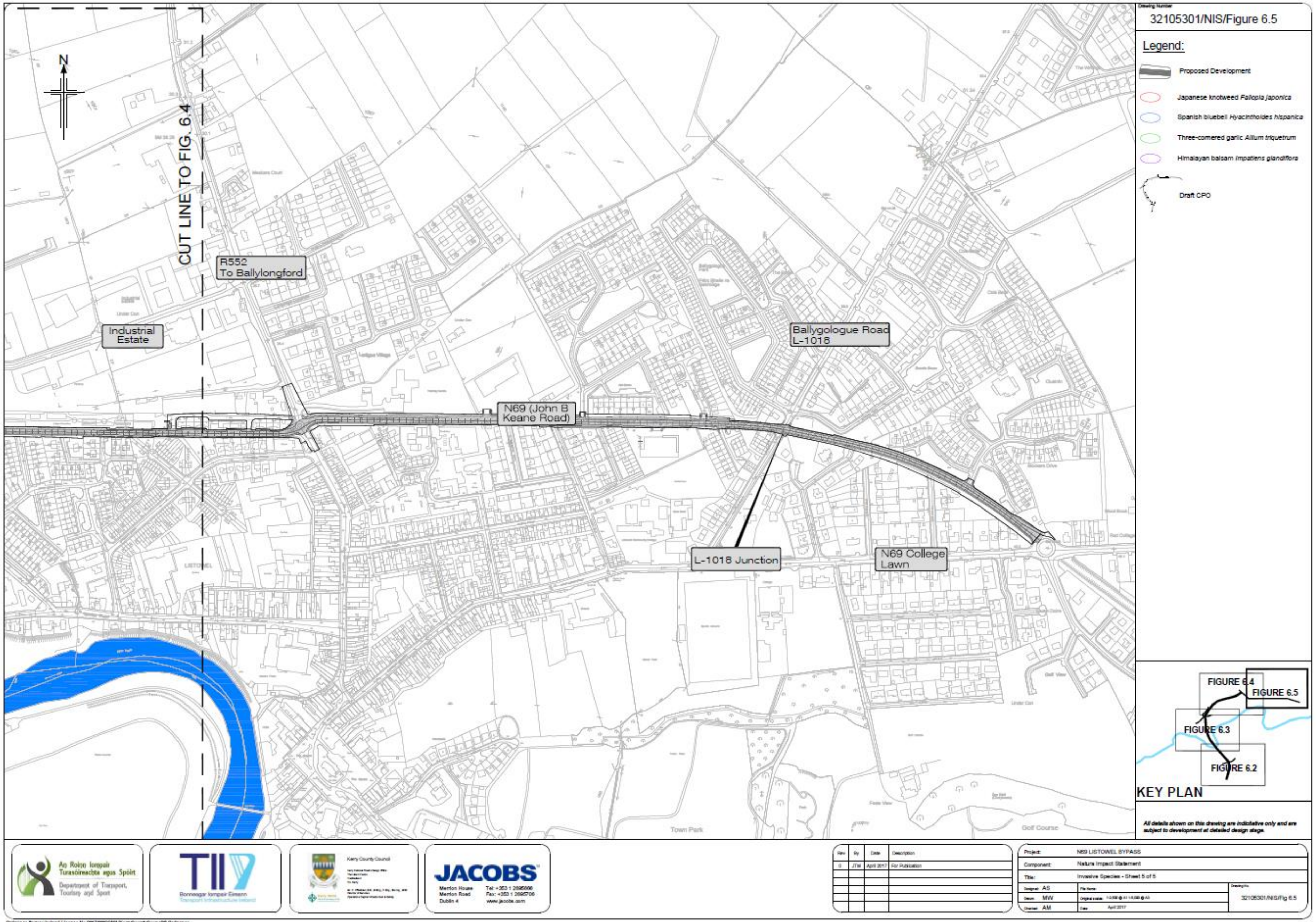
File Name:
Date: April 2017
Drawing No.
32105301/NIS/Fig 6.4



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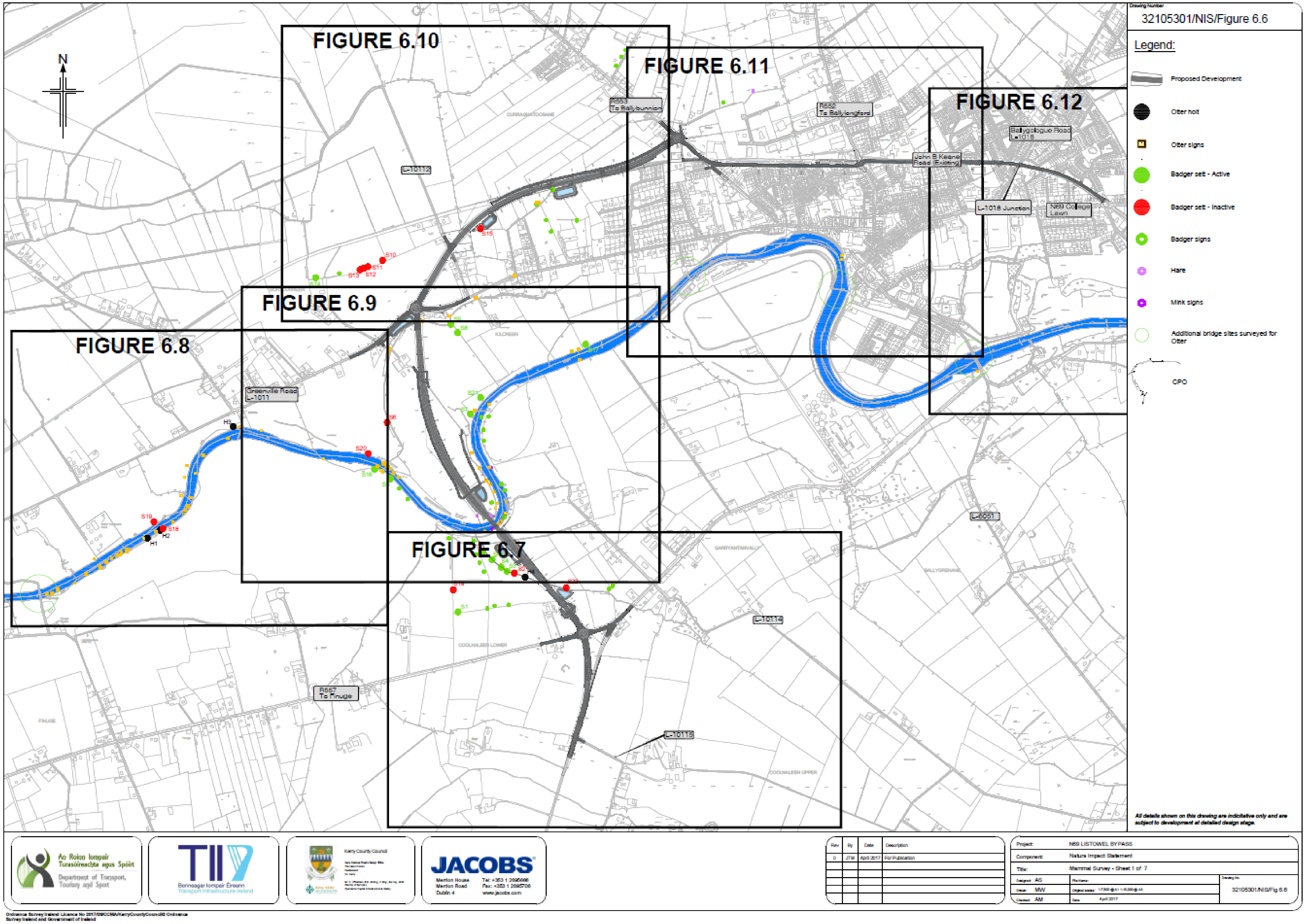
Figures 6.6 - 6.12: Mammal Survey Results


32105301/NIS/Figure 6.6
N
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
R553 To Ballybunion
R552 To Ballylongford
Ballygologue Road L-1018
John B Keane Road (Existing)
L-1018 Junction
N69 College Lawn
L-10112
Greenville Road L-1011
L-6051
L-10114
L-10115
R557 To Finuge
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
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Component: Natura Impact Statement
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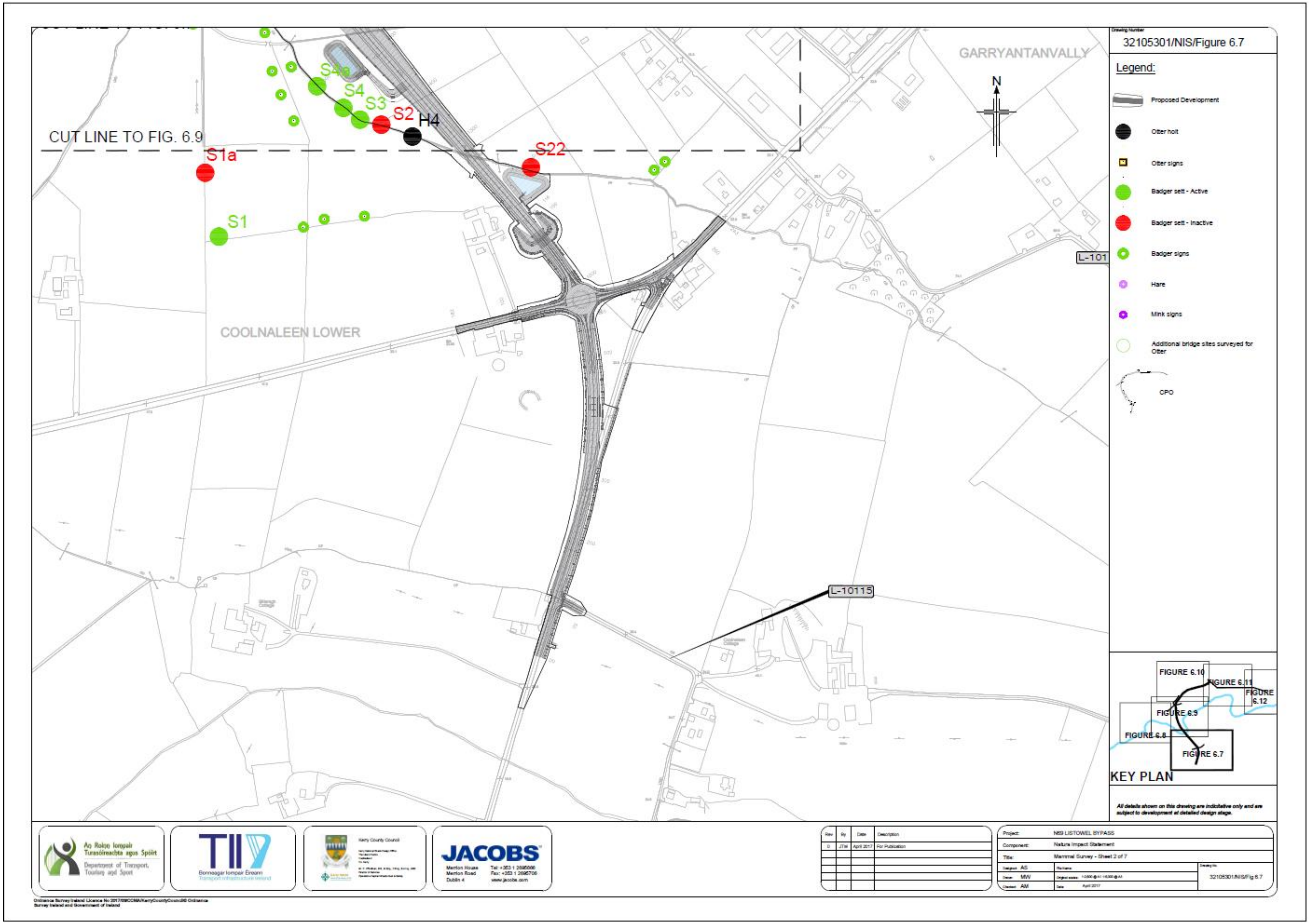

Drawing Number
32105301/NIS/Figure 6.7
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
GARRYANTANVALLY
N
CUT LINE TO FIG. 6.9
S4a
S4
S3
S2
H4
S22
S1a
S1
COOLNALEEN LOWER
L-101
L-10115
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
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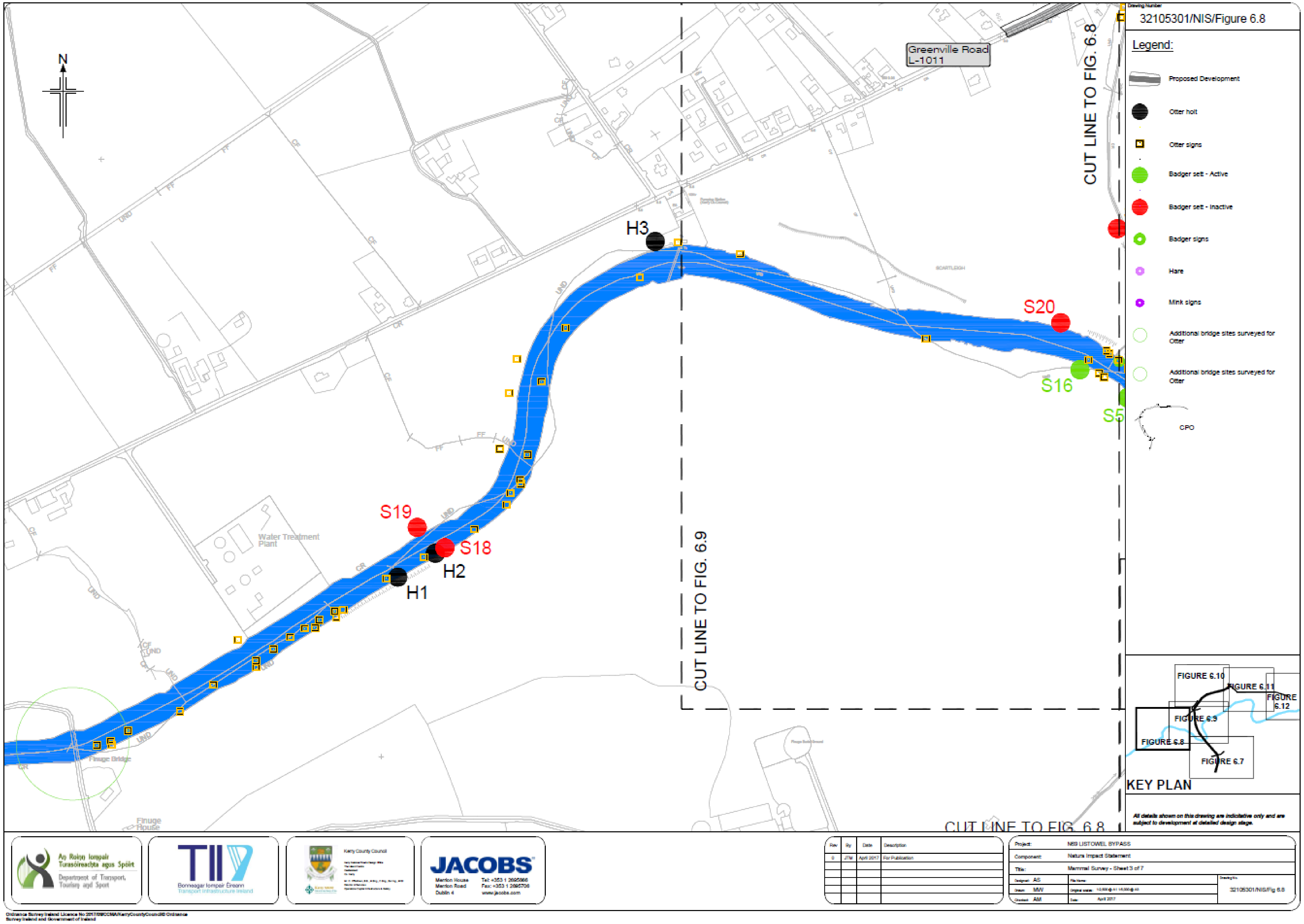
Date: April 2017
32105301/NIS/Fig 6.7



32105301/NIS/Figure 6.8
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
Additional bridge sites surveyed for Otter
CPO
N
Greenville Road L-1011
CUT LINE TO FIG. 6.8
CUT LINE TO FIG. 6.9
CUT LINE TO FIG. 6.8
H1
H2
H3
S16
S18
S19
S20
S5
Water Treatment Plant
Finuge Bridge
Finuge House
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
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Component: Natura Impact Statement
Title: Mammal Survey - Sheet 3 of 7
Designed: AS
Drawn: MW
Checked: AM
Date: April 2017
32105301/NIS/Fig 6.8
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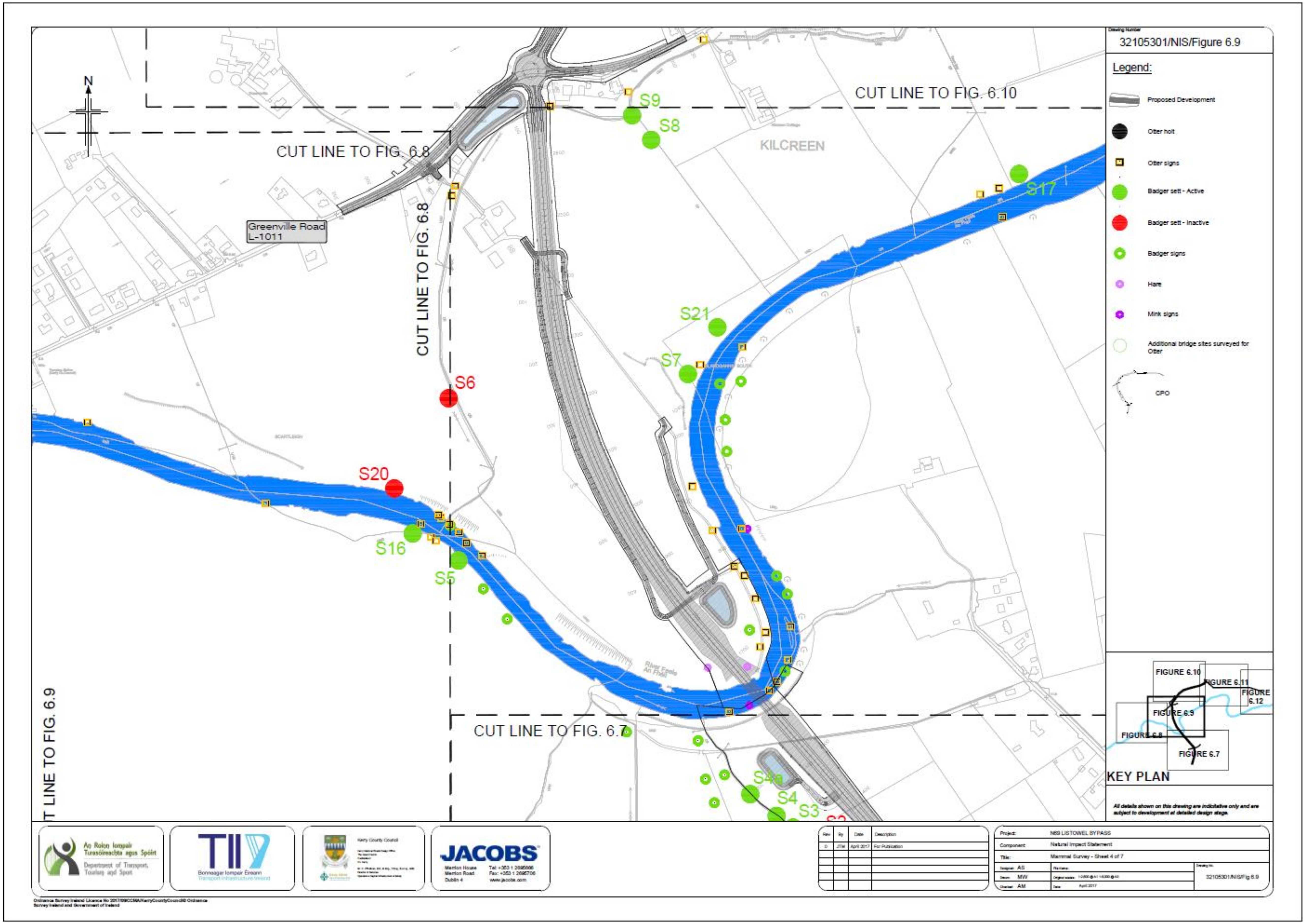
32105301/NIS/Figure 6.9
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
N
CUT LINE TO FIG. 6.10
CUT LINE TO FIG. 6.8
CUT LINE TO FIG. 6.8
CUT LINE TO FIG. 6.7
CUT LINE TO FIG. 6.9
KILCREEN
Greenville Road
L-1011
S9
S8
S17
S21
S7
S6
S20
S16
S5
S4a
S4
S3
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
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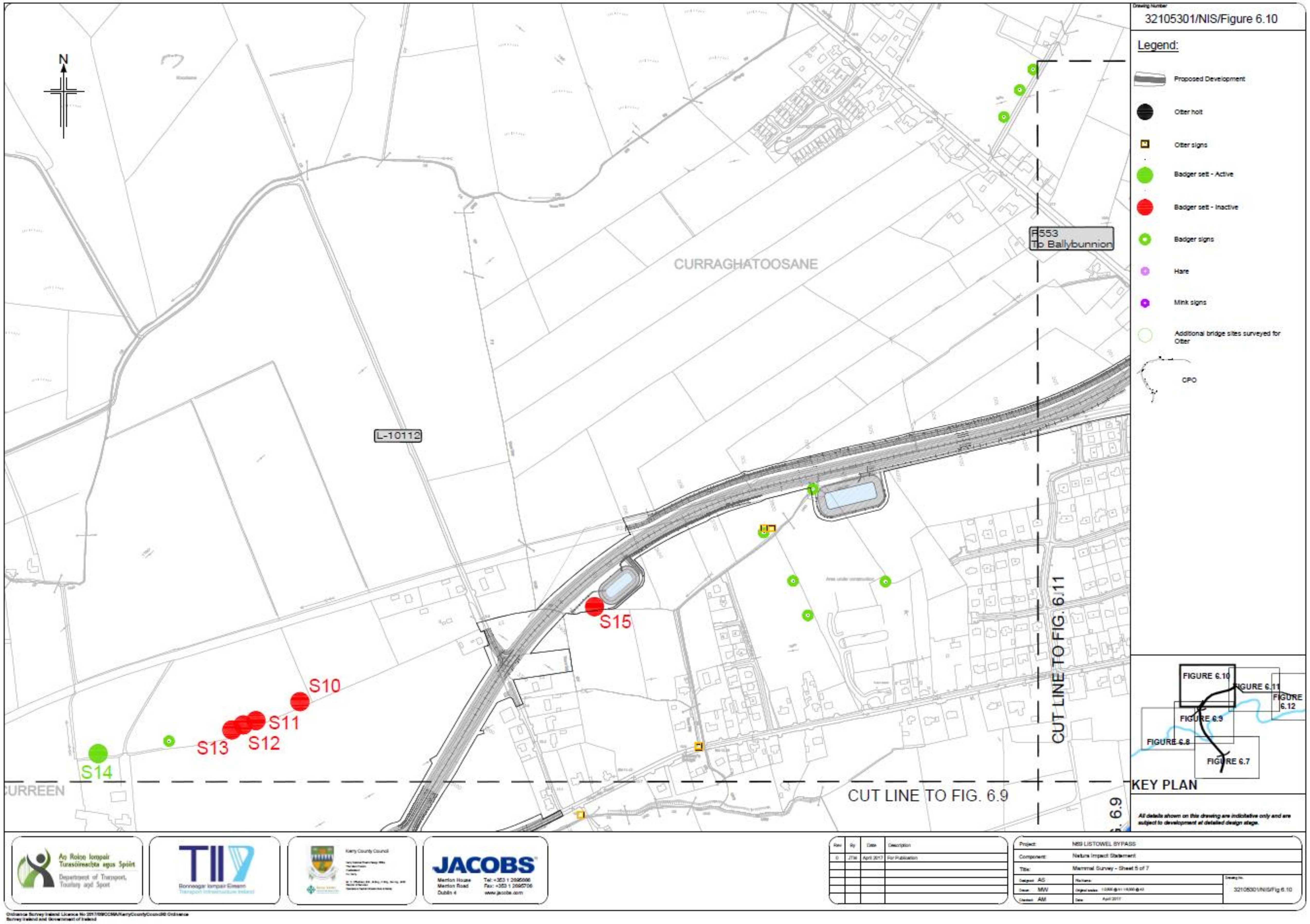
32105301/NIS/Fig 6.9


Drawing Number
32105301/NIS/Figure 6.10
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
N
L-10112
CURRAGHATOOSANE
R553
To Ballybunnion
S10
S11
S12
S13
S14
S15
CURREEN
CUT LINE TO FIG. 6.9
CUT LINE TO FIG. 6.11
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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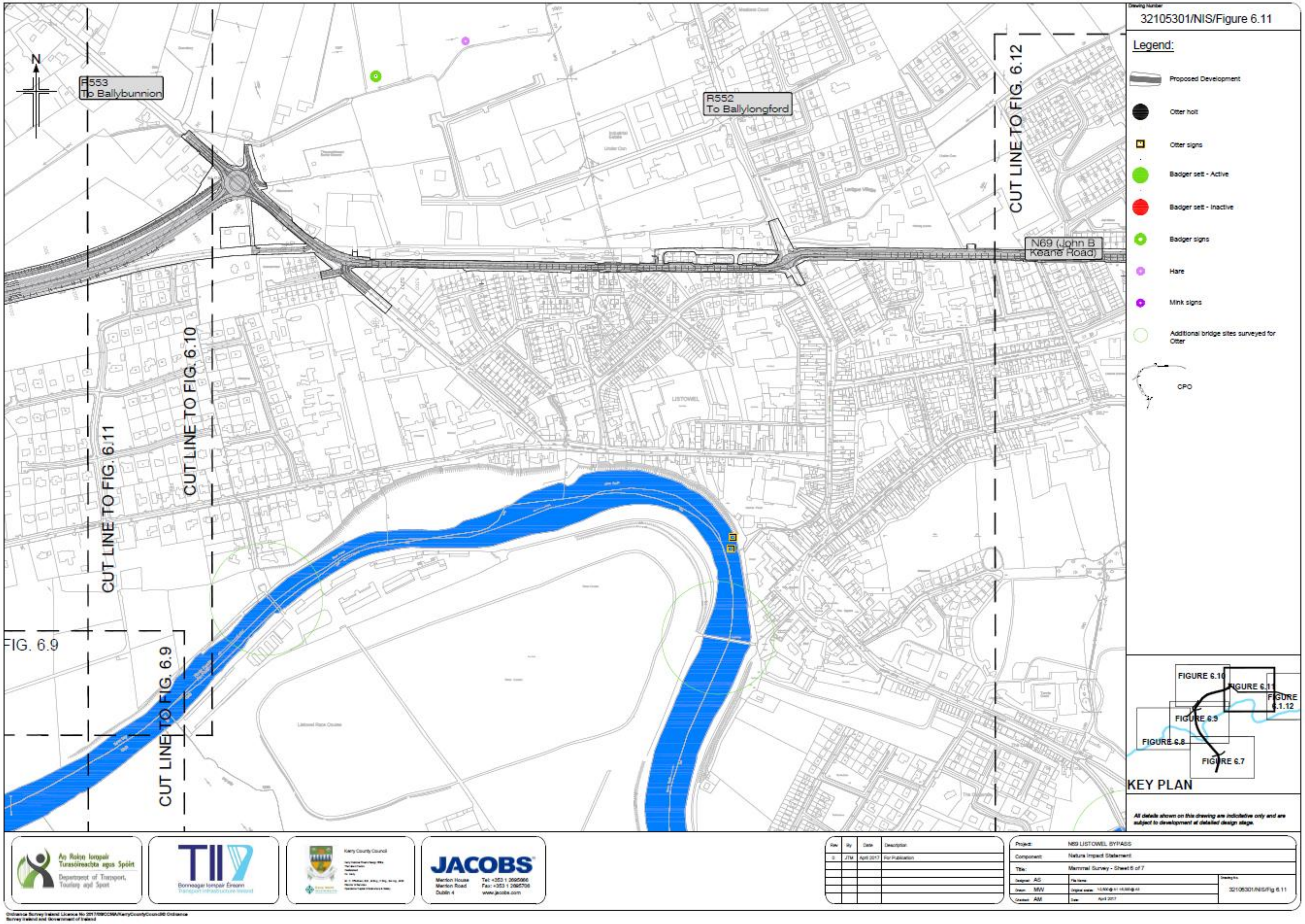
Drawing No. 32105301/NIS/Fig 6.10



Drawing Number
32105301/NIS/Figure 6.11
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
R553
To Ballybunnion
R552
To Ballylongford
N69 (John B Keane Road)
CUT LINE TO FIG. 6.12
CUT LINE TO FIG. 6.11
CUT LINE TO FIG. 6.10
CUT LINE TO FIG. 6.9
FIG. 6.9
N
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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Component: Natura Impact Statement
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Designed: AS
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Date: April 2017
32105301/NIS/Fig 6.11
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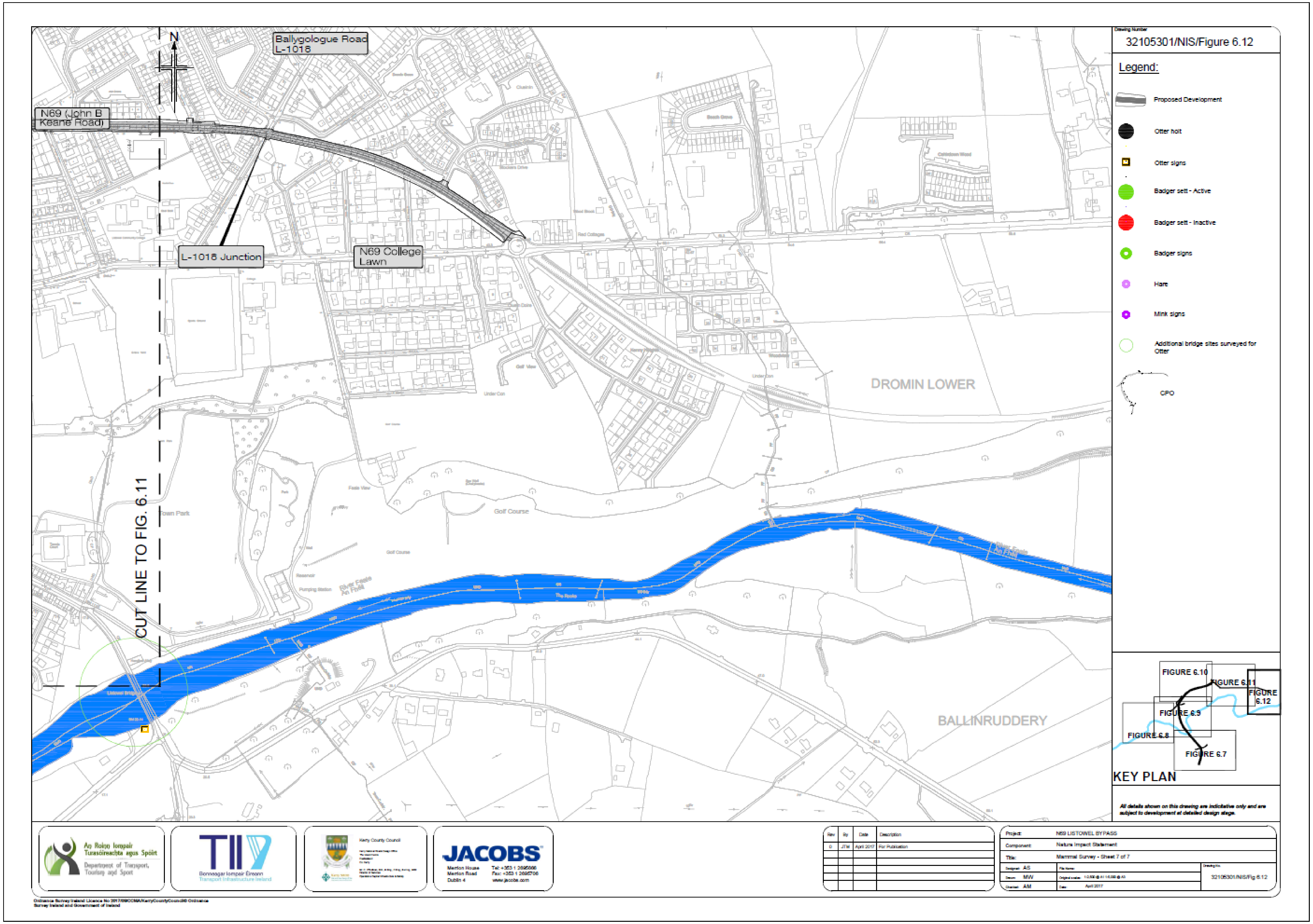

32105301/NIS/Figure 6.12
Legend:
Proposed Development
Otter holt
Otter signs
Badger sett - Active
Badger sett - Inactive
Badger signs
Hare
Mink signs
Additional bridge sites surveyed for Otter
CPO
N
Ballygologue Road L-1016
N69 (John B Keane Road)
L-1016 Junction
N69 College Lawn
CUT LINE TO FIG. 6.11
DROMIN LOWER
BALLINRUDDERY
Golf Course
River Feale An Fhéil
FIGURE 6.10
FIGURE 6.11
FIGURE 6.12
FIGURE 6.9
FIGURE 6.8
FIGURE 6.7
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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Component: Nature Impact Statement
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Designed: AS
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32105301/NIS/Fig 6.12
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Figures 6.13 - 6.18: Bird Survey Results

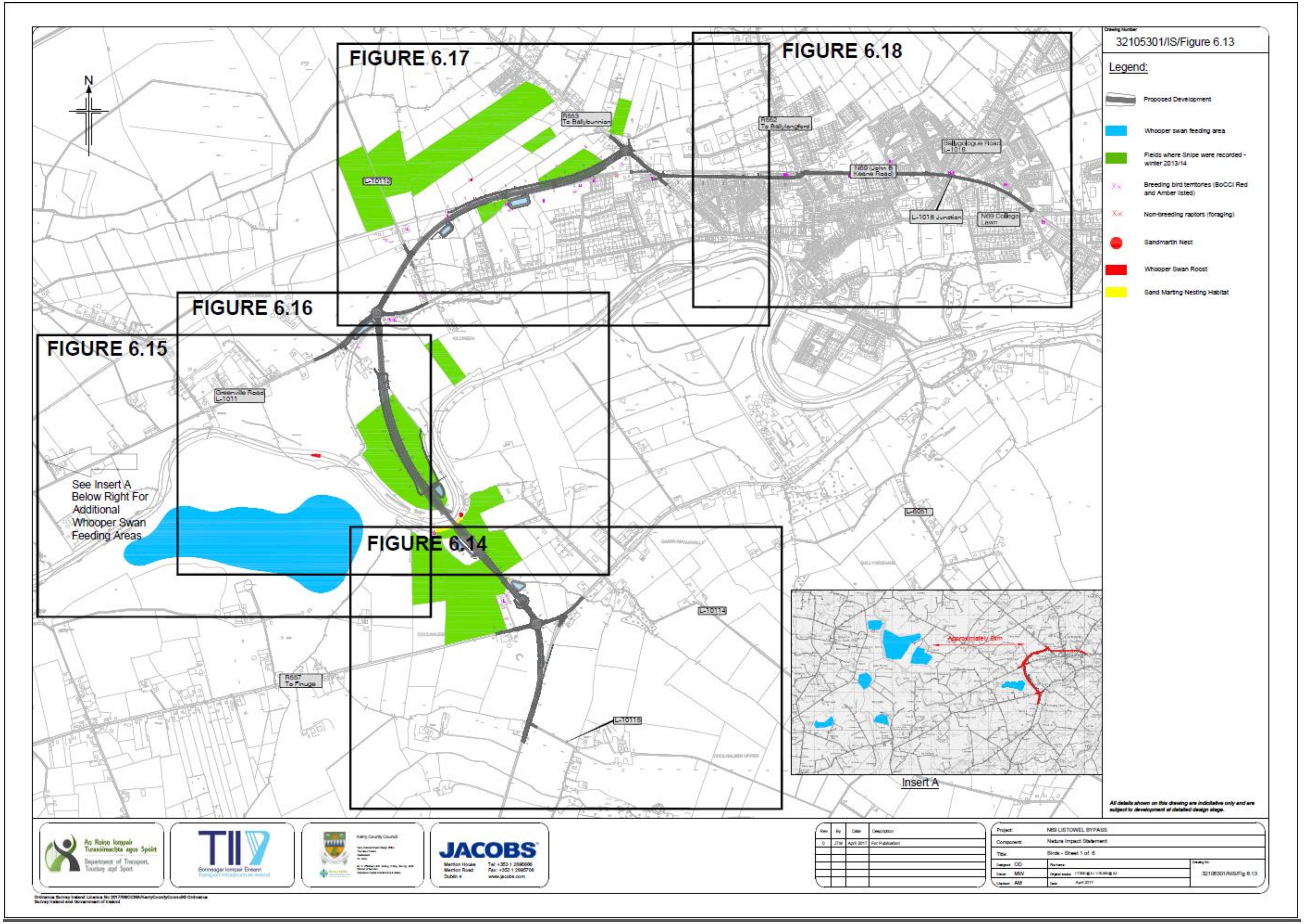
FIGURE 6.17
FIGURE 6.18
FIGURE 6.16
FIGURE 6.15
FIGURE 6.14
N
R553 To Ballybunnion
R552 To Ballylongford
L-1011
Ballygologue Road L-1016
N69 (John B Keane Road)
L-1016 Junction
N69 College Lawn
Greenville Road L-1011
See Insert A Below Right For Additional Whooper Swan Feeding Areas
L-6051
L-10114
R557 To Finuge
L-10115
Insert A
Approximately 8km
Drawing Number
32105301/IS/Figure 6.13
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
All details shown on this drawing are indicitative only and are subject to development at detailed design stage.
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Component: Nature Impact Statement
Title: Birds - Sheet 1 of 6
Designed: OD
Drawn: MW
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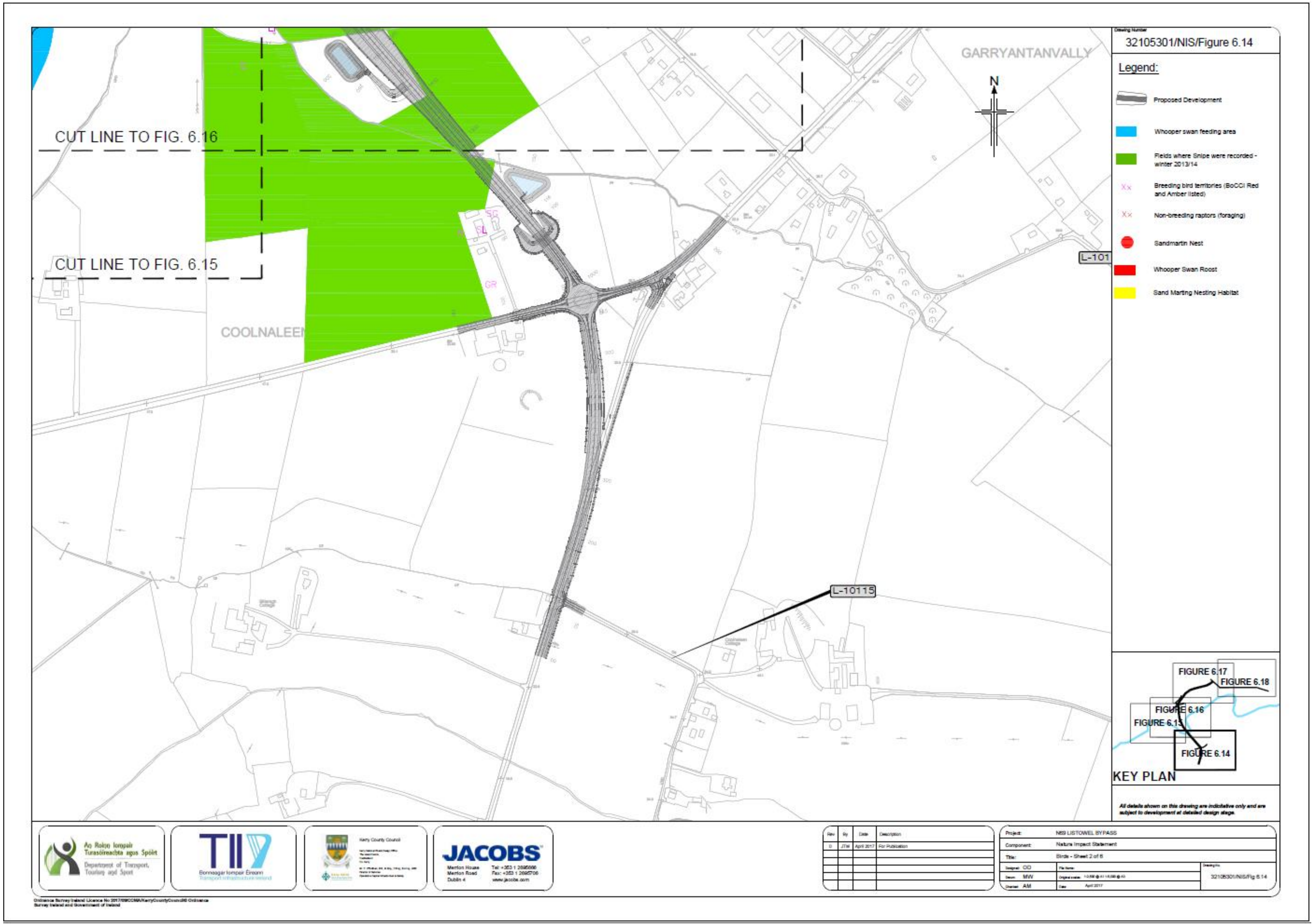
Date: April 2017
32105301/NIS/Fig 6.13


Drawing Number
32105301/NIS/Figure 6.14
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
CUT LINE TO FIG. 6.16
CUT LINE TO FIG. 6.15
GARRYANTANVALLY
COOLNALEEN
N
L-101
L-10115
FIGURE 6.17
FIGURE 6.18
FIGURE 6.16
FIGURE 6.15
FIGURE 6.14
KEY PLAN
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Designed: OO
Drawn: MW
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32105301/NIS/Fig 6.14
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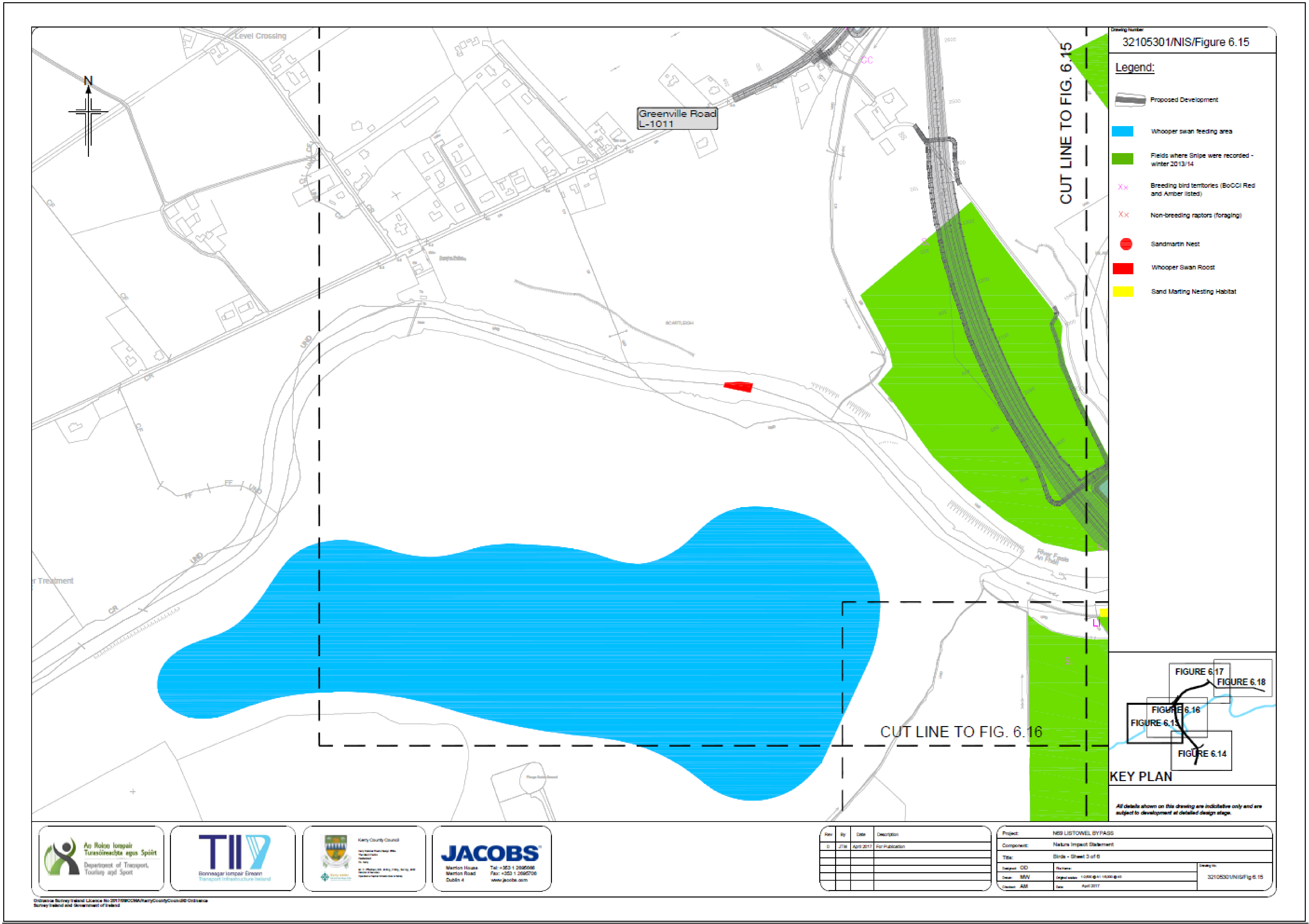

32105301/NIS/Figure 6.15
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
N
Level Crossing
Greenville Road
L-1011
CUT LINE TO FIG. 6.15
CUT LINE TO FIG. 6.16
FIGURE 6.17
FIGURE 6.18
FIGURE 6.16
FIGURE 6.15
FIGURE 6.14
KEY PLAN
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Component: Natura Impact Statement
Title: Birds - Sheet 3 of 8
Designed: OD
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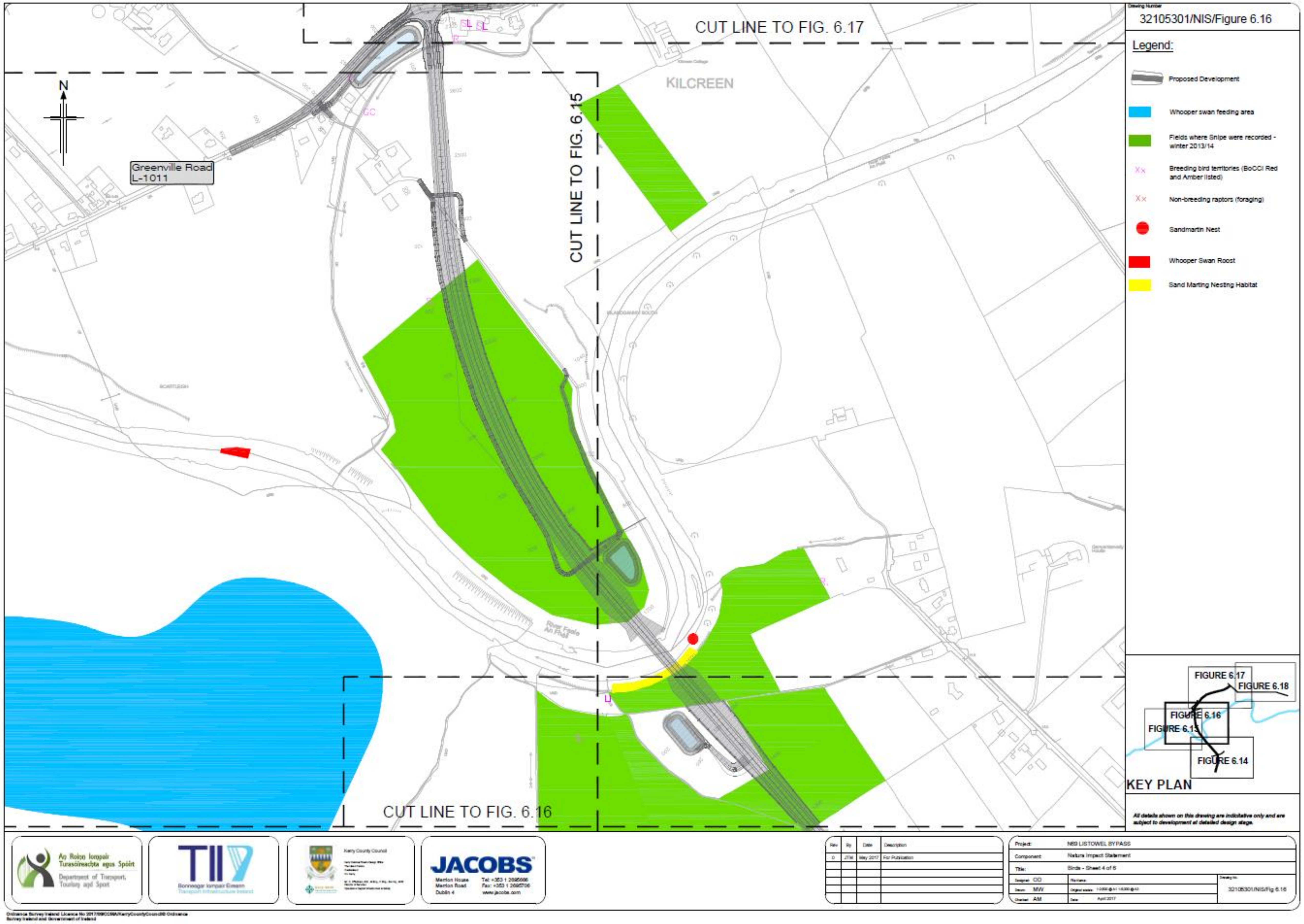
Checked: AM
Date: April 2017
32105301/NIS/Fig 6.15



Drawing Number
32105301/NIS/Figure 6.16
CUT LINE TO FIG. 6.17
CUT LINE TO FIG. 6.15
CUT LINE TO FIG. 6.16
KILCREEN
N
Greenville Road
L-1011
River Feale
An Fhéil
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
FIGURE 6.17
FIGURE 6.18
FIGURE 6.16
FIGURE 6.15
FIGURE 6.14
KEY PLAN
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Component: Natura Impact Statement
Title: Birds - Sheet 4 of 6
Designed: OD
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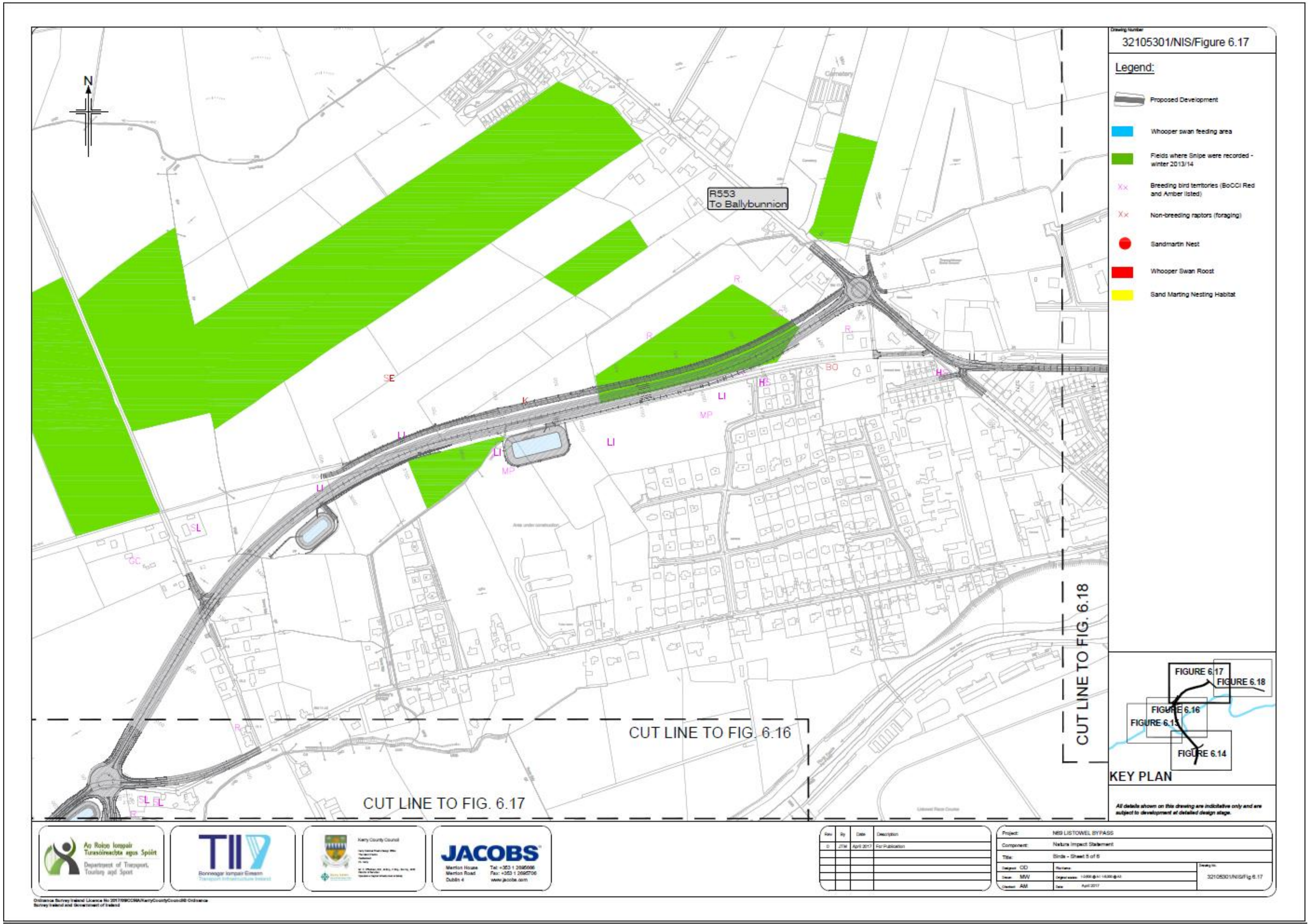
Date: April 2017
Drawing No. 32105301/NIS/Fig 6.16



32105301/NIS/Figure 6.17
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
R553
To Ballybunnion
CUT LINE TO FIG. 6.18
CUT LINE TO FIG. 6.16
CUT LINE TO FIG. 6.17
FIGURE 6.17
FIGURE 6.18
FIGURE 6.16
FIGURE 6.15
FIGURE 6.14
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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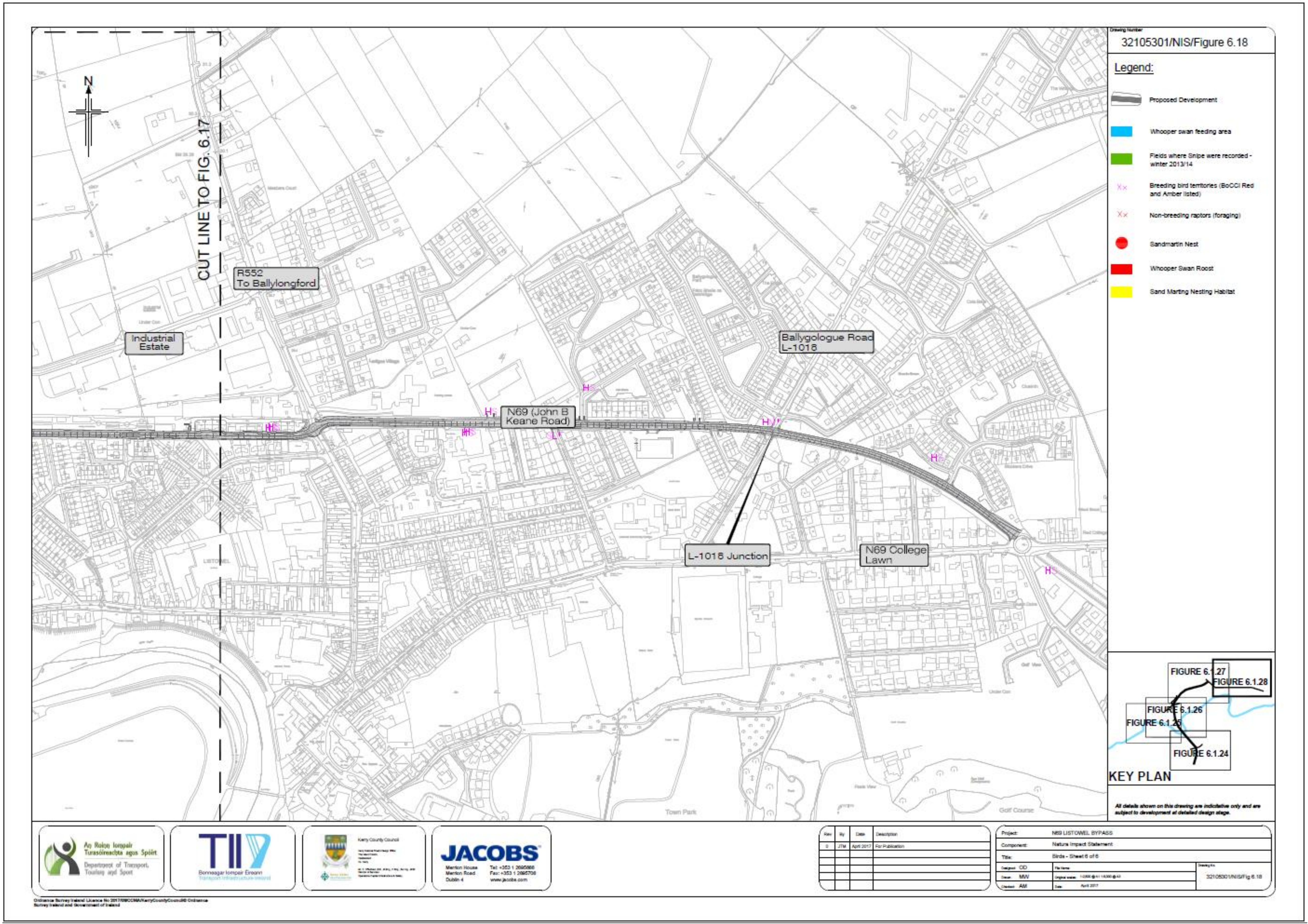
Natura Impact Statement
Birds - Sheet 5 of 6


Drawing Number
32105301/NIS/Figure 6.18
Legend:
Proposed Development
Whooper swan feeding area
Fields where Snipe were recorded - winter 2013/14
Breeding bird territories (BoCCI Red and Amber listed)
Non-breeding raptors (foraging)
Sandmartin Nest
Whooper Swan Roost
Sand Marting Nesting Habitat
N
CUT LINE TO FIG. 6.17
R552
To Ballylongford
Industrial Estate
N69 (John B Keane Road)
Ballygologue Road L-1018
L-1018 Junction
N69 College Lawn
Town Park
Golf Course
FIGURE 6.1.27
FIGURE 6.1.28
FIGURE 6.1.26
FIGURE 6.1.25
FIGURE 6.1.24
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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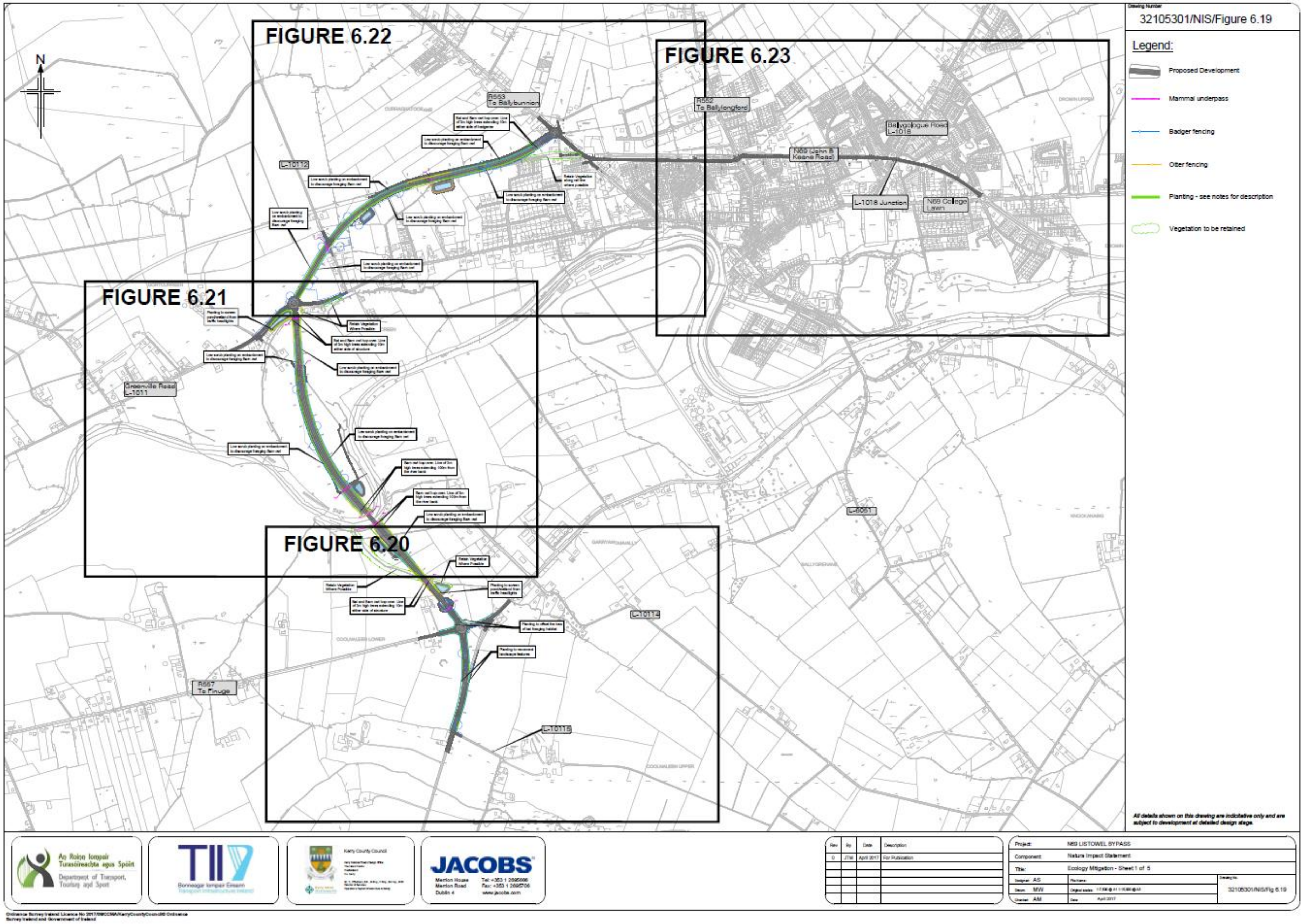
Component:
Natura Impact Statement
Title:
Birds - Sheet 6 of 6
Designed OD
Drawn MW
Checked AM
Date April 2017
Drawing No.
32105301/NIS/Fig 6.18

Figures 6.19 - 6.23: Ecology Mitigation


Drawing Number
32105301/NIS/Figure 6.19
Legend:
Proposed Development
Mammal underpass
Badger fencing
Otter fencing
Planting - see notes for description
Vegetation to be retained
FIGURE 6.22
FIGURE 6.23
FIGURE 6.21
FIGURE 6.20
N
R553 To Ballybunnion
R552 To Ballylongford
Ballygologue Road L-1018
N69 (John B Keane Road)
L-1018 Junction
N69 College Lawn
L-10112
Greenville Road L-1011
L-6061
L-10114
L-10115
R557 To Finuge
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Project: N69 LISTOWEL BYPASS
Component: Natura Impact Statement
Title: Ecology Mitigation - Sheet 1 of 5
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Drawn MW
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32105301/NIS/Fig 6.19
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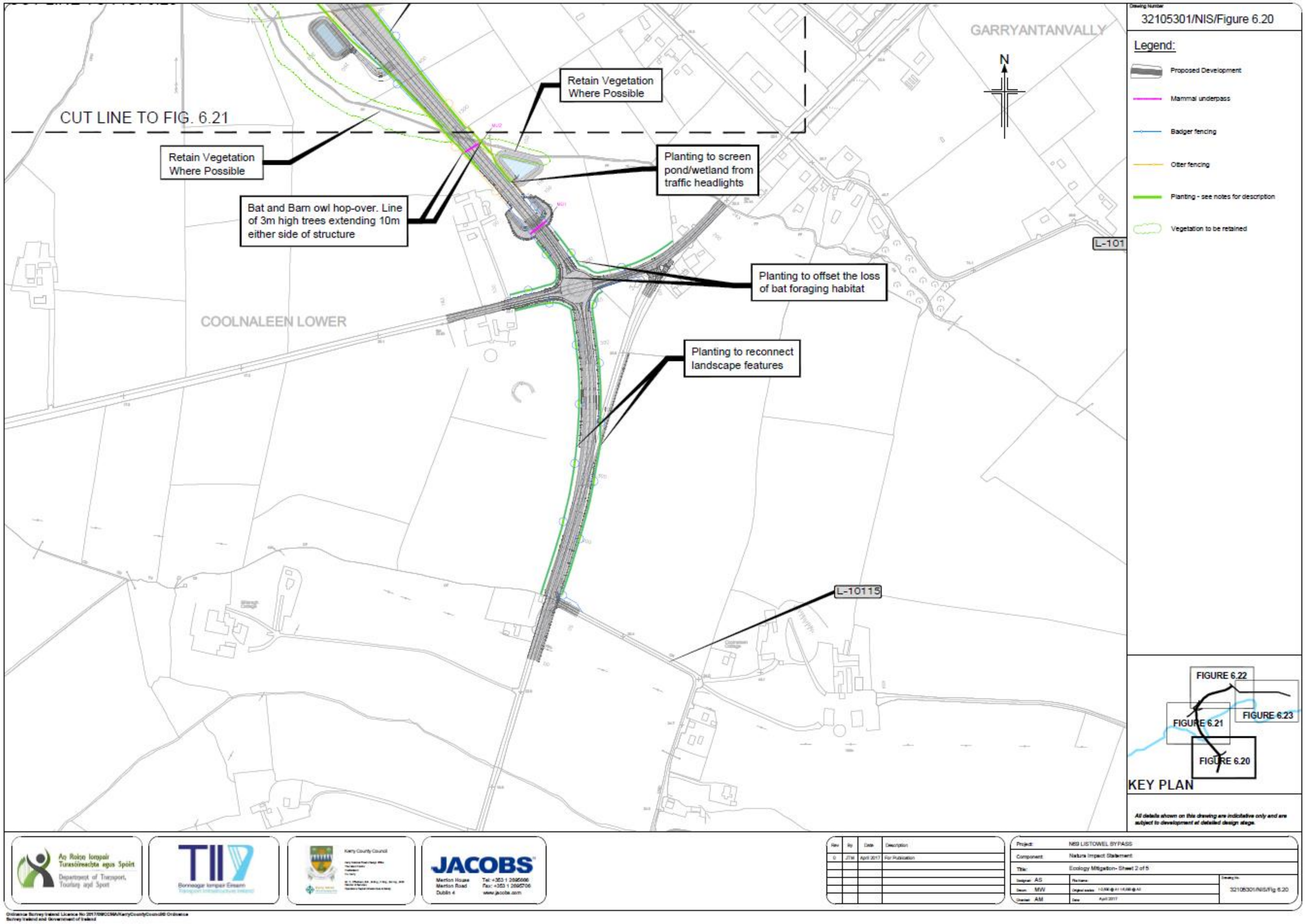

32105301/NIS/Figure 6.20
Legend:
Proposed Development
Mammal underpass
Badger fencing
Otter fencing
Planting - see notes for description
Vegetation to be retained
GARRYANTANVALLY
COOLNALEEN LOWER
N
CUT LINE TO FIG. 6.21
Retain Vegetation Where Possible
Retain Vegetation Where Possible
Planting to screen pond/wetland from traffic headlights
Bat and Barn owl hop-over. Line of 3m high trees extending 10m either side of structure
Planting to offset the loss of bat foraging habitat
Planting to reconnect landscape features
L-101
L-10115
FIGURE 6.22
FIGURE 6.23
FIGURE 6.21
FIGURE 6.20
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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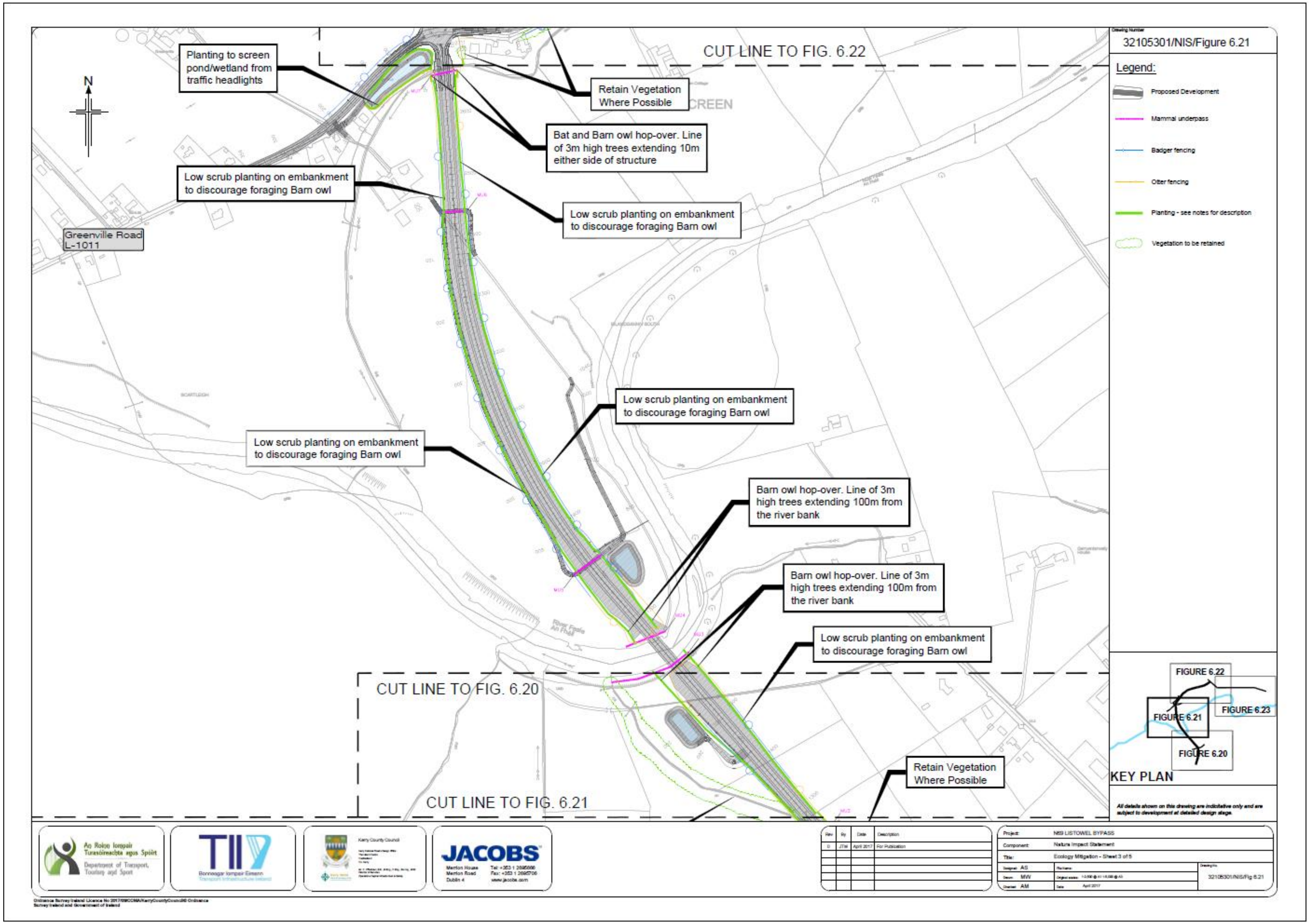
Project: N69 LISTOWEL BYPASS
Component: Natura Impact Statement
Title: Ecology Mitigation- Sheet 2 of 5
Designer: AS
Drawn: MW
Checked: AM
Date: April 2017
32105301/NIS/Fig 6.20



CUT LINE TO FIG. 6.22
Planting to screen pond/wetland from traffic headlights
Retain Vegetation Where Possible
CREEN
Bat and Barn owl hop-over. Line of 3m high trees extending 10m either side of structure
N
Low scrub planting on embankment to discourage foraging Barn owl
Greenville Road L-1011
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
Barn owl hop-over. Line of 3m high trees extending 100m from the river bank
Barn owl hop-over. Line of 3m high trees extending 100m from the river bank
Low scrub planting on embankment to discourage foraging Barn owl
CUT LINE TO FIG. 6.20
Retain Vegetation Where Possible
CUT LINE TO FIG. 6.21
Drawing Number
32105301/NIS/Figure 6.21
Legend:
Proposed Development
Mammal underpass
Badger fencing
Otter fencing
Planting - see notes for description
Vegetation to be retained
FIGURE 6.22
FIGURE 6.23
FIGURE 6.21
FIGURE 6.20
KEY PLAN
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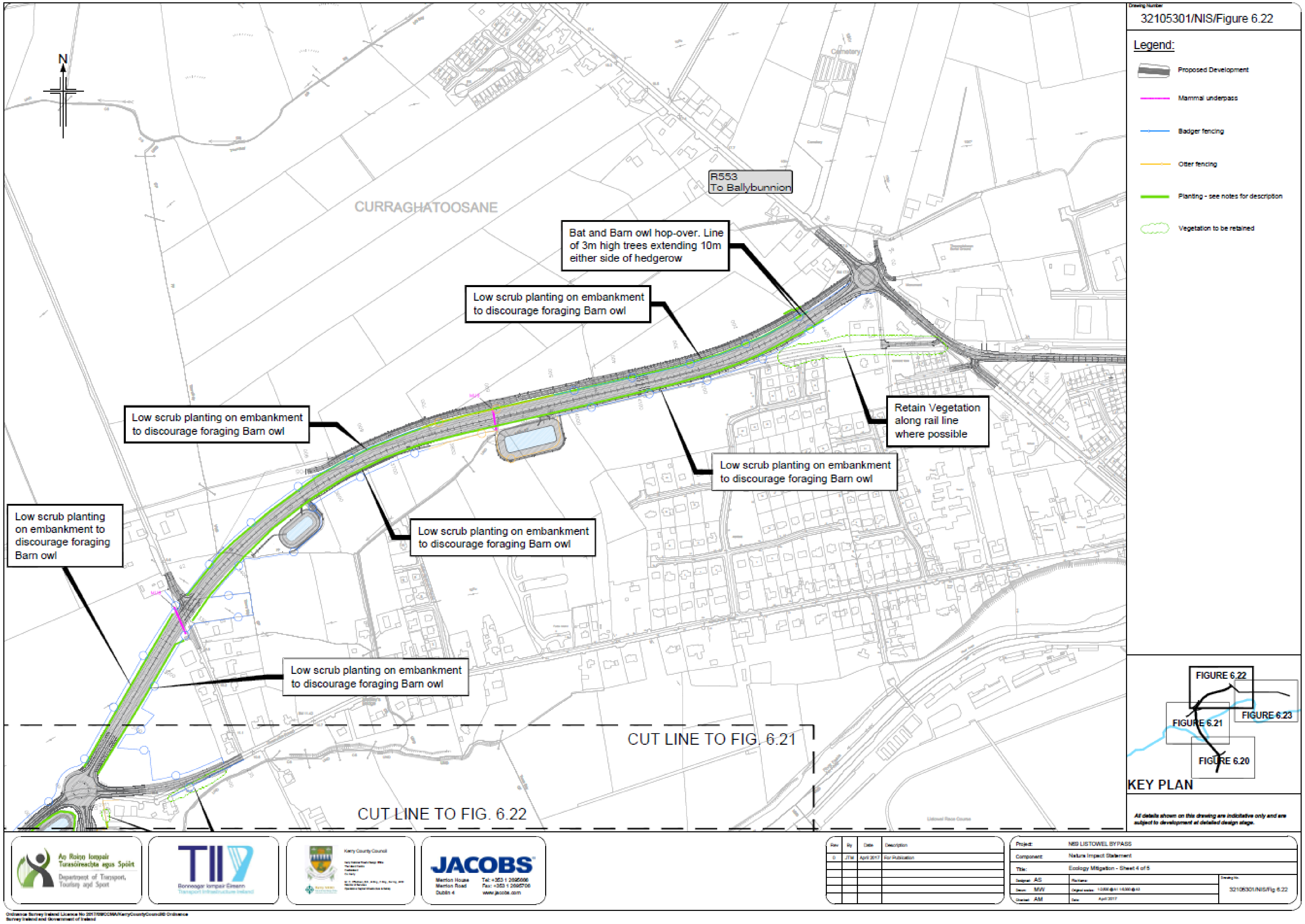
32105301/NIS/Fig 6.21


32105301/NIS/Figure 6.22
Legend:
Proposed Development
Mammal underpass
Badger fencing
Otter fencing
Planting - see notes for description
Vegetation to be retained
N
CURRAGHATOOSANE
R553
To Ballybunnion
Bat and Barn owl hop-over. Line of 3m high trees extending 10m either side of hedgerow
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
Retain Vegetation along rail line where possible
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
Low scrub planting on embankment to discourage foraging Barn owl
CUT LINE TO FIG. 6.21
CUT LINE TO FIG. 6.22
FIGURE 6.22
FIGURE 6.23
FIGURE 6.21
FIGURE 6.20
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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Project: N69 LISTOWEL BYPASS
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Title: Ecology Mitigation - Sheet 4 of 5
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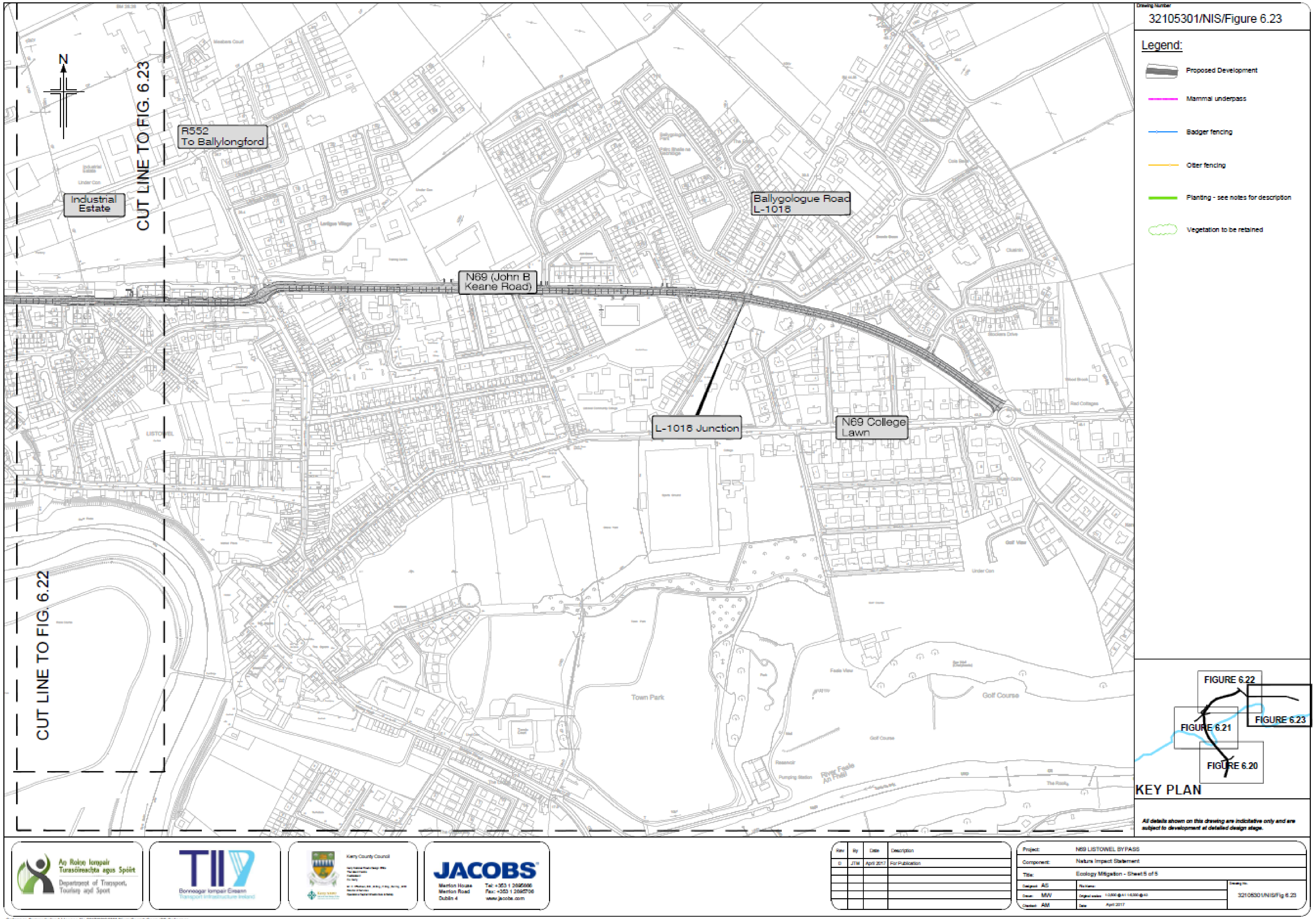
32105301/NIS/Fig 6.22



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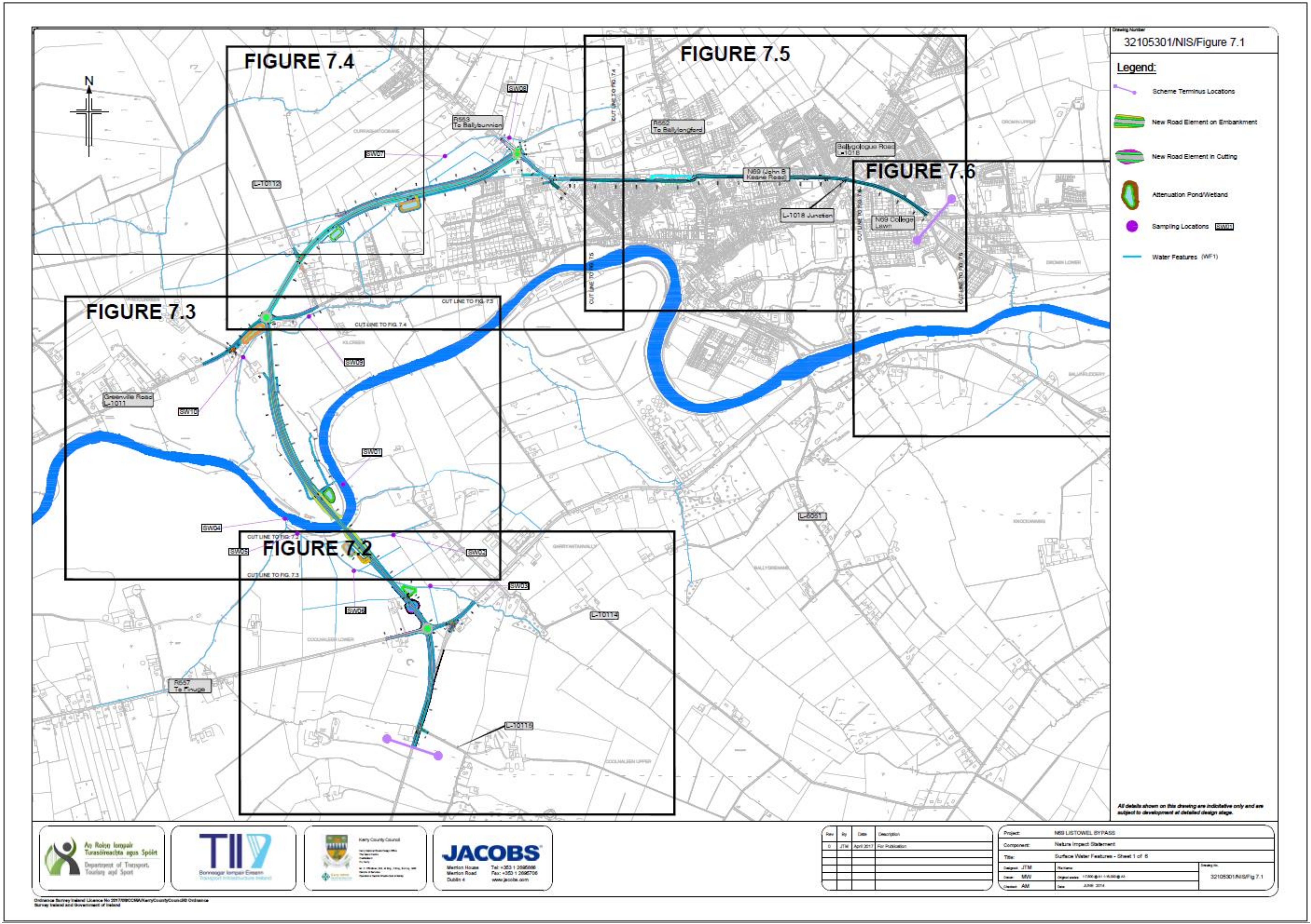
Figures 7.1 - 7.6: Surface Water Features



32105301/NIS/Figure 7.1
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Sampling Locations
Water Features (WF1)
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
N
R553 To Ballybunnion
R552 To Ballylongford
Ballygologue Road L-1016
N69 (John B Keane Road)
L-1018 Junction
N69 College Lawn
L-10112
Greenville Road L-1011
SW01
SW02
SW03
SW04
SW05
SW06
SW07
SW08
SW09
SW10
L-6051
L-10114
L-10115
R557 To Finuge
CUT LINE TO FIG 7.4
CUT LINE TO FIG 7.3
CUT LINE TO FIG 7.5
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Project: N69 LISTOWEL BYPASS
Component: Natura Impact Statement
Title: Surface Water Features - Sheet 1 of 6
Designed: JTM
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Date: JUNE 2014
32105301/NIS/Fig 7.1
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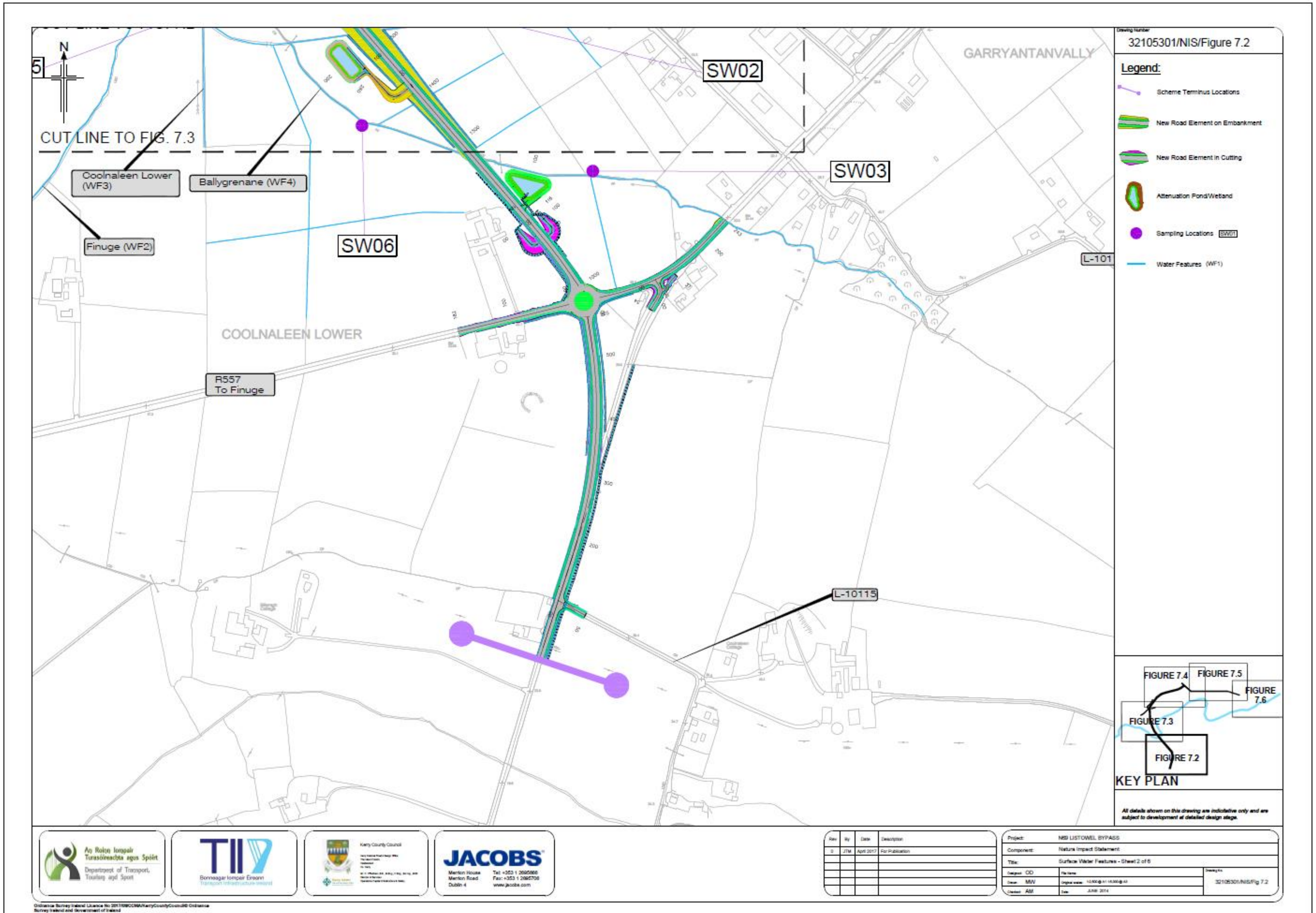
32105301/NIS/Figure 7.2
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Sampling Locations SW01
Water Features (WF1)
N
CUT LINE TO FIG. 7.3
SW02
SW03
SW06
GARRYANTANVALLY
Coolnaleen Lower (WF3)
Ballygrenane (WF4)
Finuge (WF2)
COOLNALEEN LOWER
R557 To Finuge
L-101
L-10115
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
KEY PLAN
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Title: Surface Water Features - Sheet 2 of 6
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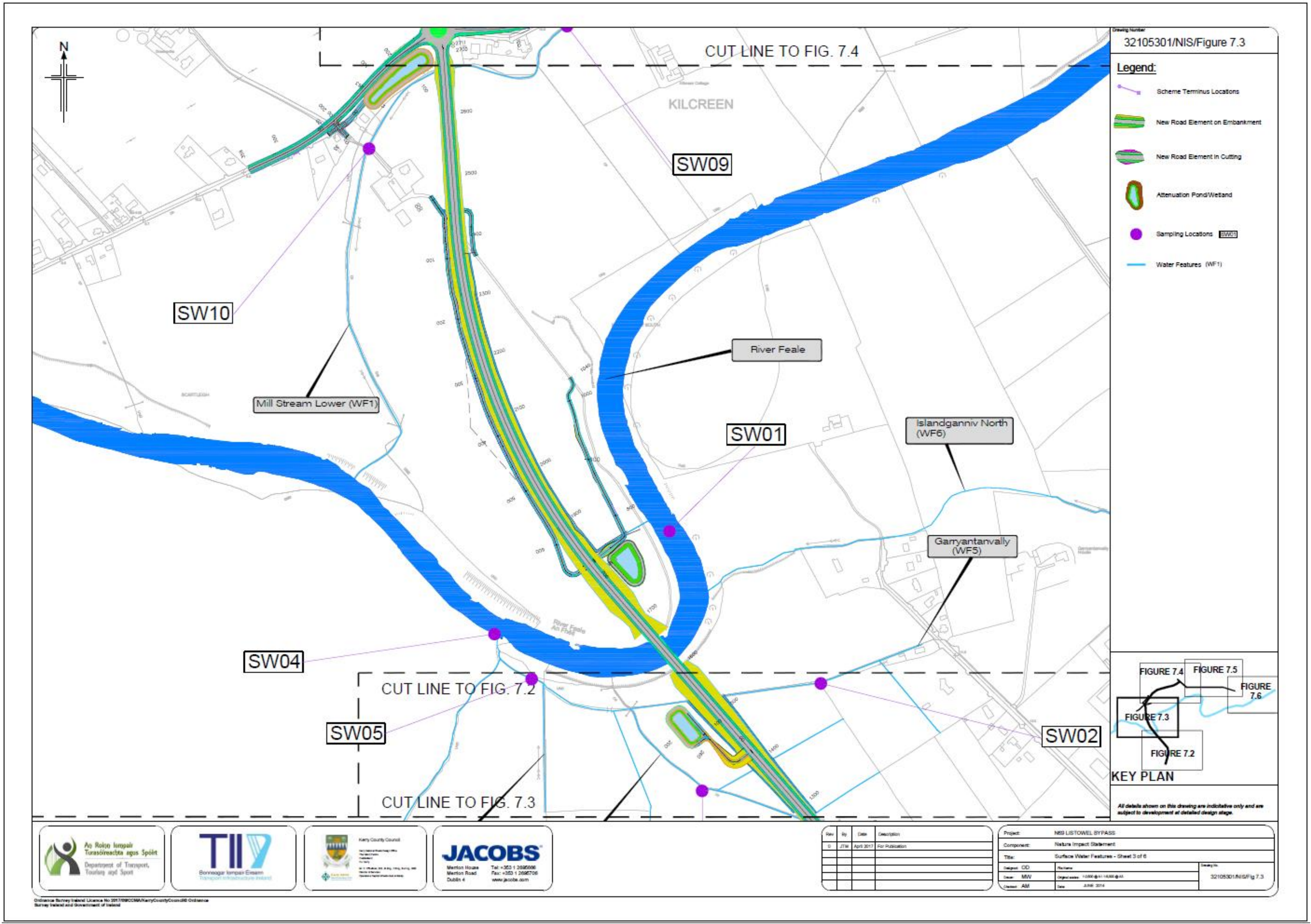
Date: JUNE 2014
Drawing No. 32105301/NIS/Fig 7.2


32105301/NIS/Figure 7.3
N
CUT LINE TO FIG. 7.4
KILCREEN
SW09
SW10
River Feale
Mill Stream Lower (WF1)
SW01
Islandganniv North (WF6)
Garryantanvally (WF5)
SW04
CUT LINE TO FIG. 7.2
SW05
SW02
CUT LINE TO FIG. 7.3
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Sampling Locations SW01
Water Features (WF1)
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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Component: Natura Impact Statement
Title: Surface Water Features - Sheet 3 of 6
Designed: OD
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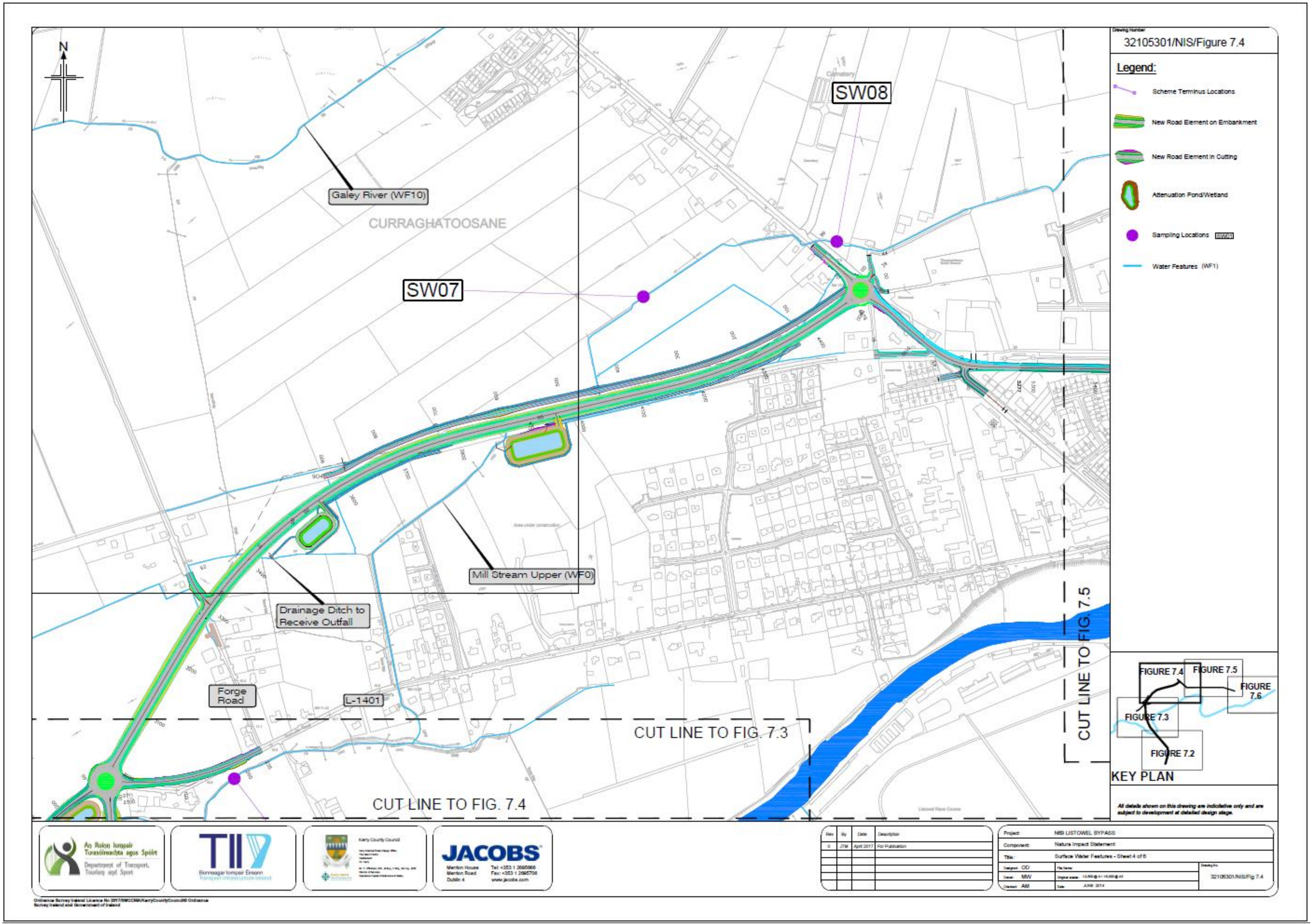
Checked: AM
Date: JUNE 2014
32105301/NIS/Fig 7.3



Drawing Number
32105301/NIS/Figure 7.4
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Sampling Locations
Water Features (WF1)
N
SW08
SW07
Galey River (WF10)
CURRAGHATOOSANE
Mill Stream Upper (WF0)
Drainage Ditch to Receive Outfall
Forge Road
L-1401
CUT LINE TO FIG. 7.3
CUT LINE TO FIG. 7.4
CUT LINE TO FIG. 7.5
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
KEY PLAN
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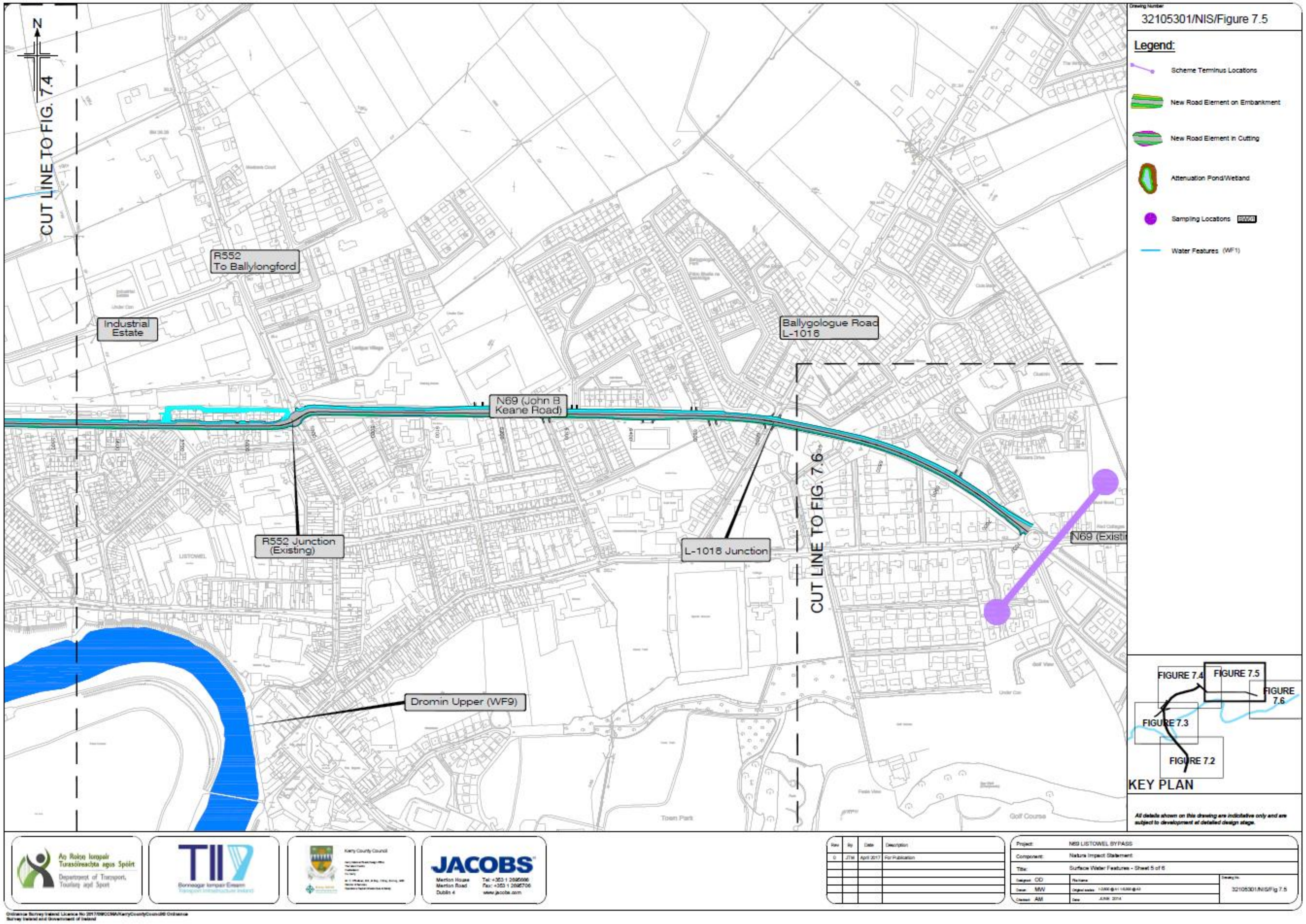
Date: JUNE 2014
32105301/NIS/Fig 7.4


32105301/NIS/Figure 7.5
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element in Cutting
Attenuation Pond/Wetland
Sampling Locations
Water Features (WF1)
N
CUT LINE TO FIG. 7.4
CUT LINE TO FIG. 7.6
R552
To Ballylongford
Industrial
Estate
Ballygologue Road
L-1016
N69 (John B
Keane Road)
R552 Junction
(Existing)
L-1016 Junction
N69 (Existi
Dromin Upper (WF9)
Town Park
Golf Course
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
KEY PLAN
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Component: Nature Impact Statement
Title: Surface Water Features - Sheet 5 of 6
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Date: JUNE 2014
Drawing No. 32105301/NIS/Fig 7.5
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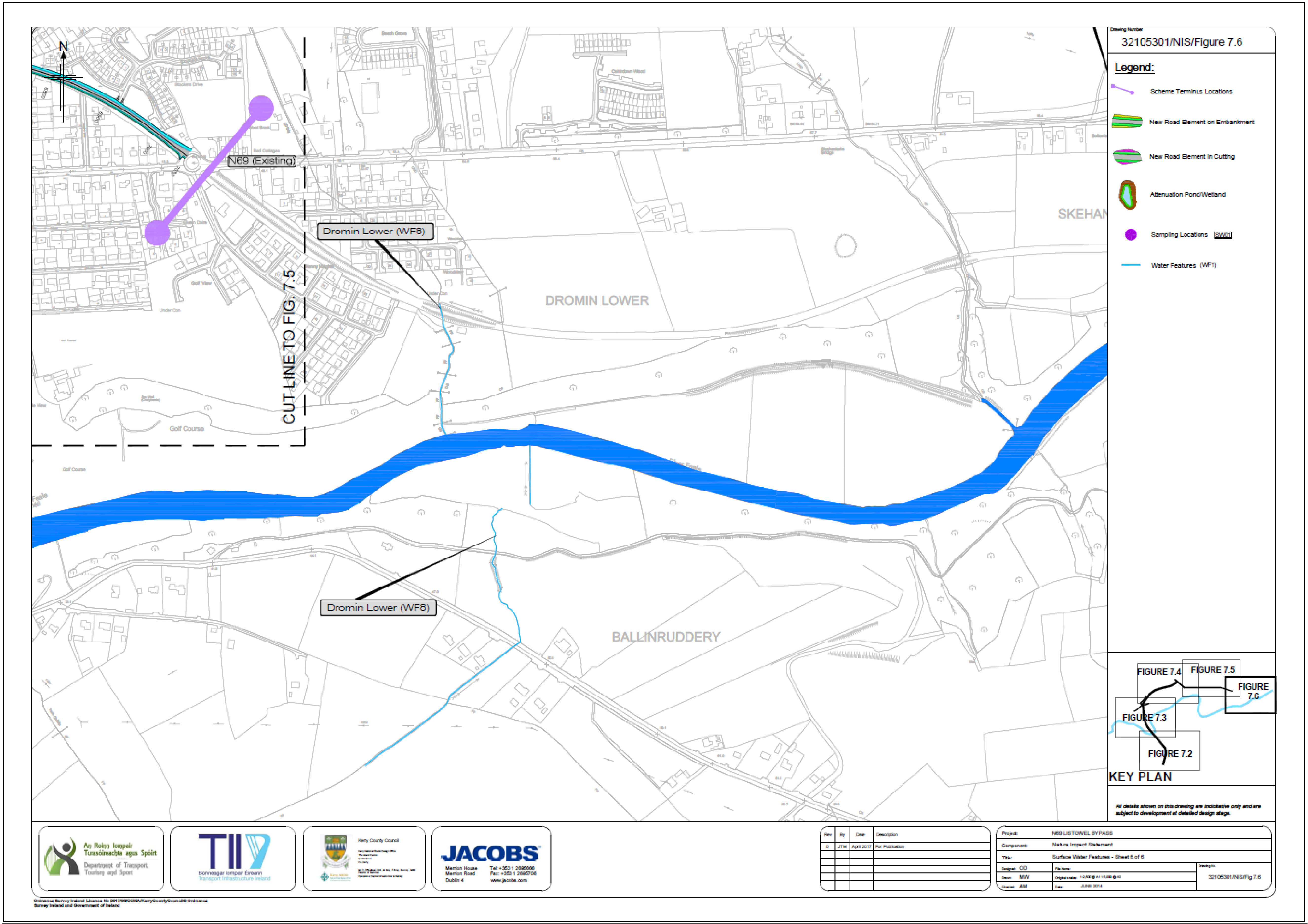

Drawing Number
32105301/NIS/Figure 7.6
Legend:
Scheme Terminus Locations
New Road Element on Embankment
New Road Element In Cutting
Attenuation Pond/Wetland
Sampling Locations SW01
Water Features (WF1)
N
N69 (Existing)
Dromin Lower (WF8)
CUT LINE TO FIG. 7.5
DROMIN LOWER
SKEHAN
Golf Course
Dromin Lower (WF8)
BALLINRUDDERY
FIGURE 7.4
FIGURE 7.5
FIGURE 7.6
FIGURE 7.3
FIGURE 7.2
KEY PLAN
All details shown on this drawing are indicative only and are subject to development at detailed design stage.
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Rev By Date Description
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Project: N69 LISTOWEL BYPASS
Component: Natura Impact Statement
Title: Surface Water Features - Sheet 6 of 6
Designer: OD
Drawn: MW
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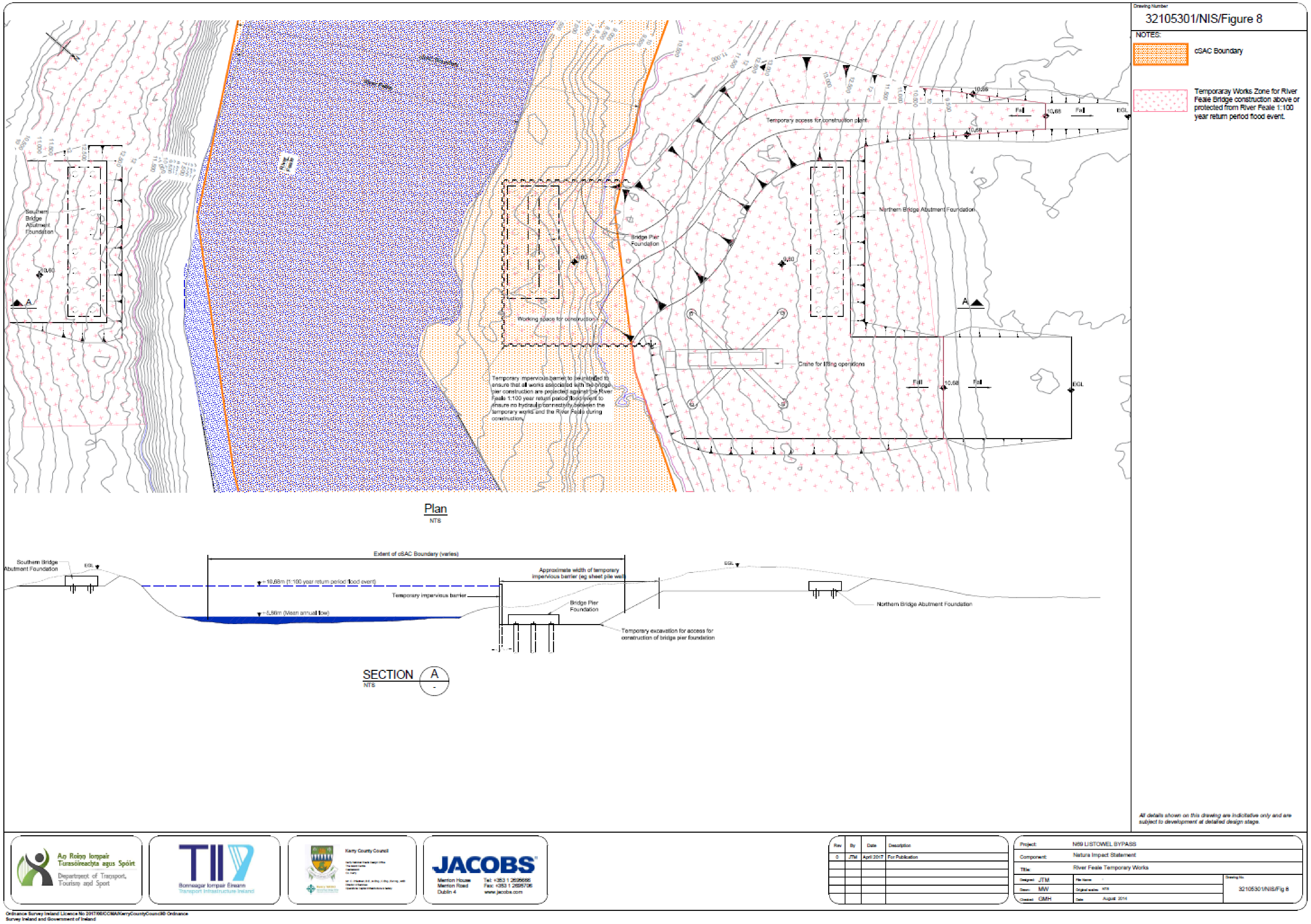
Date: JUNE 2014
Drawing No. 32105301/NIS/Fig 7.6

Figure 8 & 9: River Feale Bridge Temporary Works & General Arrangement



Drawing Number
32105301/NIS/Figure 8
NOTES:
cSAC Boundary
Temporaray Works Zone for River Feale Bridge construction above or protected from River Feale 1:100 year return period flood event.
Southern Bridge Abutment Foundation
Temporary access for construction plant
Northern Bridge Abutment Foundation
Bridge Pier Foundation
Working space for construction
Crane for lifting operations
Temporary impervious barrier to be installed to ensure that all works associated with the bridge pier construction are protected against the River Feale 1:100 year return period flood event to ensure no hydraulic connectivity between the temporary works and the River Feale during construction.
Fall
EGL
Plan
NTS
Extent of cSAC Boundary (varies)
Southern Bridge Abutment Foundation
10.68m (1:100 year return period flood event)
5.58m (Mean annual flow)
Temporary impervious barrier
Approximate width of temporary impervious barrier (eg sheet pile wall)
Bridge Pier Foundation
Temporary excavation for access for construction of bridge pier foundation
Northern Bridge Abutment Foundation
SECTION A
NTS
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Project: N69 LISTOWEL BYPASS
Component: Natura Impact Statement
Title: River Feale Temporary Works
Designed: JTM
Drawn: MW
Checked: GMH
Original scales: NTS
Date: August 2014
Drawing No. 32105301/NIS/Fig 8
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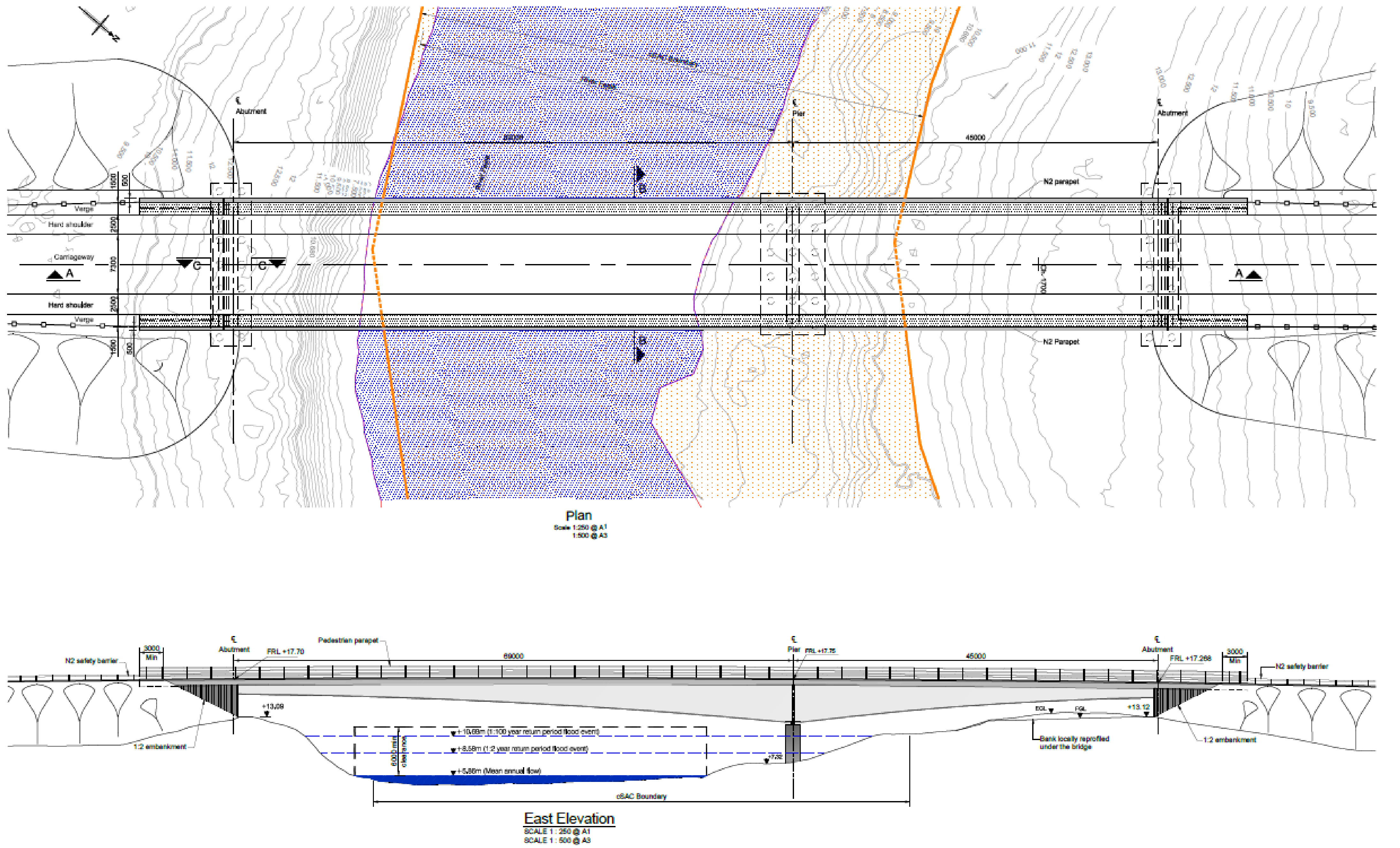

Notes:

1. All dimensions are in millimetres unless noted otherwise.
2. All levels and chainage in metres. All levels refer to Malin Head Datum.

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Component:	Environmental Impact Statement		
Title:	River Feale Bridge General Arrangement		
Designed: JTM	File Name:		Drawing No. 32105301/NIS/Fig 9
Drawn: JTM	Original scales: As shown @ A1		
Checked: GMH	Date: April 2017		

Ecological Valuation Criteria

International Importance:

- 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation.
- Proposed Special Protection Area (pSPA).
- Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended).
- Features essential to maintaining the coherence of the Natura 2000 Network.[1]
- Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive.
- Resident or regularly occurring populations (assessed to be important at the national level)[2] of the following:
    - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and / or
    - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive.
- Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971).
- World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972).
- Biosphere Reserve (UNESCO Man & The Biosphere Programme).
- Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979).
- Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979).
- Biogenetic Reserve under the Council of Europe.
- European Diploma Site under the Council of Europe.
- Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988).[3]

National Importance:

- Site designated or proposed as a Natural Heritage Area (NHA).
- Statutory Nature Reserve.
- Refuge for Fauna and Flora protected under the Wildlife Acts.
- National Park.
- Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park.
- Resident or regularly occurring populations (assessed to be important at the national level)[4] of the following:
    - Species protected under the Wildlife Acts; and/or
    - Species listed on the relevant Red Data list.
- Site containing 'viable areas'[5] of the habitat types listed in Annex I of the Habitats Directive.

[1] See Articles 3 and 10 of the Habitats Directive.

[2] It is suggested that, in general, 1% of the national population of such species qualifies as an internationally important population. However, a smaller population may qualify as internationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[3] Note that such waters are designated based on these waters' capabilities of supporting salmon (*Salmo salar*), trout (*Salmo trutta*), char (*Salvelinus*) and whitefish (*Coregonus*).

[4] It is suggested that, in general, 1% of the national population of such species qualifies as a nationally important population. However, a smaller population may qualify as nationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[5] A 'viable area' is defined as an area of a habitat that, given the particular characteristics of that habitat, was of a sufficient size and shape, such that its integrity (in terms of species composition, and ecological processes and function) would be maintained in the face of stochastic change (for example, as a result of climatic variation).

Ecological Valuation Criteria

County Importance:

- Area of Special Amenity.[6]
- Area subject to a Tree Preservation Order.
- Area of High Amenity, or equivalent, designated under the County Development Plan.
- Resident or regularly occurring populations (assessed to be important at the County level)[7] of the following:
    - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
    - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
    - Species protected under the Wildlife Acts; and/or
    - Species listed on the relevant Red Data list.
- Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance.
- County important populations of species, or viable areas of semi-natural habitats or natural heritage features identified in the National or Local Biodiversity Action Plan (BAP) if this has been prepared.
- Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county.
- Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.

Local Importance (higher value):

- Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared;
- Resident or regularly occurring populations (assessed to be important at the Local level)[8] of the following:
    - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
    - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
    - Species protected under the Wildlife Acts; and/or
    - Species listed on the relevant Red Data list.
- Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality;
- Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.

Local Importance (lower value):

- Sites containing small areas of semi-natural habitat that are of some local importance for wildlife;
- Sites or features containing non-native species that are of some importance in maintaining habitat links.

[6] It should be noted that whilst areas such as Areas of Special Amenity, areas subject to a Tree Preservation Order and Areas of High Amenity are often designated on the basis of their ecological value, they may also be designated for other reasons, such as their amenity or recreational value. Therefore, it should not be automatically assumed that such sites are of County importance from an ecological perspective.

[7] It is suggested that, in general, 1% of the County population of such species qualifies as a County important population. However, a smaller population may qualify as County importance where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[8] It is suggested that, in general, 1%of the local population of such species qualifies as a locally important population. However, a smaller population may qualify as locally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

The impact significance for terrestrial and aquatic habitats has been assessed using the Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2006), taking full cognisance of the NRA's Guidelines for assessment of Ecological Impacts of National Road Schemes (NRA, 2009b). Ecological Impact Assessment was undertaken for all Key Ecological Receptors (KER's are defined in the NRA guidelines (2009b), as "both of sufficient value to be material in decision making, and likely to be affected significantly". According to the NRA guidelines, KER's are of Local Importance (Higher Value) or higher as per NRA value criteria. Features of Local Importance (Lower Value) are not Key Ecological Receptors and are excluded from impact assessment. The Zone of Influence for each KER is defined in Section 6.3.1 (a); the criteria used to characterise impacts are outlined in the Table below.

Table of Magnitude Parameters

Parameter	Categories	
Type of impact	Positive/ Negative	
Magnitude of impact	Size or amount of impact	
Extent	Area over which impact occurs (may be the same as magnitude if whole habitat impacted)	
Duration	Time over which impact is expected to last. For example, described as Short-term, Medium-term or Long-term in relation to relevant species/ habitat time-scales.	
Reversibility	Temporary/ Permanent	
Timing and frequency	Timing of impacts in relation to relevant life-stages or seasons	
Likelihood of impact occurring	Near-certain: Probable: Unlikely: Extremely unlikely:	probability >95% probability 50-95% probability 5-50% probability <5%

An impact is considered to be ecologically significant if it impacts the conservation status of a Key Ecological Receptor within a specified geographical area. If impacts are not found to be significant at the highest geographical level at which the Key Ecological Receptor has been valued using NRA Valuation Criteria, then the impacts may be significant at a lower level. For instance, there may be a significant impact at a local level on a species which is valued at an international level (Appendix 6.5). The highest levels of impact significance for each Key Ecological Receptor 'value' rating are shown in the Table below.

Table of Significance

Table of Highest Levels of Impact Significance Sensitive Ecological Receptor 'value' rating	Highest significance level
International Importance	Significant Positive/ Negative impact at International level
National Importance	Significant Positive/ Negative impact at National level
County Importance	Significant Positive/ Negative impact at County level
Local Importance (higher value)	Significant Positive/ Negative impact at Local level
Local Importance (lower value)	Significant Positive/ Negative impact at Local level

Flora and fauna species have been evaluated in relation to the NRA criteria set out in Appendix 6.5 which includes for example legal protection they may be afforded (at International or National level), their conservation status and local abundance. For instance, a species that is listed on Annex II or IV of the EC Habitats Directive is considered to be of 'International' importance. As above, this does not mean that an impact will necessarily be significant at an International level.

scott cawley

DRAFT APPLICATION FOR LICENCE WITH REGARD TO THE PROTECTION AFFORDED TO BADGER *MELES MELES* UNDER SECTION 23 (5)(D) OF THE WILDLIFE ACTS 1976 AND 2000 (AS AMENDED)

RELATING TO THE PROPOSED N69 LISTOWEL BYPASS, CO. KERRY

DATE OF DRAFT APPLICATION: 9TH MAY 2017

Proposed Licensee:

To be confirmed – the appointed contractor

Proposed Scientific Agent:

Scott Cawley
College House
Rock Road
Blackrock
Co. Dublin
A94 F9X9

1 INTRODUCTION

A licence is being sought to permit disturbance to, and the removal of, six badger setts located along the Compulsory Purchase Order (CPO) fenceline/boundary of the N69 Listowel bypass.

2 BACKGROUND

As part of the EIA process, a dedicated Badger survey was carried out in April 2013 having regard to the survey methodology set out in *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (National Roads Authority, 2009) and the *Design Manual for Roads and Bridges* (Highways Agency, 2001). Any badger setts encountered during the course of other survey works were also recorded. These surveys findings were updated following the undertaking of a repeat site walkover in September 2016.

A total of 24 Badger setts were recorded overall. Of these, six setts were found to be within the zone of influence of general construction activities for the N69 Listowel bypass based on the impact distance bands (*i.e.* within 50 m) described in the NRA guidance (National Roads Authority, 2006) – setts S2, S3, S4, S4a S15 and S22. See Table 1 below and the accompanying set of figures for sett locations relative to the proposed development (*i.e.* Figures 6.1.11-6.1.17 in Volume 3 of the EIS).

Table 1: Badger setts within the study area of the proposed development

Ref. No.	Type of sett[1]	Status and description	Approximate distance from proposed development boundary
S1	Subsidiary	Active sett with two entrances. In hedgerow along field boundary.	270 m west of the proposed development boundary
S1a	Outlier	Inactive mammal burrow.	260m west of the proposed development boundary
S2	Outlier	Inactive sett with two entrances. In hedgerow along field boundary.	Along the western edge of the proposed development boundary
S3	Outlier	Active sett with a single entrance. In hedgerow along field boundary.	Along the western edge of the proposed development boundary
S4	Outlier	Active sett with two entrances. In hedgerow along field boundary.	Along the western edge of the proposed development boundary
S4a	Outlier	Active outlier sett.	Along the western edge of the proposed development boundary
S5	Main sett	Active sett with at least three entrances with fresh bedding and recently excavated spoil. In woodland at the top of the river bank/field boundary.	230 m west of the proposed development boundary
S6	Outlier	Inactive sett with a single overgrown entrance. Along the bank of a small stream.	160 m west of the proposed development boundary
S7	Main sett	Active sett with at least five entrances. In dense scrub cover at the top of the river bank/field boundary.	175 m east of the proposed development boundary
S8	Outlier	Active sett with two entrances. In hedgerow along field boundary.	120 m south of the proposed development boundary

[1] Main sett = breeding sett, focus of most badger activity; Annexe sett = large sett, usually within 50 m of the main sett; Subsidiary sett = smaller sett, not peripheral, within territory of badger social group; Outlier sett = small sett, usually on periphery of group territory; Minor sett = incidental sett, not on periphery of group territory.

Ref. No.	Type of sett[1]	Status and description	Approximate distance from proposed development boundary
S9	Subsidiary	Active sett with five entrances. In hedgerow along field boundary.	80 m south of the proposed development boundary
S10	Outlier	Inactive sett with a single entrance. In hedgerow along field boundary. Mammal burrow was in use by rabbits in 2016.	220 m north-west of the proposed development boundary
S11	Outlier	Inactive sett with a single entrance. In hedgerow along field boundary. Mammal burrow was in use by rabbits in 2016.	250 m north-west of the proposed development boundary
S12	Outlier	Inactive sett with a single entrance. In hedgerow along field boundary. Mammal burrow was in use by rabbits in 2016.	260 m north-west of the proposed development boundary
S13	Outlier	Inactive sett with a single entrance. In hedgerow along field boundary. Mammal burrow was in use by rabbits in 2016.	270 m north-west of the proposed development boundary
S14	Outlier	Active sett with a single entrance. In hedgerow above wet ditch along field boundary.	380 m north-west of the proposed development boundary
S15	Outlier	Inactive sett with a single entrance. In hedgerow along field boundary.	Along the southern edge of the proposed development boundary
S16	Annexe	Active sett with three entrances. In dense scrub cover at the top of the river bank/field boundary.	280 m west of the proposed development boundary
S17	Outlier	Active sett with two entrances. In dense scrub cover at the top of the river bank/field boundary.	590 m south-east of the proposed development boundary
S18	Outlier	Inactive sett with a single entrance. Along hedgerow on river bank.	1.3 km west of the proposed development boundary
S19	Outlier	Inactive sett with a single entrance. In dense scrub cover along the river bank.	1.35 km west of the proposed development boundary
S20	Outlier	Inactive sett with a single entrance. In scrub cover along the river bank.	290 m west of the proposed development boundary
S21	Annexe	Active sett with two entrances. In dense scrub cover at the top of the river bank/field boundary. May be linked underground to S7.	240 m east of the proposed development boundary
S22	Outlier	No-longer an active sett with a single entrance. In hedgerow along field boundary. 2016 Update: it appears that this sett has been covered by large felled tree trunks which were placed on top of it. No signs of activity in 2016.	Along the eastern edge of the proposed development boundary

Three of these six setts were active at the time of survey in 2016, with the remainder being inactive. The affected badger setts were considered to be within two distinct badger territories, separated by the River Feale; one territory along the southern bank of the river in the townlands of Coolnaleen Lower and Garryantanvally, covering an area of c.80ha, the second territory on the north bank in the townlands of Scartleigh, Kilcreen and Islandganniv North, covering an area of c.105ha. There was also evidence of badger activity to the north of the R553 but no setts were present here; it is likely that this is from a badger group located further to the north and represents the southern extent of this group's territory.

Five setts of the badger group found south of the River Feale lie along the proposed development boundary (S2, S3, S4 S4a and S22). All of these setts are small, outlier setts on the periphery of the badger group's territory. As a minimum, these setts will be subject to indirect, temporary disturbance as a result of increased human presence, noise and vibration associated with the construction works and will likely be abandoned for the duration of construction works. However these setts may need to be removed to facilitate the site clearance and construction works.

Given that these are outlier setts and that there are other alternative setts available to the badger group within their territory (including the mains sett S5), the disturbance and (if required) removal of these setts will not significantly affect the badger group long-term nor will it affect the conservation status of the species.

One of the setts of the badger group north of the River Feale lies along the proposed development boundary (S15). This is a small outlier sett on the periphery of the badger group's territory. No other setts in this badger territory are located within the zone of influence of the proposed development. As a minimum this sett will be subject to indirect temporary disturbance as a result of increased human presence, noise and vibration associated with the construction works and will likely be abandoned for the duration of construction works. However this sett may need to be removed to facilitate the site clearance and construction works.

Given that this is an outlier sett and that there are many other alternative setts available to the badger group within their territory (including the mains sett S7), the disturbance and (if required) removal of this sett will not significantly affect the badger group long-term nor will it affect the conservation status of the species.

3 MITIGATION MEASURES

All exclusion works will be undertaken in accordance with the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes (National Roads Authority, 2005).*

- A non-interference zone of 30 m, extended to 50 m during the breeding season (December to June inclusive) if the sett is active, to be established using temporary fencing at the outset of works (accompanied by appropriate signage). The fencing shall be of a post and rail type (or equivalent) and of a sufficient durability to maintain the exclusion zone throughout the construction period.
- No heavy machinery shall be used within 30 m of Badger setts at any time. Lighter machinery (generally wheeled vehicles) shall not be used within 20 m of a sett entrance. No works shall be under taken within 50 m of active setts during the breeding season. Neither blasting nor pile driving shall be undertaken within 150 m of active setts during the breeding season (December to June inclusive).
- If necessary works within the distance bands described above will only be carried out in consultation with the NPWS and only during daylight hours so as not to disturb foraging Badgers.
- If the sett requires exclusion (or temporary exclusion for the duration of the construction period) and removal this will be undertaken in accordance with the methodology detailed in the *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (National Roads Authority, 2006). If the sett is active then it shall not be removed within the breeding season (December to June inclusive).

REFERENCES

Highways Agency (2001) *Design Manual for Roads and Bridges: Volume 10: Environmental Design and Management. Section 4: Nature Conservation: Part 2, HA 59/92; Mitigating against Effects on Badgers.* The Highways Agency.

National Roads Authority (2005) *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes.*

National Roads Authority (2009) *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes.* National Roads Authority.

Figures

Results of the N69 Listowel Bypass mammal survey

EIS Volume 3 Figures 6.1.11-6.1.17 *Mammal Survey of the EIS*

scott cawley

DRAFT APPLICATION FOR DEROGATION WITH REGARD TO THE PROTECTION AFFORDED TO OTTER *LUTRA LUTRA* UNDER *EUROPEAN COMMUNTIES (BIRDS AND NATURAL HABITATS) REGULATIONS, 2011* (AS AMENDED)

RELATING TO THE PROPOSED N69 LISTOWEL BYPASS, CO. KERRY.

DATE OF DRAFT APPLICATION: 9TH MAY 2017

Proposed Licensee:

To be confirmed – the appointed contractor

Proposed Scientific Agent:

Scott Cawley
College House
Rock Road
Blackrock
Co. Dublin
A94 F9X9

1 INTRODUCTION

A derogation licence is being sought to permit the disturbance of one potential otter holt in the vicinity of the River Feale (the River Feale lies within the Lower River Shannon SAC at this location), during construction works associated with the proposed N69 Listowel Bypass.

2 BACKGROUND

As part of the EIA process, a programme of otter surveys were carried out over the period April 2013 to April 2014 having regard to the survey methodology set out in *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (National Roads Authority, 2009) and the *Design Manual for Roads and Bridges* (Highways Agency, 2001). Subsequent rechecks of the survey route were undertaken in September 2016.

Evidence of otter activity was recorded frequently on watercourses within the locality and most notably, due to these watercourses being crossed by the proposed development, along the banks of the River Feale and on the Mill Stream Lower (a tributary of the River Feale). Three potential otter holts and an otter couch site were recorded within the study area (see Table 1 below and accompanying figures (Figures 6.1.11-6.1.17 in Volume 3 of the EIS) which present the findings of the otter surveys).

Table 1: Otter holts/couches within the study area of the proposed development

Ref. No.	Feature	Status and description	Approximate distance from proposed development boundary
H1	Potential holt	Active burrow. Hollow underneath exposed tree roots with well-worn path into the entrance.	1.95 km downstream of the proposed development boundary (*c.* 1.2 km straight line distance)
H2	Potential holt	Inactive potential holt. Hollow underneath exposed tree roots.	1.9 km downstream of the proposed development boundary (*c.* 1.1 km straight line distance)
H3	Couch site	Active couch site within a concrete pipe next to the river bank.	1.3 km downstream of the proposed development boundary (*c.* 560 m straight line distance)
H4	Potential holt	Inactive potential holt. Hollow underneath exposed tree roots on the stream bank.	Along the proposed development boundary

The zone of influence in relation to potential disturbance/displacement effects of construction works on otter holts/couch sites is considered to be 150m, in a worst case scenario (National Roads Authority, 2006 and Highways Agency, 2001). Therefore, only one potential otter holt (H4) will be disturbed by construction works associated with the proposed N69 Listowel Bypass at Coolnaleen Lower/Garryantanvally. Although this burrow along the stream bank displays the characteristics of otter holts, no evidence of any otter activity was recorded in its vicinity throughout the survey period. The hedgerow/treeline embankment containing the potential otter holt will be retained and therefore, there is no proposal to destroy/remove the potential holt site. However, the potential holt site may need to be removed, if only partially in the event that tunnels extend beyond the embankment edge, to facilitate the site clearance and construction works.

The impact of construction works on this potential otter holt will be temporary (*i.e.* restricted to the construction period) and, given that no evidence of any otter activity had been recorded in its vicinity throughout the survey period and that the other holt/couch sites are remote from any potential disturbance effects, the works will not affect the conservation status of the species either locally or within the Lower River Shannon SAC.

3 MITIGATION MEASURES

Despite the absence of any evidence to suggest that H4 was in use by otter at the time of the surveys, given this feature displays the characteristics of an otter holt (and could potentially have been used as a resting site in the past), a precautionary approach is being taken with regard to seeking a licence to monitor and carry out works in close proximity to this potential holt.

A non-interference zone of 20 m, extended to 150 m if the holt/couch is in use by a breeding female or where cubs are present, will be established using temporary fencing at the outset of works (accompanied by appropriate signage). The fencing shall be of a post and rail type (or equivalent) and of a sufficient durability to maintain the exclusion zone throughout the construction period. Works within the distance bands described above will only be carried out during daylight hours so as not to disturb foraging otters.

A period of monitoring (of at least five days) will be required in order to determine the status of the potential holt.

In the event that any confirmed holt will be directly affected and require removal, the following procedure will apply. If inactive, the holt can be hard blocked for the duration of the construction works, or removed immediately. If active, otter may be deterred from using the area during construction and if the holt is abandoned (following a period of monitoring as above) the procedure described above for inactive holts can be followed. If breeding otter or cubs present then no exclusion procedures can be undertaken until the holt has been abandoned.

All works will be undertaken in accordance with the methodology detailed in the *Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes* (National Roads Authority, 2008) and the *Design Manual for Roads and Bridges: Volume 10: Environmental Design and Management. Section 4: Nature Conservation: Part 4, HA 81/99; Nature Conservation Advice in Relation to Otters* (Highways Agency, 2001).

REFERENCES

Highways Agency (2001) *Design Manual for Roads and Bridges: Volume 10: Environmental Design and Management. Section 4: Nature Conservation: Part 2, HA 59/92; Nature Conservation Advice in Relation to Otters*. The Highways Agency.

National Roads Authority (2008) *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes*. National Roads Authority.

National Roads Authority (2009) *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes*. National Roads Authority.

Figures

Results of the N69 Listowel Bypass mammal survey

EIS Volume 3 Figures 6.1.11-6.1.17 *Mammal Surveyof the EIS*

scott cawley

DOCUMENT SUPPORTING A DRAFT APPLICATION FOR A WILDLIFE ACTS SECTION 22 LICENCE

WITH RESPECT TO THE N69 LISTOWEL BYPASS

Proposed Licensee:

To be confirmed – the appointed contractor

Proposed Scientific Agent:

Scott Cawley Ltd.
College House
71-73 Rock Road
Blackrock
Co. Dublin
A94 F9X9

1 INTRODUCTION

The licence is being sought to permit works that will disturb/obstruct a sand martin nest site on the banks of the River Feale at Q 97312 32484 (see Figure 1).

2 PROPOSED WORKS

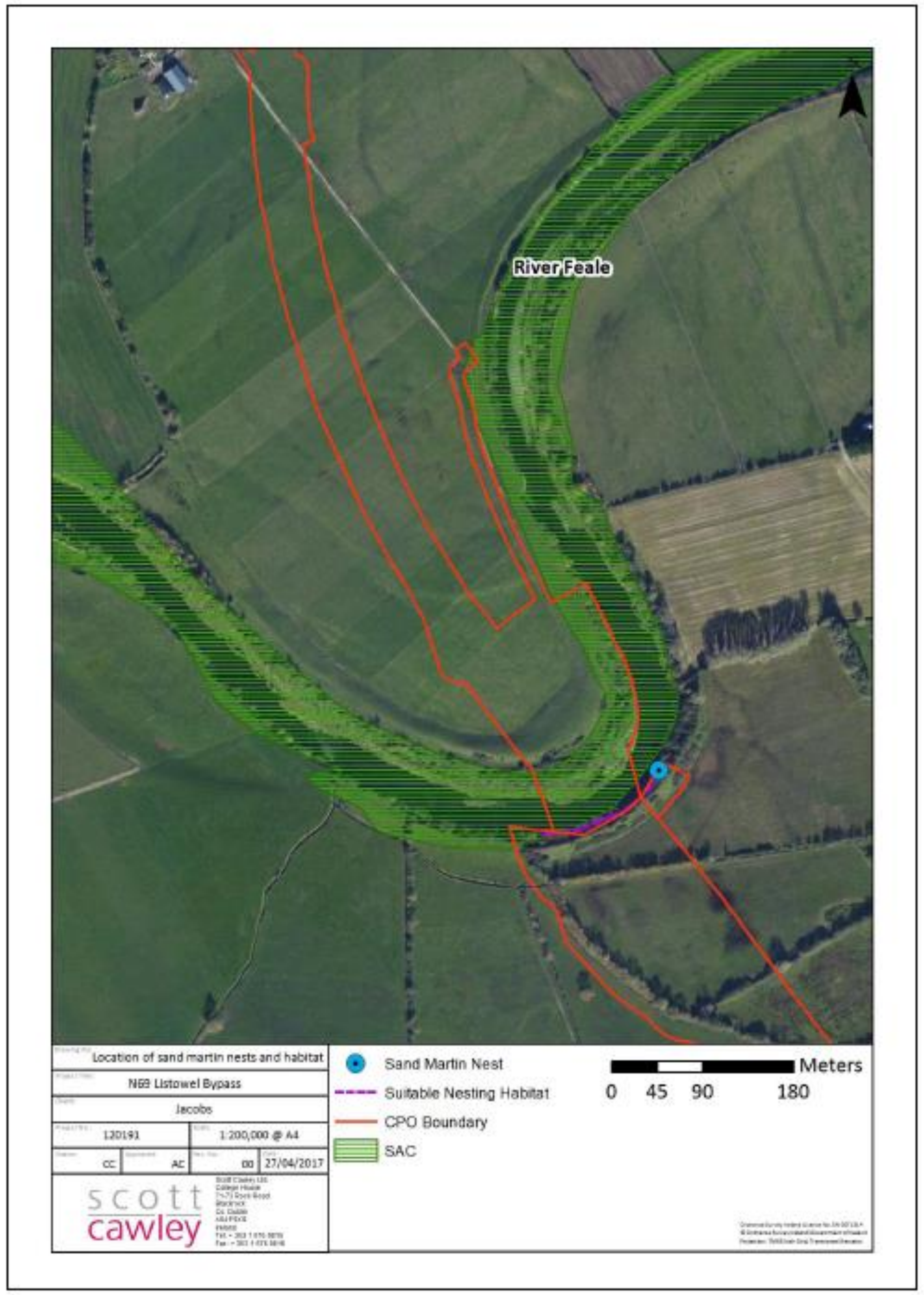
The bridge is being constructed as part of the proposed N69 Listowel Bypass project. With regards to sand martins, the construction of the proposed New River Feale Bridge *c.* 20m east of a breeding site will not result in direct impacts to nests. Nonetheless, the nest site will be subject to disturbance effects during the breeding seasons when the bridge is being constructed. Any disturbance to the nest site will be short-term (*i.e.* would last for the duration of the bridge construction works), and is considered to be a local level impact given the small number of holes (three recorded within a 3m x 3m area of cliff face) at the site.

3 MITIGATION MEASURES

The following mitigation measures are proposed:

> **MMB1:** Substantive construction works will commence on the bridge in the period 1st October through 28th February inclusive. However, where this seasonal constraint cannot be adhered to (*e.g.* due to high water levels or other constraints on construction works commencing at the River Feale Crossing Point such as mitigation necessary for other species or environmental criteria) then the measure below will be undertaken.
>
> **MMB2:** The sand martin nest holes and the area of cliff face within the CPO boundary at the River Feale crossing point which is suitable for nesting sand martin, will be covered over by the installation of mesh netting or similar material prior to the commencement of the bird breeding season (*i.e.* before 1st March or after 31st August). This will prevent sand martins from establishing nests within or immediately adjacent to the area of proposed works. Once construction works at the crossing are completed, the fine mesh will be removed, restoring access to the area for the species.

Figure 1: Location of sand martin nest and suitable habitat in relation to the area of proposed works.



WILDLIFE ACTS 1976 TO 2012 - SECTION 22(9)(d)

APPLICATION FOR LICENCE TO EXAMINE, INSPECT OR TAKE THE NESTS OR EGGS OF PROTECTED WILD BIRDS FOR EDUCATIONAL, SCIENTIFIC OR OTHER PURPOSES

ALL DETAILS IN BLOCK LETTERS

Name of applicant:	Proposed Licensee: To be confirmed – the appointed contractor Proposed Scientific Agent: Scott Cawley Ltd.,
Address: (in full include Post Code)	Proposed Licensee: To be confirmed – the appointed contractor Proposed Scientific Agent: College House, 71-73 Rock Road, Blackrock, Co. Dublin, A94 F9X9
Email Address:	To be confirmed – the appointed contractor
Telephone No: (Landline / Mobile)	To be confirmed – the appointed contractor

Please fill in where necessary overleaf:

****N.B. Where necessary attach any additional relevant information.****

DECLARATION

I declare that all particulars are correct to the best of my knowledge and belief, and I apply for a licence in accordance with these particulars.

I understand that any false declaration may lead to having my licence revoked.

Signature: ……………………………………………… **Date:** 9th May 2017

Please return the completed application form to:
Wildlife Licensing
National Parks and Wildlife Service
7 Ely Place
Dublin 2

An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs

Tel.: (01) 888 3242
Email: wildlifelicence@ahg.gov.ie

ALL DETAILS IN BLOCK LETTERS

1. Purpose of licence:

THE CONSTRUCTION OF THE PROPOSED NEW RIVER FEALE BRIDGE AS PART FO THE PROPOSED N69 LISTOWEL BYPASS PROJECT INCLUDES WORKING WITHIN *C.* 20M OF A BREEDING SITE FOR SAND MARTIN. WHILE CONSTRUCTION WILL NOT DIRECTLY IMPACTS NESTS, THE NEST SITE WILL BE SUBJECT TO DISTURBANCE EFFECTS DURING THE BREEDING SEASONS WHEN THE BRIDGE IS BEING CONSTRUCTED. ANY DISTURBANCE TO THE NEST SITE WILL BE SHORT-TERM (*I.E.* WOULD LAST FOR THE DURATION OF THE BRIDGE CONSTRUCTION WORKS), AND IS CONSIDERED TO BE A LOCAL LEVEL IMPACT GIVEN THE SMALL NUMBER OF NESTING HOLES (THREE RECORDED WITHIN A 3M X 3M AREA OF CLIFF FACE) AT THE SITE.

2. Species Name: (Common & Scientific)

SAND MARTIN *RIPARIA RIPARIA*

3. Area(s) in which applicant will operate: (e.g. county & townland) (map(s) may be requested)
Finuge, Listowel, Co. Kerry. Irish Grid Reference Q 97313 32495

4. State qualifications/experience in this field of activity:
To be confirmed – the appointed contractor's scientific agent to complete this

5. State any other supporting licence/permit(s): (include photocopy with application)

6. Organisation to which applicant is affiliated:

To be confirmed – the appointed contractor's scientific agent to complete this

7. Period for which licence is required: (include start/end date)

To be confirmed by the appointed contractor

8. Number of previous licence (if any) **and date of expiry:**
To be confirmed – the appointed contractor's scientific agent to complete this

Note: That insufficient information will lead to a delay in issuing your licence

OUTLINE INVASIVE SPECIES MANAGEMENT PLAN

N69 LISTOWEL BYPASS, CO. KERRY

Prepared For Jacobs Engineering Ltd.

Rev.	Status	Author	Reviewed By	Approved By	Issue Date
R00	Final	DB/CC	AC	AC	06/05/2017

Scott Cawley, College House, 71-73 Rock Road, Blackrock, Co. Dublin, A96 X6V2, Ireland

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TABLE OF CONTENTS

1 Introduction

This purpose of this Outline Invasion Species Management Plan is to describe the mitigation options available to the contractor to manage and prevent the spread of non-native invasive plant species recorded along the alignment of the proposed N69 Listowel Bypass.

This outline plan is intended to be a working document and will be updated by the contractor to form the detailed Invasion Species Management Plan which will form part of the contractors Environmental Operating Plan (EOP) for the construction of the proposed road development.

Construction (and potentially operational maintenance works) will disturb stands of non-native invasive plants and/or soils contaminated with non-native invasive plant material. Given that the proposed development crosses the Lower River Shannon cSAC [002165] and crosses watercourses that drain to the Cashen River Estuary pNHA [001340] downstream, there is an identified risk of the plant species in question being spread locally (*e.g.* during intentional movement of contaminated material, or accidentally where soils/plant material are spread by machinery tracks/tyres) or washed downstream to the lower reaches of the River Feale and Cashen Estuary, affecting habitats there.

Therefore, the implementation of the management measures set out in this plan is required to avoid any indirect or *ex-situ* impacts to habitats and species within these areas designated for nature conservation, both during construction and operation, and in the case of the Lower River Shannon cSAC, to avoid adverse effects on the integrity of this European site[1].

2 Methodology

This report and the mitigation strategies relating to each invasive plant species have been prepared with regard to the following guidance documents, where relevant:

- *Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads* (National Roads Authority, 2010);
- *Managing Japanese Knotweed on Development Sites (version 3, amended in 2013): The Knotweed Code of Practice* (Environment Agency, 2013);
- *Managing Invasive Non-native Plants in or near Freshwater* (Environment Agency, 2010);
- *Best Practice Management Guidelines for Japanese Knotweed* (Invasive Species Ireland, 2008);
- Royal Horticultural Society guidance for the control of Spanish bluebell and hybrids https://www.rhs.org.uk/advice/profile?pid=426; and
- Royal Horticultural Society guidance for the control of Wild garlic https://www.rhs.org.uk/advice/profile?PID=384.

3 Results

Habitat surveys were undertaken along the proposed alignment of the N69 Listowel Bypass during multidisciplinary surveys carried out for the preparation of an Environmental Impact Statement and Natura Impact Statement from the 3rd to 5th April 2013, and as part of dedicated detailed botanical surveys carried out between the 17th and 18th July 2013 and on the 26th June 2014 and a site walkover conducted between 31st August and 2nd September 2016.

There were four non-native invasive plant species listed in the Third Schedule of the *European Communities (Birds and Natural Habitats) Regulations, 2011* as amended found to be present within, or in close proximity to, the proposed alignment of the N69 Listowel Bypass (see Table 1 below and Figures in Appendix B).

[1] European sites or Natura 2000 sites are defined under the Habitats Directive (Article 3) as a European ecological network of special areas of conservation composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II. The aim of the network is to aid the long-term survival of Europe's most valuable and threatened species and habitats. In Ireland these sites are designed as *European sites* - defined under the Planning Acts and/or Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special area of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as candidate Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

Table 1 Summary of non-native invasive plant species, listed in the Third Schedule of the Birds and Habitats Regulations 2011 (as amended), recorded along or near the alignment of the proposed N69 Listowel Bypass

Common Name	Scientific Name	Location
Japanese knotweed	*Fallopia japonica*	Along both banks of the River Feale in the vicinity of the proposed crossing point; Along field boundary within the proposed alignment at Islandganniv North; Along the disused railway embankment and in the unfinished housing estate near Ashfield - Islandganniv North/Curraghatoosane; Along the north-eastern road verge at the tie-in with the R553
Indian balsam	*Impatiens glandulifera*	Along both banks of the River Feale and a drainage ditch c.100 m north of the proposed crossing point
Spanish bluebell & Hybrids	*Hyacinthoides hispanica & H. x massartiana*	Along the southern roadside verge at the tie-in with the R557; Along a field/property boundary at the eastern end of the tie-in with the Greenville Road
Three-cornered garlic	*Allium triquetrum*	On the south bank of the River Feale at the proposed crossing point; On the bank of the River Feale/drainage ditch c.100 m north of the proposed crossing point; Along property boundary c.50 m north of the tie-in with the Forge Road

4 Measures to Control/Prevent the Spread of Non-native Invasive Plant Species

4.1 Pre-construction Re-survey

As species may have spread, or their distribution may have changed, between the habitat surveys carried out for the EIS and NIS, and the commencement of construction works, the implementation of this Outline Invasive Species Management Plan will include a pre-construction re-survey within the Compulsory Purchase Order (CPO) boundary and any additional areas where construction works are required (*e.g.* temporary construction compounds, haul routes *etc.*). In accordance with the NRA guidance this survey will produce accurate 1:5,000 scale mapping for the precise location of invasive species. The pre-construction surveys will be undertaken by suitable experts with competence in identifying the species concerned having regard to any seasonal constraint.

4.2 General Measures to Avoid Spreading Invasive Species during Construction or Soil Movement

Many of the species noted above are highly invasive, and can easily spread to new areas. Most are particularly effective at colonising disturbed ground (*e.g.* construction sites). Some species spread by the re-growth of cut fragments or root material (Japanese Knotweed, Spanish Bluebell and Three-cornered garlic and Canadian waterweed), so if they are broken up during site clearance or other earthworks they can readily re-grow in new areas to which soil is moved. In the case of Indian Balsam, Three-cornered Garlic and Spanish Bluebell, even if all adult plants are removed, their seeds can remain viable in the soil for a number of years, and these can re-grow in sites of former infestation, or seeds can be carried to other parts of the site during soil movements.

The unintentional spread of invasive species during construction works is a significant issue, and if not managed in the correct manner, species like Japanese Knotweed could be spread to uninfested areas, which would increase the future cost and effort required to control the species, and could pose further public health and safety risks (Japanese Knotweed can cause damage to buildings and infrastructure).

The most common ways that these species can be spread is:

- Site and vegetation clearance, mowing, hedge-cutting or other landscaping activities;
- Spread of seeds or plant fragments during the movement or transport of soil;
- Spread of seeds or plant fragments through the local surface water and drainage network;
- Contamination of vehicles or equipment with seeds or plant fragments which are then transported to other areas; and
- Importation of soil from off-site sources contaminated with invasive species plant material.

As road verges are routinely mowed and shrubby vegetation cut back for road maintenance, it is recommended that no mowing or hedge-cutting activities take place in any areas containing invasive species (refer to Table 1 and Figures in Appendix B for locations) until successfully treated. It is important that no Japanese Knotweed plants are cut prior to or during the lifetime of the treatment programme as this is the only invasive species present along the alignment of the proposed road scheme which regrows from cut fragments.

Depending on the timescale for the construction of the proposed road scheme it may be possible to eradicate some species prior to the onset of construction on the site; this would be preferable. However if control programmes have not been achieved before construction begins, then it is recommended that the affected areas should be fenced off prior to and during construction in order to avoid spreading seeds or plant fragments around or off the construction site. Earthworks or machinery movement should be avoided in these areas until the relevant species have been eradicated. In particular, all Japanese Knotweed and Indian balsam should be fenced off during works, using a buffer of 10m around the area. Signs should be erected to inform contractors of the risk.

If soil is imported to the site for landscaping, infilling or embankments, the contractor will gain documentation from suppliers that the material is free from invasive species.

Japanese Knotweed in particular can be spread very easily during construction works. Even if stands of Japanese Knotweed and Indian Balsam are treated using herbicide, care should still be taken regarding the future use of the soil in the relevant area. For specific measures in relation to these species, reference should be made to the UK Environment Agency document *The Knotweed Code of Practice: Managing Japanese knotweed on development sites* (UK Environment Agency, 2006) and to the *Best Practice Management Guidelines for Japanese Knotweed* (Invasive Species Ireland, 2008).

4.2.2 Disposal of Material

If any invasive species plant material is collected (*e.g.* by hand-pulling or mowing), it is important that its disposal should not lead to a risk of further spread. The movement of invasive plant material requires a licence from the National Parks and Wildlife Service (NPWS) under Section 49 of the *European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended)*. Invasive species (particularly roots, flower heads or seeds) should be disposed of at licensed waste facilities or composting sites, appropriately buried, or incinerated having regard to relevant legislation (e.g. Section 32 of the Waste Management Act, 1996 to 2008; Section 4 of the Air Pollution Act, 1987; relevant local authority byelaws and any other relevant legislation). All disposals should be carried out in accordance with the relevant Waste Management legislation (as per guidance from NRA, 2008). It should be noted that some invasive species plant material or soil containing residual herbicides may be classified as either 'hazardous waste' or 'non-hazardous waste' under the terms of the Waste Management Acts, and both categories may require special disposal procedures or permissions. Advice should be sought by the contractor from a suitably qualified waste expert regarding the classification of waste and the suitability of different disposal measures this will be detailed further in the contractors detailed Invasion Species Management Plan. As noted above, additional specific measures for the management of Japanese Knotweed cuttings or contaminated soil can be found in the UK Environment Agency document *The Knotweed Code of Practice: Managing Japanese knotweed on development sites* (UK Environment Agency, 2013).

4.2.3 Measures to be Followed During the Application of Herbicides

The control of some species will require the use of herbicides (if not buried), which can pose a risk to human health, to non-target plants or to wildlife. In order to ensure the safety of herbicide applicators and of other public users of the site, a qualified and experienced contractor should be employed to carry out all work.

It is advised that Kerry National Road Office and the contractor refer to the following documents, which provides detailed recommendations for the control of invasive species and noxious weeds:

- Chapter 7 and Appendix 3 of the NRA Publication *The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads* (NRA, 2008)
- *Invasive Species Ireland Best Practice Management Guidelines for Japanese Knotweed* [Available online at www.invasivespeciesireland.com]
- *The Knotweed Code of Practice: Managing Japanese knotweed on development sites* (UK Environment Agency ,2013)

These documents include measures to aid the identification of relevant species, with details for the timing, chemicals and methodology for chemical control, and for measures to avoid environmental damage during the use of herbicides. It is recommended that all contractors should prepare a specific plan in accordance with the relevant guidelines and involving consultation of the Kerry National Road office before commencing works. In order to ensure that the use of herbicides does not contravene legislation, the applicant must comply with *Circular Letter NPWS 2/08* dealing with the application on to non-target areas from the National Parks and Wildlife Service (see Appendix A).

4.2.4 Post-construction Monitoring

Following the construction of the road, it is important that the scheme is systematically re-surveyed to determine the success of control measures and to identify areas where invasive plants are reinvading. This is particularly important for Japanese Knotweed as road maintenance works (mowing and hedge cutting) have the potential to spread this plant via the dispersal of shredded plant material. If invasive plants are found then they should be treated as per the measures outlined in the plan and the species specific guidelines below.

4.3 Japanese Knotweed *Fallopia japonica*

The guidance *Knotweed Code of Practice: Managing Japanese Knotweed on Development Sites* (UK Environment Agency, 2013) and Invasive Species Ireland's *Best Practice Management Guidelines for Japanese Knotweed* (ISI, 2008) provide very detailed information on the control of this species, including methodology for herbicidal treatment, methodology for preventing re-growth in soil (burial, use of membranes etc.), and the management of soil on site. Some general principles are summarised below

The area of infestation is generally accepted as being 7m horizontally from the nearest Japanese knotweed plant, in order to take into account the area potentially infected by the network of underground rhizomes. If possible, the plant should be eradicated prior to construction works taking place. The most effective control of Japanese Knotweed is achieved through chemical treatment. Numerous treatment methods are available; however in this case the recommended treatment would be stem injection using a systemic herbicide (*e.g.* Picloram). Strong systemic herbicides are most effective at targeting the persistent roots of Japanese Knotweed, however it should be noted that they may also persist in the soil and/or kill surrounding vegetation. Stem injection is the most effective approach for use in publicly accessible areas. Foliar spraying would also be effective, as recommended by Invasive Species Ireland (ISI, 2008). The optimal time period for treatment is May - June and September - October. If highly-persistent herbicides are used, it may be possible to eradicate the plant within one or two years. Chemical control using a biactive formulation of glyphosate is the most appropriate herbicide for use in or near water (Environment agency, 2010). As Glysophate is non-persistent it will be necessary to re-treat regularly in years two and three, and then to conduct annual spot-checks in May-June to identify and retreat any re-growth. Japanese Knotweed does not produce viable seed in Ireland, and therefore seed germination in subsequent years will not be an issue.

If time constraints do not allow for herbicide treatment, infested soil can be excavated and buried. Movement of contaminated soil will be done in consultation with a professional expert under licence from the NPWS. Material should be buried at least 5m deep and the Japanese Knotweed material should be covered with a root barrier membrane layer before infilling it to 5m deep with inert fill or topsoil. Root barrier membranes that may have been used to protect clean ground from vehicles involved in excavating Japanese Knotweed can also be buried as this method relies on the depth of burial as the main Japanese Knotweed treatment, rather than the protection from the root barrier membrane. Where on-site burial is used, it is strongly advised that the burial site is accurately mapped and the location of the burial site recorded to prevent potential disturbance and re-infestation, and that any future owners are advised of its position. Japanese knotweed is likely to survive for many years, depending on how effective the treatment, if any, was before it was buried. It is essential that it isn't buried where landscaping, installing or access to services/utilities, erosion from a watercourse or subsequent development will disturb it.

If it is not feasible for Japanese Knotweed to be eradicated prior to construction commencing then measures will need to put in place to ensure that construction works do not spread the plant to new areas until such time as the plants can be treated. If soil containing Japanese Knotweed material is being excavated under licence from the NPWS, it should be stored in a designated area and clearly fenced off and sign posted. A fence that can clearly be seen should mark out the area of infestation. Signs should warn people working there that there is Japanese Knotweed contamination. Vehicles with caterpillar tracks should not be used within the infested area and vehicles leaving the area should either be confined to haulage routes protected by root barrier membranes, or be pressure washed. Vehicles used to transport infested soils that are subject to pressure-washing must be done so in a designated wash-down area before being used for other work. Areas infested by Japanese Knotweed that are not going to be excavated should be protected by root barrier membrane if they are likely to be disturbed by vehicles. Root barrier membranes will need to be protected from damage by vehicles with a layer of sand above and below the root barrier membrane, topped with a layer of hard core or other suitable material as specified by an architect or engineer. The material left after the vehicles have been pressure washed must be contained, collected and disposed of along with the other Japanese Knotweed material. A clerk of works should oversee the Japanese Knotweed management plan, including the provisions for avoiding contamination. Everyone working on site must clearly understand the role and authority of the clerk of works. At the crossing point for the road scheme over the River Feale, it is critical that earthworks do not lead to the dispersal of plant material downstream. This will take the form of installing impermeable barriers down-slope of the area to be excavated.

After construction works are complete, follow up surveys should be conducted to survey for regrowth. If regrowth is observed then foliar treatment should be conducted.

4.4 Indian Balsam *Impatiens glandulifera*

As this species does not reproduce asexually, control is more straightforward than for Japanese Knotweed. Control measures for Indian Balsam should aim to prevent flowering and are therefore ideally undertaken before the commencement of flowering in June. Where flower production can be prevented, eradication may still take over 5 years. Mechanical control is only likely to be effective where good access is available and the ground smooth enough to permit either mowing or cutting back. Where accessible, plants can be cut, mown or strimmed back to ground level in April or early May; before flowering in June. Do not cut earlier than this period as this promotes greater seed production in any re-growth. Unless the plant is cut to below the lowest node, it will re-sprout. Regular mowing will control the plant provided the frequency of mowing is regular enough to prevent sprouting and flower formation. Repeat annually until complete control is attained. As plants are very shallow rooted, they can also be easily pulled by hand. Hand pulling will require a follow up pull in August due to new seeds sprouting. Vegetative material can be disposed of by composting unless seeds are present, in which case the material should be disposed of at a licensed landfill or burnt. The movement of invasive plant material requires a licence from the National Parks and Wildlife Service (NPWS) under Section 49 of the *European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended).*

Chemical control of Indian Balsam is readily achieved with the use of glyphosate or 2,4-D amine, which should be applied during active growth in late spring but late enough to ensure that germinating seedlings have grown sufficiently to be covered by the spray. Glyphosate is systemic and can be applied as a foliar spray where extensive infestations occur. However, it is a broad-spectrum herbicide and care should be taken where non-target species are also present. In such cases, application can be made by weed-wiper. 2, 4-D amine is effective against many broad-leaved weeds but does not affect grasses which may be important in stabilizing soils. It may therefore be a preferable choice to glyphosate in certain situations where it would be preferable to retain some level of vegetation cover at the treatment site. Repeat treatments or other means of controlling seedling germination will be required for a period of five or more years. Annual monitoring of the site will be required in mid-spring and mid-summer to assess the occurrence of seedlings and determine appropriate control.

4.5 Spanish Bluebell & Hybrids *Hyacinthoides hispanica & H. x massartiana*

It is important when controlling Spanish Bluebells and their hybrids that native bluebell *Hyacynthoides non-scripta* is not inadvertently targeted. It is recommended that contractors familiarise themselves with the key characteristics that separate the native species from Spanish and hybrid bluebell (see http://www.bsbi.org.uk/Hyacinthoides_Crib.pdf). This species can be spread via seeds or by vegetative means (underground bulbs) and there is a risk that this species could be spread by the movement of soil during construction. As bluebells are very resistant to most herbicides, control measures involve the physical removal of plants during the growing period (April-June), by digging up the growing plants and bulbs and storing them in black plastic bags for one year, before composting. Annual follow up visits to area of infestation will need to be conducted due to the presence of a seed bank and the presence of bulbs that were not removed previously. It is preferable that this plant is removed before road construction works take place in order to minimise dispersal via movement of soil containing seeds and bulbs. As this species has quite a restricted distribution along the proposed route of the road scheme, control and removal should be straight forward. If invasive plant material is being

transported from the site it requires a licence from the National Parks and Wildlife Service (NPWS) under Section 49 of the European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended).

4.6 Three-cornered Garlic *Allium triquetrum*

Like Spanish Bluebell and their hybrids, the Three-cornered Garlic can be spread via seeds or by vegetative means (bulbs). Risk of dispersal of this species as a result of construction works is particularly high due the large population located at the crossing point over the River Feale for the road scheme. Excavation and construction works in this area may lead to the deposition of plant material into the river that could disperse downstream and take root in new locations. The species can be treated using Glysophate-based herbicides and is best applied during the growing period just before the plants flower (March-June). Crushing the plant before application of the herbicide helps speed up the absorption of the herbicide.

4.7 Site specific non-native invasive plant species control measures

Table 2 outlines the Site specific non-native invasive plant species control measures.

Table 2 Site specific non-native invasive plant species control measures

Japanese knotweed *Fallopia japonica*
Location: Along both banks of the River Feale in the vicinity of the proposed crossing point
Prior to works commencing, a 7m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented. *Option 1 - Chemical Control* This is the preferred option for control and removal of this species within and in close proximity to the SAC, as there is a low risk of other methods spreading plant material downstream in the River Feale. Given the ecological sensitivity of this location and its SAC status, stem injection only will be used to control Japanese knotweed in this area. A glyphosate based herbicide will be applied during either the May-June or September-October periods in years one, two, and three; and subject to ongoing monitoring of the affected area, follow up applications in any to persistent regrowth during subsequent years, if required. No works movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within the 7m exclusion zone until such time as the plant species has been eradicated from the contaminated area. *Option 2 - Mechanical Control* In the event that chemical control is not feasible, the option of mechanical control measures is available as described above in Section 4.3, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of contaminated material spreading from the works area. *Post-construction* Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Japanese knotweed has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Japanese knotweed along the river banks in the immediate vicinity. If present, then the chemical control measures detailed above will be implemented. In order to minimise the risk of Japanese knotweed recolonising lands within the CPO boundary from adjacent stands, a root barrier membrane will be installed along the boundary fencing. However this would need to be buried to a depth of 5m to be effective long-term.
Location: Along the southern bank of the Mill Stream stream near Greenville Road
Prior to works commencing, a 7m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented. *Option 1 - Chemical Control* This is the preferred option for control and removal of this species, as there is a risk of other methods spreading plant material downstream to the River Feale and the cSAC. Stem injection only will be used to control Japanese knotweed in this area. A glyphosate based herbicide will be applied during either the May-June or September-October periods in years one, two, and three; and subject to ongoing monitoring of the affected area, follow up applications in any to persistent regrowth during subsequent years, if required. No works movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within

the 7m exclusion zone until such time as the plant species has been eradicated from the contaminated area.

Option 2 - Mechanical Control

In the event that chemical control is not feasible, the option of mechanical control measures is available as described above in Section 4.3, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of contaminated material spreading from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Japanese knotweed has not recolonised lands within the CPO boundary. If present, then the chemical control measures detailed above will be implemented.

In order to minimise the risk of Japanese knotweed recolonising lands within the CPO boundary from adjacent stands, a root barrier membrane will be installed along the boundary fencing. However this would need to be buried to a depth of 5m to be effective long-term.

Location: At Islandganniv North

Prior to works commencing, a 7m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Chemical Control

This is the preferred option for control and removal of this species, as there is lesser risk that this method would spread plant material downstream of any nearby waterbodies. Stem injection only will be used to control Japanese knotweed in this area. A glyphosate based herbicide will be applied during either the May-June or September-October periods in years one, two, and three; and subject to ongoing monitoring of the affected area, follow up applications in any to persistent regrowth during subsequent years, if required. No works movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within the 7m exclusion zone until such time as the plant species has been eradicated from the contaminated area.

Option 2 - Mechanical Control

In the event that chemical control is not feasible, the option of mechanical control measures is available as described above in Section 4.3, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of contaminated material spreading from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Japanese knotweed has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Japanese knotweed along the river banks in the immediate vicinity. If present, then the chemical control measures detailed above will be implemented.

In order to minimise the risk of Japanese knotweed recolonising lands within the CPO boundary from adjacent stands, a root barrier membrane could be installed along the boundary fencing. However this would need to be buried to a depth of 5m to be effective long-term.

Location: Along the disused railway embankment and in adjacent field - Curraghatoosane

Prior to works commencing, a 7m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Chemical Control

This is the preferred option for control and removal of this species, as there is a lesser risk that this method would spread plant material downstream of any nearby waterbodies. Stem injection only will be used to control Japanese knotweed in this area. A glyphosate based herbicide will be applied during either the May-June or September-October periods in years one, two, and three; and subject to ongoing monitoring of the affected area, follow up applications in any to persistent regrowth during subsequent years, if required. No works movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within the 7m exclusion zone until such time as the plant species has been eradicated from the contaminated area.

Option 2 - Mechanical Control

In the event that chemical control is not feasible, the option of mechanical control measures is available as described above in Section 4.3, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of contaminated material spreading from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Japanese knotweed has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Japanese knotweed in the adjoining lands in the Ashfield housing estate. If present, then the chemical control measures detailed above will be implemented.

In order to minimise the risk of Japanese knotweed recolonising lands within the CPO boundary from adjacent stands, a root barrier membrane could be installed along the boundary fencing. However this would need to be buried to a depth of 5m to be effective long-term.

Location: Along the north-eastern road verge at the tie-in with the R553

Prior to works commencing, a 7m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Chemical Control

This is the preferred option for control and removal of this species, as there is a lesser risk that this method would spread plant material downstream of any nearby waterbodies. Stem injection only will be used to control Japanese knotweed in this area. A glyphosate based herbicide will be applied during either the May-June or September-October periods in years one, two, and three; and subject to ongoing monitoring of the affected area, follow up applications in any to persistent regrowth during subsequent years, if required. No works movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within the 7m exclusion zone until such time as the plant species has been eradicated from the contaminated area.

Option 2 - Mechanical Control

In the event that chemical control is not feasible, the option of mechanical control measures is available as described above in section 4.3, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of contaminated material spreading from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Japanese knotweed has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Japanese knotweed along the river banks in the immediate vicinity. If present, then the chemical control measures detailed above will be implemented.

In order to minimise the risk of Japanese knotweed recolonising lands within the CPO boundary from adjacent stands, a root barrier membrane could be installed along the boundary fencing. However this would need to be buried to a depth of 5m to be effective long-term.

Indian balsam *Impatiens glandiflora*

Location: Along the both banks of the Mill Stream from near Greenville Road to the confluence with the River Feale

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Manual Control

This is the preferred option for controlling this species as there is a lesser risk of extensive soil disturbance from this method, due to the shallow roots on balsam plants and the avoidance of a risk of water pollution that would exist with foliar spraying (note proximity of these areas to the River Feale and cSAC boundary). Hand pulling shall be conducted during the active growth period in late spring but late enough to ensure that germinating seedlings have grown sufficiently to be pulled. This method will require a follow up visit in August due to new seeds sprouting and the site will need to be revisited over a number of years and new plants pulled until the seedbank is exhausted. Vegetative material can be disposed of by composting unless seeds are present, in which case the material will be disposed of at a licensed landfill or burnt.

Option 2 - Chemical Control

In the event that physical control is not feasible, the option of chemical control measures using foliar spraying is available as described above in Section 4.4, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of water pollution from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Indian balsam has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Indian balsam along the river banks in the immediate vicinity. If present, then the chemical control measures detailed above will be implemented.

Location: Along both banks of the River Feale

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Manual Control

This is the preferred option for controlling this species within or in proximity to the SAC as there is a lesser risk from this method of extensive soil disturbance, due to the shallow roots on balsam plants and the avoidance of a risk of water pollution that is exists from foliar spraying. Hand pulling shall be conducted during the active growth period in late spring but late enough to ensure that germinating seedlings have grown sufficiently to be pulled. This method will require a follow up visit in August due to new seeds sprouting and the site will need to be revisited over a number of years and new plants pulled until the seedbank is exhausted. Vegetative material can be disposed of by composting unless seeds are present, in which case the material should be disposed of at a licensed landfill or burnt.

Option 2 - Chemical Control

In the event that physical control is not feasible, the option of chemical control measures using foliar spraying is available as described above in Section 4.4, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of water pollution from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Indian balsam has not recolonised lands within the CPO boundary – this risk is noted due to the extensive coverage of Indian balsam along the river banks in the immediate vicinity. If present, then the chemical control measures detailed above will be implemented.

Spanish bluebell & Hybrids *Hyacinthoides hispanica & H. x massartiana*

Location: Along the southern roadside verge at the tie-in with the R557;

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Option 1 - Manual Control

All plant material (bulbs and leaves) shall be dug up by hand during the growing period (April-June) before the plants produce seed and will be stored in black plastic bags for one year to allow the bulbs to die before being taken to a licensed landfill or burnt. This will need to be repeated annually until no more plants are found.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Spanish bluebell and Hybrids have not recolonised lands within the CPO boundary.

Location: Along a field/property boundary at the eastern end of the tie-in with the Greenville Road

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented. The contractor who will carry out the control must be able to distinguish native bluebells from Spanish bluebells and their hybrids.

Manual Control

All plant material (bulbs and leaves) shall be dug up by hand during the growing period (April-June) before the plants produce seed and will be stored in black plastic bags for one year to allow the bulbs to die before being taken to a licensed landfill or burnt. This will need to be repeated annually until no more plants are found.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground

disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that Spanish bluebell and Hybrids have not recolonised lands within the CPO boundary.

Three-cornered garlic *Allium triquetrum*

Location: On the south bank of the River Feale at the proposed crossing point;

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Manual Control

This is the preferred option due to the absence of a risk of water pollution of the River Feale that is present with foliar spraying. However, before any ground disturbance or vegetation clearance is undertaken within the 2 m exclusion zone, the works area must be isolated from the River Feale to prevent any contaminated material getting into the surface water network.

All plant material (bulbs and leaves) shall be dug up by hand during the growing period (April-June) before the plants produce seeds and should be stored in black plastic bags for one year to allow the bulbs to die before being taken to a licensed landfill (under licence from the NPWS) or burnt. This will need to be repeated annually until no more plants are found.

Chemical Control

In the event that physical control is not feasible, the option of chemical control measures using foliar spraying is available as described above in section 4.6, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of water pollution from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that three-cornered garlic has not recolonised lands within the CPO boundary.

Location: On the bank of the River Feale/drainage ditch c.100 m north of the proposed crossing point;

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Manual Control

This is the preferred option due to the absence of a risk of water pollution of the River Feale that is present with foliar spraying. However, before any ground disturbance or vegetation clearance is undertaken within the 2 m exclusion zone, the works area must be isolated from the River Feale to prevent any contaminated material getting into the surface water network.

All plant material (bulbs and leaves) shall be dug up by hand during the growing period (April-June) before the plants produce seeds and should be stored in black plastic bags for one year to allow the bulbs to die before being taken to a licensed landfill or burnt. This will need to be repeated annually until no more plants are found.

Chemical Control

In the event that physical control is not feasible, the option of chemical control measures using foliar spraying is available as described above in section 4.6, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of water pollution from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that three-cornered garlic has not recolonised lands within the CPO boundary.

Location: Along property boundary c.50 m north of the tie-in with the Forge Road

Prior to works commencing, a 2 m exclusion zone will be established which will be clearly demarcated by fencing and signage. No construction works requiring the movement of heavy machinery, ground disturbance or vegetation clearance will be permitted within this zone prior to invasive plant control measures being implemented.

Manual Control

This is the preferred option due to the absence of a risk of water pollution of nearby water bodies that is present with foliar spraying. However, before any ground disturbance or vegetation clearance is undertaken within the 2 m exclusion zone, the works area must be isolated from the River Feale to prevent any contaminated material getting into the surface water network.

All plant material (bulbs and leaves) shall be dug up by hand during the growing period (April-June) before the plants produce seeds and should be stored in black plastic bags for one year to allow the bulbs to die before being taken to a licensed landfill or burnt. This will need to be repeated annually until no more plants are found.

Chemical Control

In the event that physical control is not feasible, the option of chemical control measures using foliar spraying is available as described above in section 4.6, however, employing these types of methods would require a detailed plan and site layout to clearly demonstrate that there is no risk of water pollution from the works area.

Post-construction

Prior to routine maintenance works being carried out in this area during operation, if such works would result in ground disturbance or require vegetation cutting/removal, the area shall be surveyed to ensure that three-cornered garlic has not recolonised lands within the CPO boundary.

5 Conclusion

This report details the distribution of invasive plants along the proposed N69 Listowel Bypass at the times surveyed and details the management options required to ensure that invasive plants are not spread to new areas during construction or operational works associated with the proposed road development. A pre-construction re-survey within the CPO boundary is required to gather up to date distribution maps for all invasive plant species prior to control measures being implemented.

6 References

Environment Agency (2010) *Managing invasive non-native plants in or near fresh water.*

Environment Agency (2013) *Managing Japanese knotweed on Development Sites (version 3, amended in 2013): The Knotweed Code of Practice.*

Invasive Species Ireland (2008) *Best Practice Management Guidelines for Japanese Knotweed.*

National Roads Authority (2010) *Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads.*

Websites

Royal Horticultural society guidance for Spanish bluebell and hybrids

https://www.rhs.org.uk/advice/profile?pid=426

Royal Horticultural society guidance for wild garlic

https://www.rhs.org.uk/advice/profile?PID=384

Appendix A NPWS Circular Letter 2/08

Circular Letter NPWS 2/08

30 May 2008

Use of Herbicide Spray on Vegetated Road Verges

Dear Manager

I am directed by the Minister for the Environment, Heritage and Local Government to refer to Section 40 of the Wildlife Act 1976, as amended by Section 46 of the Wildlife (Amendment) Act 2000 (which places restrictions on the destruction of vegetation on uncultivated land during the period from 1 March to 31 August in any year), and to the Habitats Regulations 1997-2005.

The Minister has reason to believe that there have been recent instances in which extensive poorly-targeted spraying of road verges with herbicide has been carried out by local authorities, ostensibly in an effort to control noxious weeds. The Minister has been in contact with the National Roads Authority regarding a circular which they issued in regard to the control of noxious weeds, and understands that that circular, and accompanying guidelines, contained detailed procedures that, if observed, would not have led to such spraying.

It must be emphasised that while Section 40 of the Wildlife Act permits the destroying of noxious weeds (section 40 (1) (d) of the Act as amended), it does not in that context authorise the destruction of adjacent vegetation. Accordingly, the Minister has asked me to say that extensive, untargeted spraying of road verges with herbicide is, *prima facie*, an offence under Section 40 of the Wildlife Acts, and it is his policy to prosecute in such cases.

The National Parks and Wildlife Service of the Department of the Environment Heritage and Local Government are currently consulting with the National Roads Authority (NRA) and the Department of Agriculture, Fisheries and Food regarding the requirements for the protection of ecologically sensitive habitats and in particular for Natura 2000 sites. It is envisaged that the NRA will issue comprehensive guidelines, which will, in addition to noxious weeds, also address the issue of controlling invasive species. In this regard, the requirements of the Noxious Weeds Act, the Wildlife Acts and the European Communities

(Natural Habitats) Regulations must be considered in tandem given the exigencies of the national roads network with regard to the control and management of noxious weeds and the requirements of national and EU law for the protection of wildlife species and habitats. It is intended that these guidelines will be available in advance of the 2009 growing season.

In conclusion, I am to emphasise that, where there is the possibility that spraying (or any other control method) could be detrimental to any Natura 2000 site or candidate site or to a species referred to in Annex IV of the Habitats Directive or to wild birds or their habitats, the procedures set out in this Department's Circular Letter PD 2/07 and NPWS 1/07 and Circular Letter NPWS 2/07 should, respectively, be followed before any spraying is carried out. Where such issues need to be considered, the local National Parks and Wildlife staff should be contacted.

Yours sincerely

Gerry Leckey

Gerry Leckey
Assistant Director
National Parks and Wildlife Service
7 Ely Place
Dublin 2

To all County and City Managers, Town Clerks

Appendix B The locations of invasive plants within the CPO for the N69 Listowel Bypass.

See EIS Volume 3 Figure 6.1.6-6.1.10 Invasive Species

BirdWatchIreland

The status of Barn Owls within the study area for the N69 Listowel Bypass 2016

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This study was designed and implemented by BirdWatch Ireland under contract to Scott Cawley Ltd & Jacobs Ltd.

O' Clery, M. & Lusby, J. (2016). The status of Barn Owls within the study area for the proposed N69 Listowel Bypass.

The status of Barn Owls within the study area for the proposed Listowel Bypass; Final Report 2016. O'Clery, M. & Lusby, J.

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SUMMARY

The Barn Owl *Tyto alba* is a *Red-listed Bird of Conservation Concern in* Ireland due to extensive declines in their breeding population over recent decades (Colhoun and Cummins, 2013). The Breeding Birds Atlas (2007–2011) highlighted a decline of 39% in the breeding range of Barn Owls in the Republic of Ireland over the 40-year period since the original Breeding Birds Atlas of Britain and Ireland (1968–1972) (Balmer *et al.*, 2013; Sharrock, 1976). Several studies have linked the increase in major road networks to Barn Owl population declines (Illner, 1992; De Bruin, 1994). Due to their hunting behaviour, low flight and poor peripheral vision, Barn Owls are particularly susceptible to collision with vehicles (Seiler 2003, Ramsden 2003, Reijnen and Foppen 2006, Boves 2007). Road mortality is a major cause of death for Barn Owls in Ireland (BirdWatch Ireland, unpublished; Lusby *et. al.*, 2013), however the extent to which mortality from vehicle collision impacts the population is not fully understood. In addition to direct mortality, the development of road networks can also affect the quality and quantity of available habitat for Barn Owls (Glista et al. 2009), and may cause local displacement of birds through loss of nest sites.

The objective of this study is to determine Barn Owl distribution and abundance within the defined study area for the proposed N69 Listowel Bypass, in order to inform the most appropriate route selection to minimise negative impacts on the local Barn Owl population.

The Barn Owl survey area was selected based on information on Barn Owl home range ecology to include all sites which may be impacted by the route development. The survey area comprised approximately 125km^2. A detailed survey was carried out in July and August 2016 to determine Barn Owl status and occupation. All roads within the survey area were systematically travelled and the suitability of all buildings and quarries were assessed and categorised on a scale of 0 – 3 based on their suitability for Barn Owls. A total of 83 sites were surveyed, of which the most common were derelict cottages (55), followed by derelict two story houses (11), stone barns (11), metal-roofed barns (3), castles (2) and a derelict mansion. A total of 17 (21%) sites were considered to be unsuitable for Barn Owls, 36 (43%) offered potential for roosting, though were not suitable for nesting, 19 (23%) were classed as having likely roosting and/or nesting opportunities and the remaining 11 (13%) sites provided suitable roosting and nesting opportunities. The survey recorded an availability of 24 sites per 100km^2 for Barn Owls within the survey area.

The presence of Barn Owls was confirmed at three sites, which included two breeding pairs in derelict cottages (Shrone East and Cloontubrid North), and activity was also recorded at a derelict cottage (Moyassa) although it was not possible to determine breeding status due to permissions to access and monitor the site. Recommendations for future monitoring and the development and implementation of appropriate mitigation are also outlined.

1. BACKGROUND

1.1 *The impacts of road networks on Barn Owls*

Extensive declines in the distribution and abundance of the Barn Owl *Tyto alba* population in Ireland have been recorded in recent decades. The *Breeding Birds Atlas (2007–2011)* highlighted a decline of 39% in the breeding range of Barn Owls in Ireland over the 40-year period since the original *Breeding Birds Atlas of Britain and Ireland (1968–1972)* (Balmer et al., 2013; Sharrock, 1976). The 2007-2011 atlas coincided with increased monitoring efforts for Barn Owl coordinated by BirdWatch Ireland, and therefore the extent of the long-term declines are likely to be more substantial than indicated through the atlas surveys. The Barn Owl is categorised as a Red-listed *Bird of Conservation Concern in Ireland* as the population is considered to have suffered losses of over 50% in the last 25 years (Colhoun & Cummins, 2013). The specific factors which influence the status and trends of Barn Owls in Ireland, and which have brought about these widespread declines are not fully understood. The population in Ireland is not limited by the availability of suitable nest sites to the same extent as has been recorded in Britain and in other parts of their range (Petty et al., 1994; Taylor, 1994; Lusby et al., 2010a, 2010b & 2012). The intensification of agriculture, particularly the reduction of prey rich foraging habitat, and the increased use of second generation anticoagulant rodenticides are known to affect Barn Owl populations elsewhere in their range (Shawyer, 1998) and have been widely implicated as the most influential drivers of the decline in Ireland. In addition, several studies have linked the increase in major road networks to Barn Owl population declines (Illner, 1992; De Bruin, 1994). Barn Owls have been routinely recorded as road casualty victims in Ireland (BirdWatch Ireland, unpublished; Lusby et al., 2013), and there has been concern over this aspect as a contributing factor in the Barn Owl decline with the recent significant expansions to the road infrastructure in Ireland. The development of road networks can also affect the quality and quantity of available habitat for Barn Owls (Glista et al. 2009), and may cause local displacement of birds through loss of nest sites.

The increases in traffic, vehicle speeds and expansions to road infrastructures that have occurred throughout the world have coincided with the continued escalation in the number of wildlife casualties on roads (Seiler et al., 2004). Due to their hunting behaviour, low flight and poor peripheral vision, Barn Owls are particularly susceptible to collision with vehicles (Seiler 2003, Ramsden 2003, Reijnen and Foppen 2006, Boves 2007). Several studies to assess avian mortality on roads have recorded Barn Owls as the most frequently affected species. However, there are numerous constraints when assessing the relative importance of road traffic accidents as a cause of mortality and determining the impact of road networks on Barn Owls at the population level. The potential to overestimate vehicle collisions as a cause of death due to methodological bias in recording causes of mortality must be taken into consideration. The probability of finding a road casualty is likely to be greater compared with a bird which died of natural causes, and therefore the ratios of recorded causes of death may not be representative. Deaths caused by man, and especially road deaths are routinely over-estimated in bird mortality studies (Hodson and Snow, 1965, Glue, 1971, Newton, 1979, Weir 1971).

Illner (1992) assessed the overall effect of road casualties on Barn Owl population trends and estimated that collision with vehicles accounted for approximately 10 – 15% of adult Barn Owl deaths in Germany, suggesting that these losses were likely to have a significant impact on the population. An intensive study over an eighteen-year period in Liemers in the Netherlands, also attributed long term Barn Owl population declines in the region to increases in major road networks (De Bruin, 1994). Newton *et al*, (1997) showed that recorded Barn Owl road fatalities increased dramatically in the UK since the early part of the last century, from 6% in 1910 – 54, to 15% in 1955

– 69, to 35% in 1963 – 70 and 50% in 1991- 96. Ramsden (2005) studied the effects of road developments on Barn Owl displacement, distribution and mortality over a 15-year period in Devon in the UK. The findings revealed that 72% of Barn Owls, which encounter a major road, are likely to be killed. Ramsden (2005) also showed that the risk of mortality to Barn Owls from motorways increased dramatically with proximity to nest and roost sites. New major road developments caused the loss of all Barn Owls within 0.5km, and severe depletion of populations within 0.5 to 2.5km of the route. An examination of body weights of carcasses and the time of year casualties were recovered also showed that there was no indication that owls killed by traffic were predominantly weak or underweight individuals and therefore in addition to dispersing juveniles, the adult breeding population was also affected. Ramsden (2005) also estimated that the presence of major roads in rural England has removed Barn Owls from an area of between 8,100 and 16,200km^2 and depleted the population over an area of roughly 48,600km^2 which corresponds to 40% of the total area of rural England.

Many studies have employed systematic searches of motorway verges for avian road casualties. In Switzerland, seven Barn Owl casualties per 100km were estimated on an annual basis along a 36.9km stretch of motorway (Bourquin, 1983). Two other studies, both in north-eastern France, estimated an annual casualty rate of 65 Barn Owls per 100km along a 259km stretch of motorway (Baudevin, 1997) and 25 Barn Owl casualties per 100km per year on a 150km stretch of motorway (Massemin & Zorn, 1998). In Britain, a 50km stretch of major road, with single and dual carriageway sections, was searched intensively over two years, and the casualty rate for Barn Owls calculated at 68 per 100km per year (Shawyer & Dixon, 1999).

Although these studies are not directly comparable to Ireland due to differences in local population densities, road types and characteristics, the combined results nevertheless illustrate the potential impacts of major roads on Barn Owl populations. A long-term study through BirdWatch Ireland provides the only data on the impacts of road networks relative to other forms of mortality in the Irish context. Over a nine year period (2006 - 2014) a total of 279 Barn Owl mortality incidents were recorded, of which the majority (64%) were vehicle collision victims. The majority of road casualties were recovered from Motorways or National routes (76%), which is in keeping with results from other studies which suggest that motorways and dual carriageways, due to their design and high vehicle speeds, present a greater threat to Barn Owls than other road types (Ramsden 2003, Ilner 1992, Shawyer & Dixon 1999). A total of 61 Barn Owl collision victims were recorded on a stretch of motorway in south Tipperary over a seven-year period, indicating that certain routes and certain stretches may be "high risk" areas and may have an effect on Barn Owl populations at a local level. Similar to other studies, peaks in the number of road casualties were observed outside of the breeding season, with highest numbers recovered in February, October and November. Of 34 Barn Owl carcasses which were retrieved and reliably aged, the majority were first calendar year or second calendar pre-breeding season birds and therefore were unlikely to have been recruited to the breeding population prior to being killed on the road. The weight at death of 23 road casualties assessed was also significantly lower than the weight of a representative sample of twenty-five live adult males trapped over the study period, which indicates that while adults and breeding birds are killed on the roads, it is predominantly birds which have not yet reached breeding age or which are in poor condition that are affected. This study also analysed 33 Barn Owl ringing recoveries between 2006 and 2013, to determine the relative importance of vehicle collisions as a cause of death from ringed birds alone, which showed that one third of Barn Owl recoveries were attributed to road traffic accidents (BirdWatch Ireland, unpublished).

An assessment of the extent and factors which influence Barn Owl mortality on the Tralee Bypass in 2014 and 2015 recorded a minimum casualty rate of 52 Barn Owls per 100km of route per year

(O'Clery *et al.*, 2016), which is in the mid-range of similar estimates available for Europe and North America. Barn Owl (n = 5) was the third most numerous of the 14 bird species recorded as road mortalities on the Tralee Bypass, representing 7% of all avian mortalities (n = 65), despite having a lower population density compared with other species for which there were two or more road mortality incidents recorded. Of ten Barn Owl road casualties recorded on the Tralee Bypass, one was recovered during the breeding season (March to July) with all other casualties (n = 9) recorded outside of the breeding season (January to February and August to December). It was possible to accurately age nine of the ten Barn Owl road casualties, of which eight (80%) were first calendar-year or second calendar-year pre-breeding season birds (i.e. recovered before March of their second calendar year) and one was an adult. The risk of collision was not significantly influenced by the embankment height or width of grass verge on the Tralee Bypass. Despite the mortality rate, survey work confirmed that all nest sites (n =2) recorded within 5km of the bypass remained active over the study period (2014 – 2015), and there was an increase from two to four breeding pairs, indicating that the Tralee Bypass has not caused the loss of sites or displacement of the local population over the study period (O'Clery *et al.*, 2016), as shown to be the case with major road developments in other parts of the Barn Owls range.

1.2 *Mitigation measures for Barn Owls*

The speed of road traffic has been shown to be an important factor in relation to the risk of Barn Owl mortality on major roads (Illner 1992). Road types also have a significant bearing on the risk and level of Barn Owl road casualties. In one study in Devon, it was found that, although owls were often seen crossing minor roads, they were rarely seen to hunt along them, most likely because of the lack of suitable wide verges of grassland habitat over which to hunt (Ramsden 2003). Several studies have linked high Barn Owl road casualties to sections of dual-carriageway and motorway where wide verges of open grassland habitat occur, thus encouraging owls to hunt along the road verges (Bouquin 1983, Taylor 1994, Baudvin 1997, Shawyer & Dixon 1999). However, there is also evidence to suggest that many owls are struck while crossing major roads and not hunting along them. In a study on a 50km section of the A303 in southern England (Shawyer & Dixon 1999), it was found that Barn Owl road casualties were more likely to occur where the road traversed linear habitat features along which the birds might hunt. In two studies, more Barn Owl casualties were found along raised (embanked) and level sections of motorway than excavated (sunken) sections (Baudvin 1997, Massemin & Zorn 1998) and that, in the latter case, most owls were killed along embanked stretches which also lacked roadside hedges and/or which crossed open fields.

Specific mitigation measures for Barn Owls have not been regularly implemented in motorway schemes in Europe, and there is also a subsequent lack of comprehensive information on the effectiveness of suggested measures. Recommendations to reduce the impacts of motorways on Barn Owls are primarily derived from data regarding the factors that present the greatest potential for negative impact. Two main mitigation measures have been proposed to reduce the risk of Barn Owl mortalities on major roads.

The first involves deflecting the flight path of Barn Owls that come into contact with major roads away from the high-risk areas. This can be achieved by planting the verges with scrub, hedges or trees, or by installing high screens that force birds to rise above passing traffic when traversing the road. This mitigation is likely to be particularly effective on embanked sections of motorway where Barn Owls are most susceptible to collision. There is conflicting opinion as to whether natural vegetation or artificial barriers to flight are the most appropriate. It has been suggested that planting natural vegetation at the edge of the roadside may have an adverse effect on other avian populations. In a publication by the British Highways Agency, it is recommended that tree plantings are kept 15–25m from the road edge, to reduced risk to a range of avian species such as Sparrowhawk *Accipiter*

nisus (Hill, 2001). This distance however would be too far from the road to deflect the flight paths of Barn Owls when crossing the road.

The second measure is aimed at discouraging Barn Owls from coming into contact with major roads or from hunting along motorway verges. The methods require limiting the quality and quantity of suitable foraging habitat in the form of rough grassland. This can be achieved by intensive mowing or by allowing dense vegetation such as bramble or gorse to prosper and dominate (Ramsden 2003, Baudvin 1997, Muller & Berthoud 1997). Again there is conflicting opinion as to the validity of this measure in terms of its benefits for wildlife in general. In the UK roadside verges have been increasingly recognised for their importance as wildlife habitats (Spellerberg and Gaywood, 1993), particularly for small mammal populations. It has been suggested that the presence of small mammals on road verges may be more beneficial to some predator populations than the impacts of road mortality (Garland, 2002). Planting roadside verges with dense shrubs would serve to conceal small mammals from foraging Barn Owls (Baudvin, 1997), and therefore birds would be less likely to be attracted to the roadside. However, alternatively, such vegetation may also increase passerine mortality, encourage deer and result in a reduction in the plant and invertebrate species associated with rough grassland. An alternative, which could benefit Barn Owls, small mammals and biodiversity in general, is to allow rough grassland habitat to flourish along the road side verges but provide continuous screens adjacent to the road surface so that Barn Owls can forage along these areas without high risk of collision (Ramsden, 2003). Further research is required to develop effective mitigation for Barn Owls on major roads which take account of local conditions and all relevant environmental as well as health and safety, engineering and economic considerations.

2. INTRODUCTION

The objective of the study is to determine Barn Owl distribution and abundance within the defined survey area. The survey area was selected based on available information on Barn Owl home range ecology to incorporate all sites which may be affected by the proposed development, in order to inform the most appropriate route selection to minimise negative impacts on the local population.

2.1 *The Barn Owl survey area*

The defined Barn Owl survey area incorporates all lands within a 5km radius from the proposed N69 Listowel Bypass. The survey area extends to 1km east of Listowel town center in the townland of Dromin, north of Listowel town along the existing John B. Keane Road, west of Listowel past Islandganniv, and south across the Feale River near Garryantanvally. The survey area also includes a section of the N69 Listowel to Tralee road just south of the junction with the R557, 2km to the south-west of Listowel town center. The survey area comprises approximately 125km² as shown in the map below (Fig 1.1).

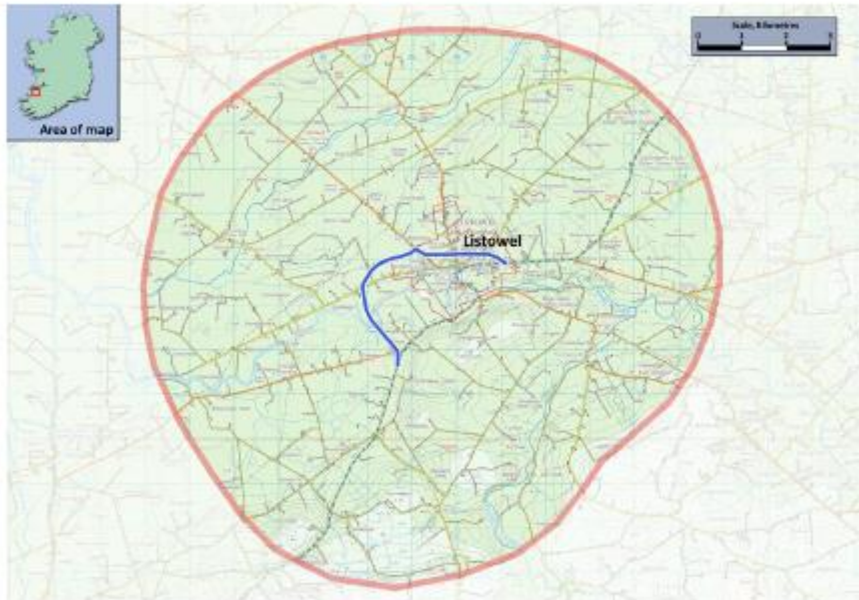

Figure 1.1 *The Barn Owl survey area.*

The most recent Barn Owl population estimate for the Republic of Ireland derived through density specific survey work is 400 – 500 pairs (Birdlife International, in prep.), however there is significant geographical variation in the distribution of the population, with the south-west being the main stronghold. In 2016, there were 44 active Barn Owl sites in Co. Kerry, which is the second highest number of confirmed active sites per county in Ireland (County Tipperary having the highest number of sites per county). Figure 1.2 shows the distribution of recorded Barn Owl sites in County Kerry in 2016.

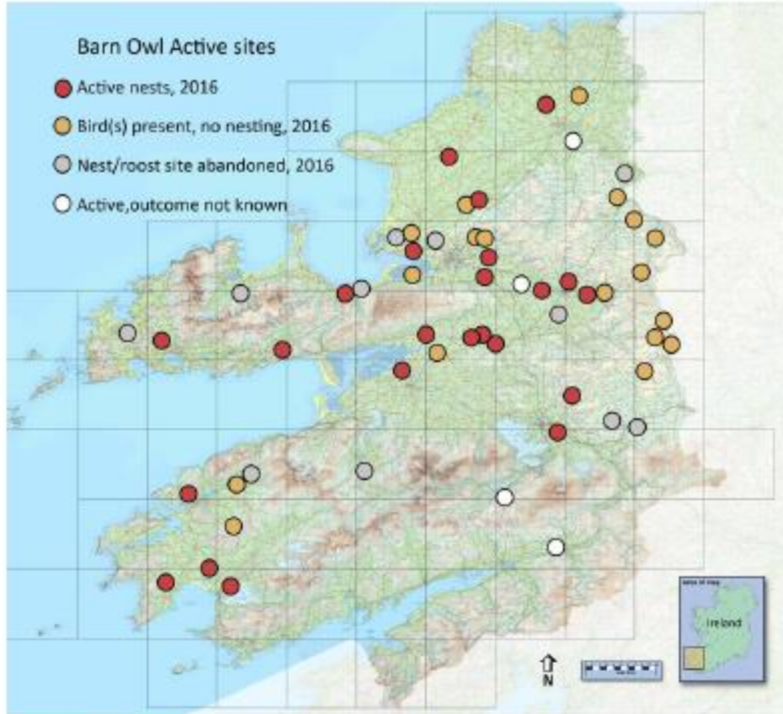

***Figure 1.2** All active Barn Owl sites in County Kerry registered in 2016*

2.2 *Objectives*

The objective of the study is to determine Barn Owl distribution and abundance within the defined survey area. It is intended that the findings will inform the route selection of the proposed Listowel Bypass. Recommendations on specific mitigation are outside the remit of the current study, however recommendations for developing and implementing such mitigation in the future phases of this development are outlined.

The specific objectives of this study are as follows:

- To undertake a comprehensive Barn Owl survey within the defined survey area, according to best practice methods, to identify all buildings and other sites within the survey area used by Barn Owls;
- To determine the activity and breeding status of all sites where Barn Owl occupation is confirmed;
- To gather and collate all available Barn Owl records from within the survey area to determine potential areas where tree nesting Barn Owls may occur; and
- To outline appropriate survey, monitoring and mitigation to be implemented within future phases of the proposed scheme to determine impacts on the local Barn Owl population and to reduce negative impacts

3. METHODS

3.1 *Barn Owl Survey and monitoring in 2016*

A desktop study in combination with ground truthing exercise was conducted in June 2016 to determine the extent of the survey area potentially suitable for Barn Owls. This initial assessment identified an area of c.2km² within Listowel town as largely unsuitable for nesting Barn Owls, which was based on knowledge of nest site selection and requirements in Ireland. Although Barn Owls may use urban areas for foraging, nesting within built up areas is not common (Copland and Lusby, 2012). Therefore the overall survey area considered as potentially suitable and which was the focus for further survey work comprised an area of c.123km². A map of the survey area is shown in the map below (Fig 3.1).

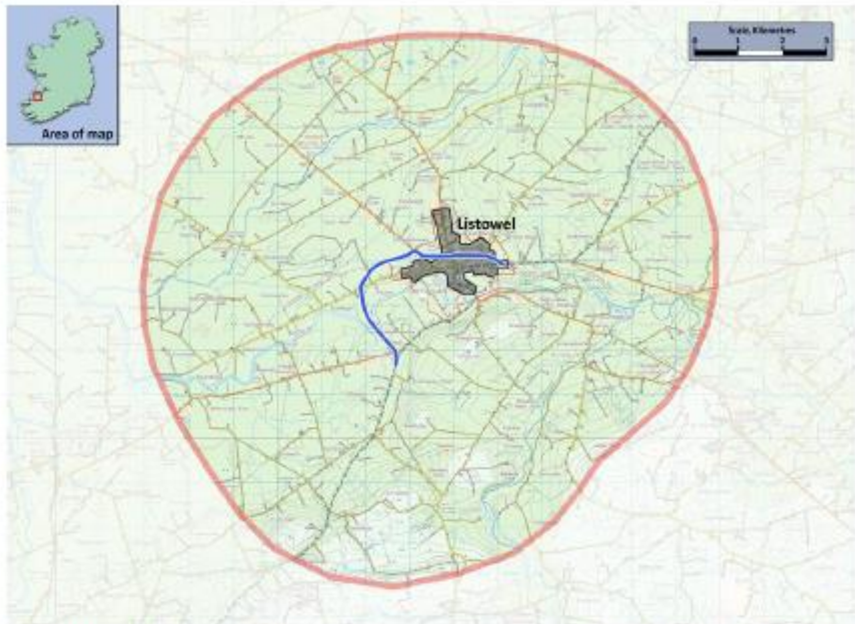

Figure 3.1 *The Barn Owl survey area (areas in grey are excluded from the survey)*

The Barn Owl survey was undertaken between June and August 2016. A team of two surveyors worked together and were equipped with official BirdWatch Ireland identification, a copy of the BirdWatch Ireland insurance policy, Authorisation of Access letter and Health and Safety Statement from Jacobs in addition to Personal Protective Equipment and health and a torch, hard hat, first-aid kit, whistle and mobile phone.

Prior to initiating fieldwork all relevant information on existing and previously active Barn Owl sites and sightings from within the survey area between the period 2009 to 2015 were extracted from relevant BirdWatch Ireland databases, including the Barn Owl registered site and sightings database and the recent Breeding Birds Atlas (2007–2011) database. All data was collated and the details included on suitable large-scale Ordnance Survey maps.

A detailed survey sheet was used to record the following aspects for each site surveyed; date, county,

grid reference, site type, site name, site suitability rating (0–3), status, nesting opportunities, signs, and whether a roost watch was required and/or carried out. Additional information was recorded relating to the suitability and presence of other raptors, corvids, or additional species of note.

All roads within the survey boundaries were systematically travelled and the suitability of all buildings within the survey area was assessed. Sites that were considered to be potentially suitable were comprehensively searched for signs of the presence of Barn Owls. All sites were categorised on a scale of 0–3 based on potential nesting and roosting opportunities for Barn Owls, 0 for unsuitable; 1 representing potentially suitable sites for roosting but unlikely for nesting; 2 being suitable roosting or nesting sites and 3 representing sites considered to be very suitable.

At each site, a thorough search was conducted inside and outside of the building in order to locate signs indicating the presence of Barn Owls, particularly pellets, evidence of whitewash splashings and moulted feathers. Depending on the site characteristics, adjacent buildings and potential perches in the immediate vicinity of the site were also assessed. At certain active Barn Owl sites, due to the concealed nature of nest and/or roost sites (i.e. blocked chimneys, deep cavities etc.), signs are not always obvious or accessible. Therefore at the particular sites where this was judged to be an issue it was necessary to conduct a roost watch lasting a minimum of one hour and commencing at dusk in order to confirm activity. These sites were then recorded as active if calls from an adult or owlets were heard, or if a Barn Owl was observed either within the site or entering or exiting the site. These methods were designed to locate all Barn Owl sites in buildings within the study area. All signs and sightings of other raptors encountered during fieldwork were also recorded.

Tree sites were not assessed as part of this study. However information on Barn Owl activity was sought from landowners encountered over the course of survey work and on an opportunistic basis during fieldwork. Interviews with landowners have been successfully used to assess Barn Owl occupation in previous Barn Owl surveys (Toms *et al.*, 2001). Landowners were asked a series of standardized questions, shown images of Barn Owls and played vocalizations of the species for identification purposes. An assessment was made as to the reliability of each individual report, based on the account, the observer's description and their relevant level of knowledge. Reports that were considered to be potentially unreliable based on professional judgment of the surveyor were discarded. Reliable reports were divided into two categories, 'breeding season' which consists of the period March to July and 'non-breeding season' which comprises the remainder of the year. Greater importance was afforded to those sightings which originated from within the defined breeding season period as these are likely to represent birds holding territory, as opposed to non-breeding season sightings which could represent dispersing juveniles.

At all active or potentially active sites or those where it was deemed necessary to conduct a roost watch to accurately determine status, additional nocturnal visits were carried out to confirm activity and breeding status in July and August 2016.

Although the methods of this survey were specifically designed to confirm Barn Owl distribution within the survey area, other raptor species encountered during survey work were also recorded.

4. RESULTS

4.1 *Barn Owl survey and monitoring*

4.1.1 Existing knowledge of Barn Owls within the study area

Collation of existing data of active Barn Owl sites within the survey area highlighted three sites which were recorded as previously active. A derelict cottage at Shrone East (IQ 974 368) and a derelict mansion at Drombeg (IQ 993 375) were confirmed as active roost sites in 2013, nesting was not previously recorded at either site. Barn Owl activity was also recorded at a derelict cottage at Cloontubrid North (IR 021 379) in 2009.

Collation of existing information on Barn Owl sightings revealed four sightings of Barn Owls within the survey area between 2010 and 2015, of which one was within the defined breeding season. These were in the proximity of Drombeg (IQ 99 37) in spring 2015; Finuge (IQ 95 31) in winter 2011/2012, and Listowel Racecourse (IQ 985 335) in February 2010 and December 2010.

The distribution of sightings and active sites in the study area between 2009 and 2015 is shown below in Figure 4.1.

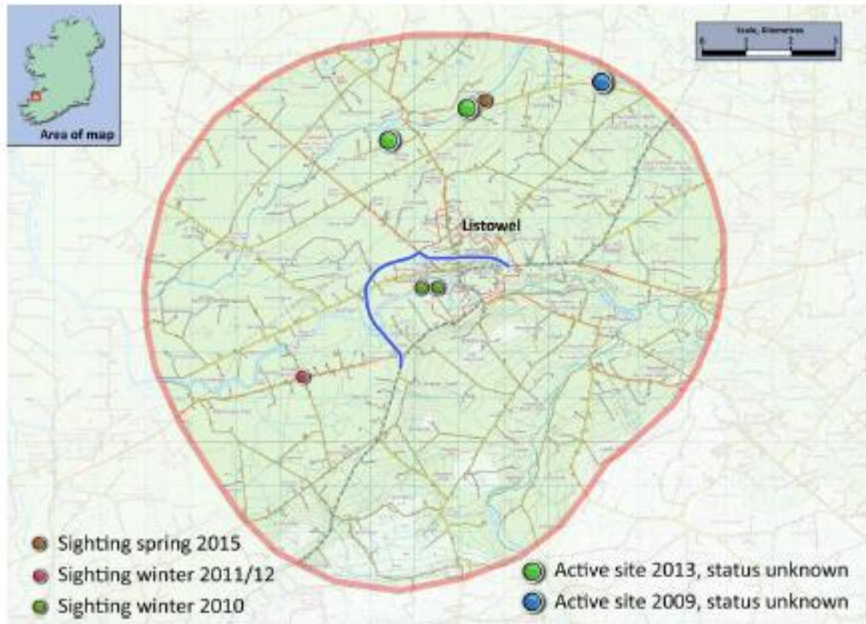

***Figure 4.1.** The distribution of all active Barn Owl sites and sightings recorded in the study area between 2009 and 2015*

4.1.2 Barn Owl status in the study area in 2016

Barn Owl survey and monitoring was carried out in July and August of 2016. A total of 83 sites were comprehensively surveyed for the presence of Barn Owls in the survey area. Of these, the most common site types were derelict cottages (55), followed by stone barns (11), derelict two-story farmhouses (11), metal-roofed barns (3), castles (2), and a derelict mansion (1). These are shown below in Figure 3.2.

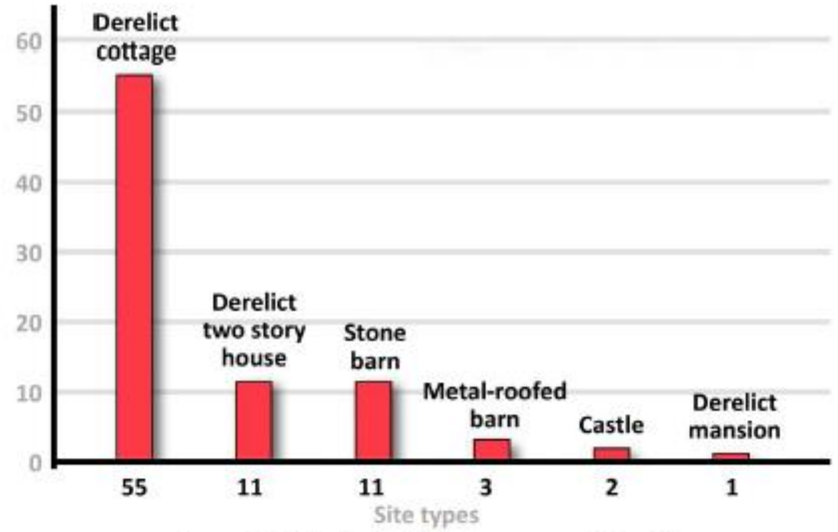

***Figure 4.2** Variation in all site types surveyed (n = 83).*

***Image 4.1** An example of a derelict cottage (near Listowel) which were the most common site type within the survey area.*

Image 4.2. Two story house near Listowel and cottage at Shrone East, a Category 2 and Category 3 site respectively.

Of the total of 83 sites, 17 (21%) sites were assigned to category 0 as they were considered to be unsuitable for Barn Owls, 36 (43%) were assigned to Category 1, offering potential for roosting, though unlikely for nesting, 19 (23%) were assigned to Category 2, having likely roosting and/or nesting opportunities. The remaining 11 (13%) sites were Category 3, as they offered excellent roosting and nesting opportunities (Figure 4.3 and 4.4 below). Therefore there were a total of 30 sites that could be used by Barn Owls in the survey area in 2016, representing an availability of 24 sites per 100km^2 for Barn Owls within the survey area. By comparison, within the study area for the Tralee Bypass (193.5 km^2), which also encompasses a 5km radius either side of the route, there were 55 buildings classed as suitable for breeding Barn Owls, representing a density of 28 suitable sites per 100 km^2 within the study area. The availability of sites in the Listowel study area, though slightly lower than that of the Tralee Bypass study area, is still higher than the recorded density of suitable sites available to Barn Owls elsewhere in County Kerry, Cork, Limerick, Galway and Offaly which ranged from 10.8 to 17 suitable sites per 100km^2.

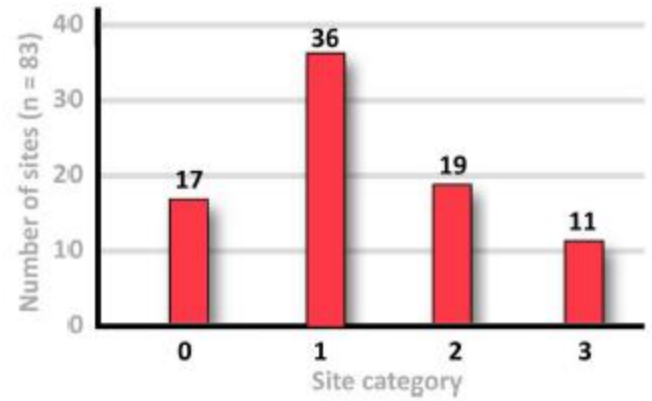

Figure 4.3 The variation in suitability (categories 0 – 3) across all sites surveyed (n = 83)

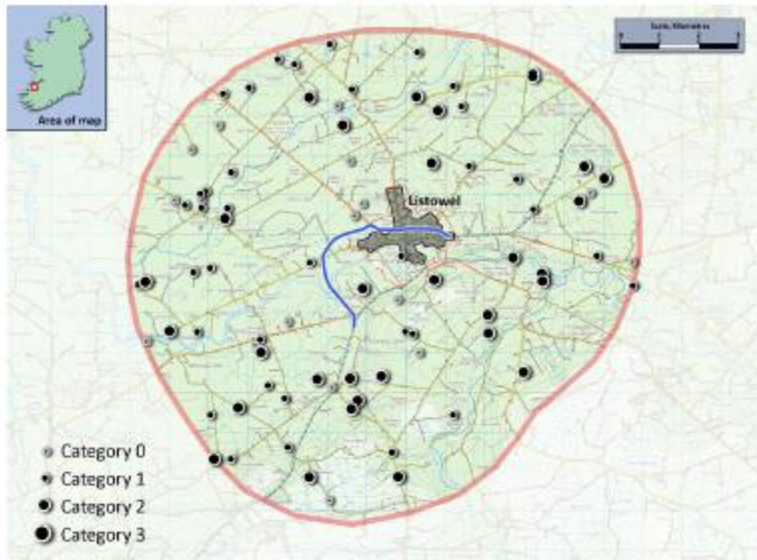

Figure 4.4 The distribution and suitability of all sites surveyed (n = 83)

The survey confirmed evidence of Barn Owl occupation at three sites within the survey area, which included two sites previously known to BirdWatch Ireland (Clontubrid North and Shrone East), and an additional previously undocumented site (Moyassa). All three active sites were in derelict cottages.

A total of 12 nocturnal visits were carried out across ten of the eleven sites classed as category 3 in 2016 to determine occupation, and for those sites where signs were encountered, to determine activity and breeding status. The derelict cottages at Shrone East and Cloontubrid North were confirmed as nest sites. Barn Owl activity was confirmed at a third derelict cottage at Moyassa, however permission to access the site was not granted and therefore it was not possible to determine breeding status. A map showing the location and status of each site is shown below (Fig 4.5)

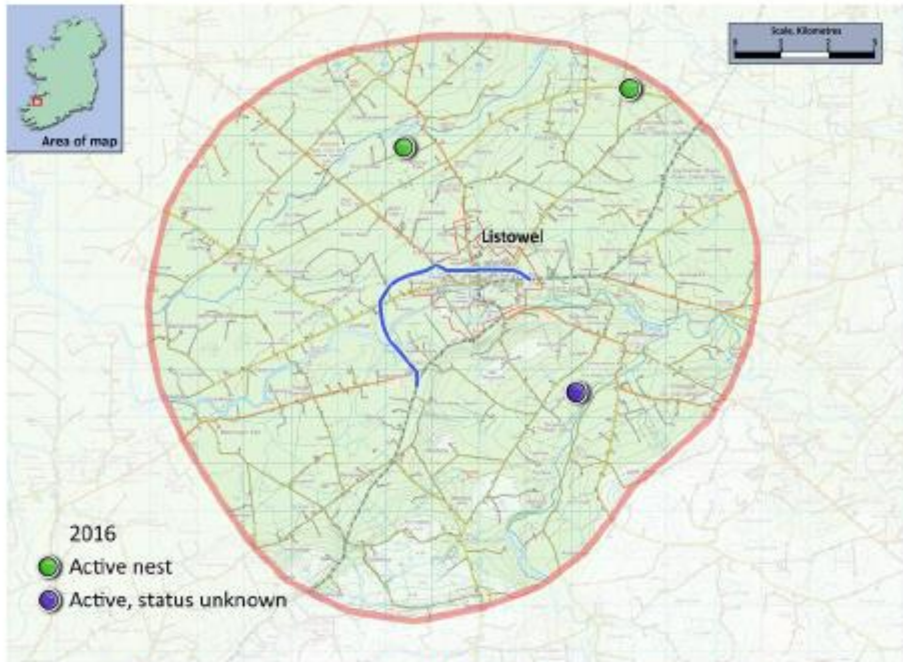

Figure 4.5 The location and status of all Barn Owls sites within the survey area in 2016

Of the two confirmed nest sites, the pair at Shrone East successfully raised young while the pair at Cloontubrid North failed to breed. The nest site at Shrone East was monitored and examined under licence from National Parks and Wildlife. The nest was located within the main chimney of the cottage. Two young, approximately 25 days old were ringed on the 29th of June (see Image 4.3 below). A summary of breeding status and outcome at all sites where activity was confirmed within the survey area is shown below in Table 4.1.

Site Name	Grid Ref.	Site Type	Pair	Nest/Roost	Successful
Shrone East	IQ 974 368	Derelict cottage	Yes	Nest	Yes
Cloontubrid North	IQ 022 380	Derelict cottage	Yes	Nest	No
Moyassa	IQ 011 315	Derelict cottage	Unknown	Unknown	Unknown

Table 4.1 The location and status of all active sites in the study area in 2016

Image 4.3 Adult female Barn Owl with two chicks at Shrone East in June 2016 (photo taken under licence from National Parks and Wildlife).

4.2 *Other raptor records*

Although the methods of this survey were specifically designed to confirm Barn Owl distribution within the survey area, other raptor species, which were encountered during survey work were also recorded. Three Kestrel roosts and two Kestrel sightings recorded are shown below in Figure 4.6.

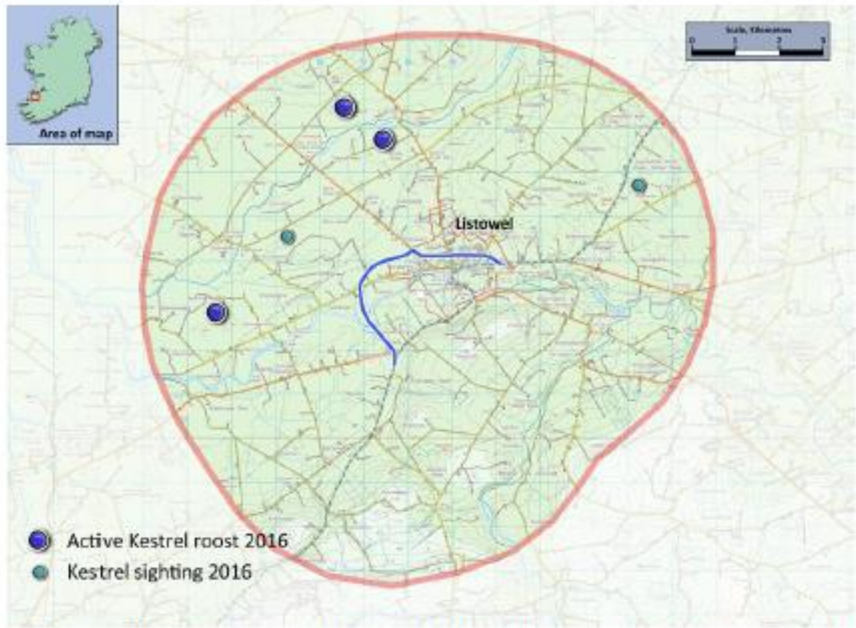

Figure 4.6 Active Kestrel roost sites and sightings of Kestrel in the survey area during survey work in 2016

5. RECOMMENDATIONS

This study provides information on Barn Owl nest and roost site locations within the defined survey area, in order to inform the route selection for the proposed N69 Listowel Bypass. Two breeding pairs were confirmed, of which one was successful which fledged two young. A third site was recorded as active however the breeding status of this site was not determined.

To minimise negative impacts of the route development to the local Barn Owl population, specific mitigation measures should be developed as necessary if/when the route is finalised. Should there be the potential of disturbance or displacement of Barn Owls as a result of the construction of the route then works should be planned accordingly to minimise negative impacts during the nesting season. Alternative nesting opportunities in the form of artificial nest sites should be provided at suitable and undisturbed locations in advance of any works. Monitoring during the post construction phase should be implemented to assess the impacts of the route development on the local Barn Owl population and to determine the effectiveness of any mitigation measures applied. This should include monitoring of known sites to determine activity, survival and dispersal in combination with a road casualty survey conducted over a two-year period to record the extent and location of road mortalities and to identify potential "high risk" areas on the route which may require mitigation. This will also take into consideration impacts on dispersing birds and not just those which might be resident within the survey area.

- Provision of artificial nesting sites at suitable locations to compensate for disturbance, displacement or loss of active or recently used sites arising from the development to include active sites, and suitable nest sites which have been used by Barn Owls in the survey area
- A post-construction road casualty survey conducted over the period of two years to determine the extent of Barn Owl road casualties, to determine the impact to local sites and dispersing birds and to identify potential 'high risk' areas for Barn Owl vehicle collisions.
- Post-construction monitoring to determine activity and breeding status of all active sites which may be affected by the route development.

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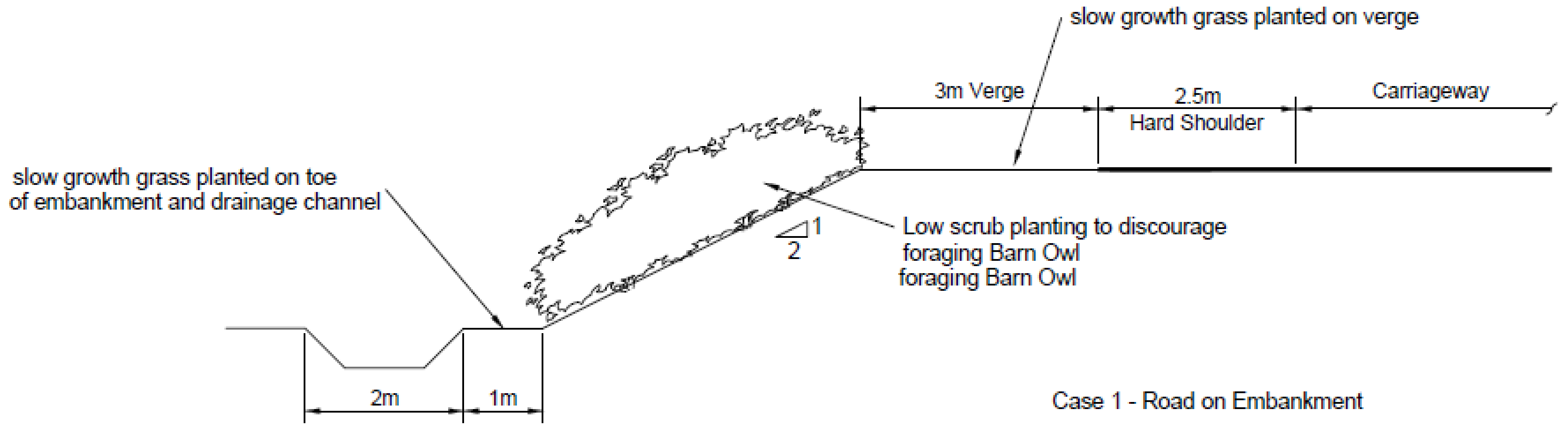
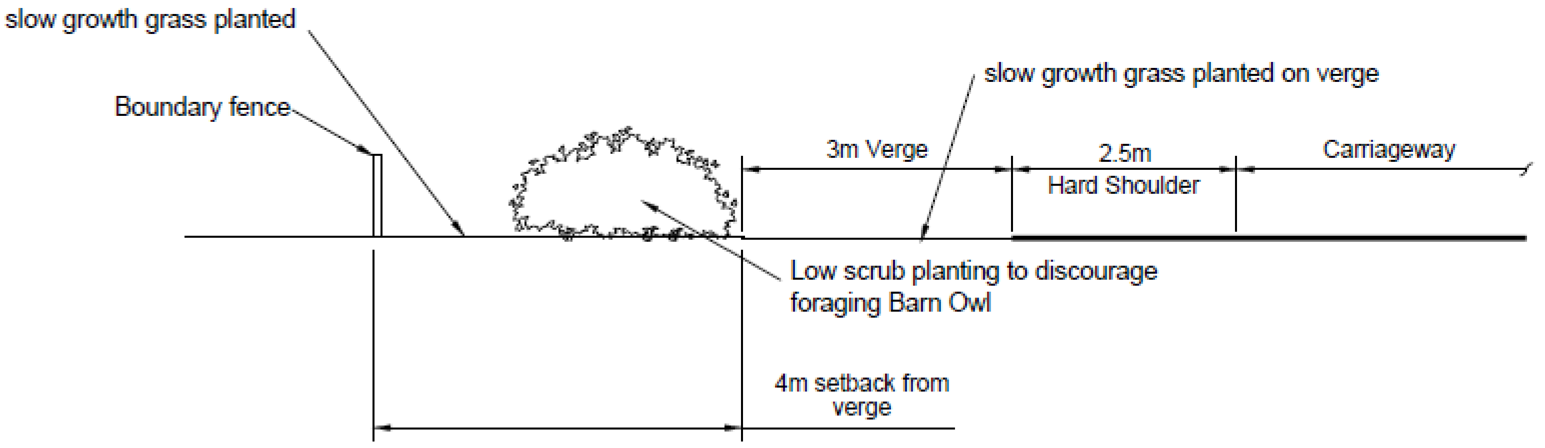
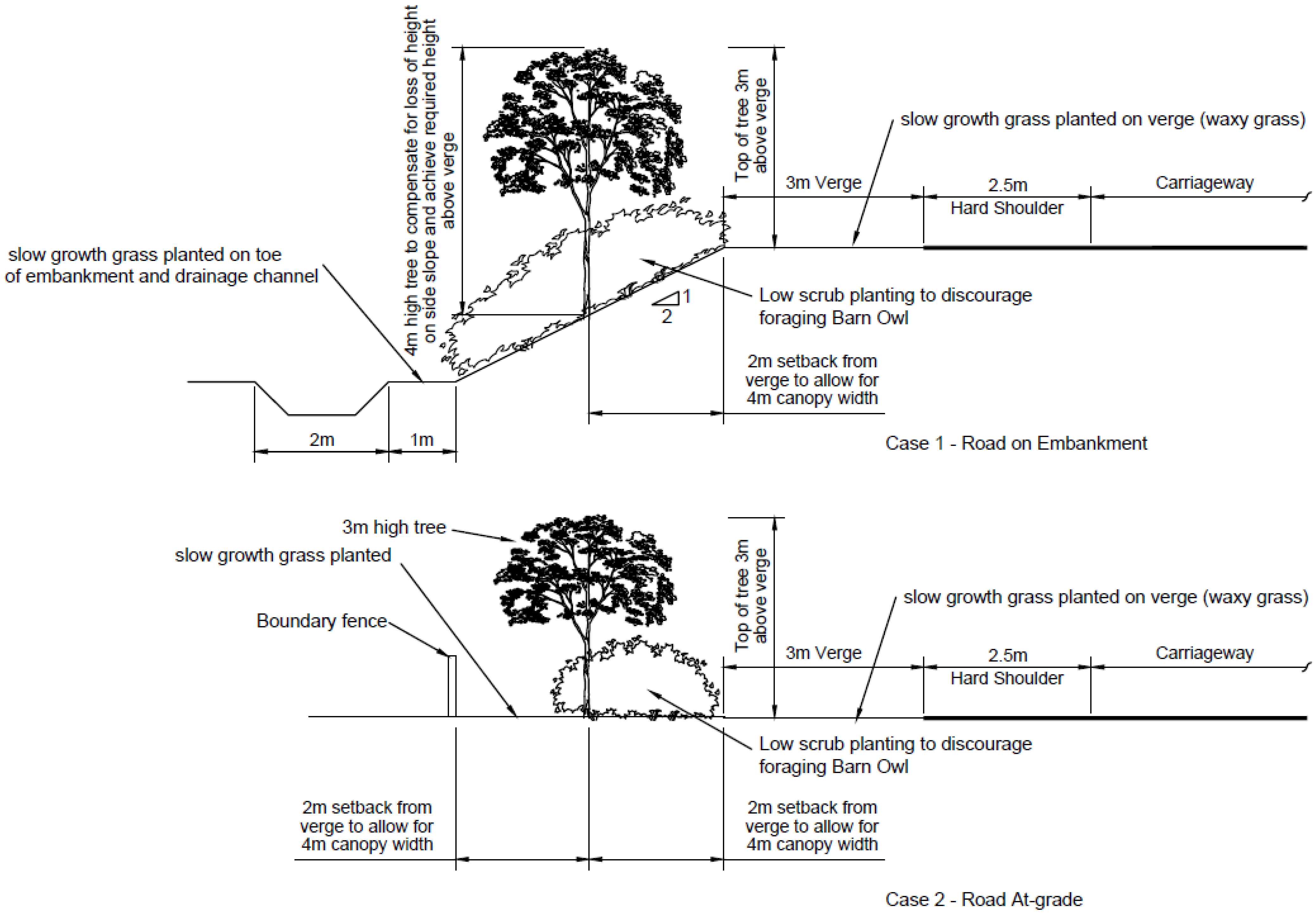
Appendix 6.10 Barn Owl Hop-overs Indicative Sketches



Case 1 - Road on Embankment



Case 2 - Road At-grade


4m high tree to compensate for loss of height on side slope and achieve required height above verge
Top of tree 3m above verge
slow growth grass planted on verge (waxy grass)
3m Verge
2.5m
Hard Shoulder
Carriageway
slow growth grass planted on toe of embankment and drainage channel
Low scrub planting to discourage foraging Barn Owl
1
2
2m setback from verge to allow for 4m canopy width
2m
1m
Case 1 - Road on Embankment
3m high tree
slow growth grass planted
Boundary fence
Top of tree 3m above verge
slow growth grass planted on verge (waxy grass)
3m Verge
2.5m
Hard Shoulder
Carriageway
Low scrub planting to discourage foraging Barn Owl
2m setback from verge to allow for 4m canopy width
2m setback from verge to allow for 4m canopy width
Case 2 - Road At-grade

Appendix 7.1 Soil Analysis Results and Risk Assessment Summary Table

				Sample Identity			BH101	BH102	BH104D	BH104S	BH105S	BH106	BH107S	TP03	TP16	TP22	TP24	TP27	TP35	TP37
				Depth			0.5	0.5	1	0	0	0.5	0	0.5	0.2	0.5	0.5	0.5	0.5	0.5
				Sample Type			SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
N69 Listowel By-pass				Sampled Date			Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided	Not provided
Geology and Soils Soil Chemical Analysis Results				Sample Received Date			01/07/13	01/07/13	19/07/13	01/07/13	01/07/13	19/07/13	01/07/13	19/07/13	01/07/13	01/07/13	04/07/13	04/07/13	04/07/13	01/07/13
Human Health Risk Assessment for Commercial End Use.				Analysis Started Date			01/07/13	01/07/13	19/07/13	01/07/13	01/07/13	19/07/13	01/07/13	19/07/13	01/07/13	01/07/13	04/07/13	04/07/13	04/07/13	01/07/13
Exceedance of Assessment Criteria				Analysis Completed Date			08/07/13	08/07/13	26/07/13	08/07/13	08/07/13	26/07/13	08/07/13	26/07/13	08/07/13	08/07/13	11/07/13	11/07/13	11/07/13	08/07/13
Below Method Detection Limit				Lab Sample Number			AI90292	AI90293	AI96982	AI90296	AI90294	AI96983	AI90295	AI96980	AI90298	AI90297	AI91785	AI91786	AI91787	AI90299
	Method	Accreditation	Units	Method Detection Limit	Assessment Criteria (where available)	No of Excedances														
Metals																				
Arsenic	2450	M	mg kg^{-1}	2	640	0	5.5	7.3	5.4	6.5	4.4	5.2	6.9	10	6.1	8.1	<2.0	12	5.3	4.5
Barium	2450	M	mg kg^{-1}	10			26	22	25	23	19	21	33	30	25	16	<10	94	39	21
Beryllium	2450	M	mg kg^{-1}	1			<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.1	<1.00	<1.00	<1.00	<1.00
Boron (hot water soluble)	2120	M	mg kg^{-1}	0.4	192000	0	<0.4	<0.4	<0.4	<0.4	<0.4	1.7	<0.4	2	<0.4	<0.4	1.3	3.7	1.3	<0.4
Cadmium	2450	M	mg kg^{-1}	0.1	230	0	<0.10	0.44	0.15	<0.10	<0.10	0.14	<0.10	0.18	<0.10	<0.10	<0.10	0.39	<0.10	<0.10
Chromium	2450	M	mg kg^{-1}	5	30400	0	23	20	22	24	16	17	23	22	17	19	<5.0	28	14	13
Copper	2450	M	mg kg^{-1}	5	71700	0	16	21	17	17	12	13	13	23	13	16	<5.0	66	7.7	10
Mercury	2450	M	mg kg^{-1}	0.1	4.3	0	0.14	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	<0.10	0.2	0.13	<0.10
Nickel	2450	M	mg kg^{-1}	5	1800	0	26	26	30	31	21	25	27	33	22	13	<5.0	39	<5.0	17
Lead	2450	M	mg kg^{-1}	5	1100 - 7000	0	14	11	10	13	8.2	9.7	11	13	10	6.3	<5.0	65	11	7.1
Selenium	2450	M	mg kg^{-1}	0.2	13000	0	<0.20	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	3.9	<0.20	<0.20	<0.20	<0.20
Vanadium	2450	M	mg kg^{-1}	5			12	12	9.9	14	9.6	7.6	15	14	11	12	<5.0	22	12	9.3
Zinc	2450	M	mg kg^{-1}	5	665000	0	40	45	53	64	39	44	50	55	41	9	14	84	22	32
Chromium (hexavalent)	2490	N	mg kg^{-1}	0.5	35	0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Petroleum Hydrocarbons (TPH)																				
TPH aliphatic >C5-C6	2675	N	mg kg^{-1}	0.1	3400	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aliphatic >C6-C8	2675	N	mg kg^{-1}	0.1	8300	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aliphatic >C8-C10	2675	N	mg kg^{-1}	0.1	2100	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aliphatic >C10-C12	2675	M	mg kg^{-1}	1	10000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aliphatic >C12-C16	2675	M	mg kg^{-1}	1	61000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aliphatic >C16-C21	2675	M	mg kg^{-1}	1	1600000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aliphatic >C21-C35	2675	M	mg kg^{-1}	1	1600000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aliphatic >C35-C44	2675	N	mg kg^{-1}	1			< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aromatic >C5-C7	2675	N	mg kg^{-1}	0.1	28000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aromatic >C7-C8	2675	N	mg kg^{-1}	0.1	59000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aromatic >C8-C10	2675	N	mg kg^{-1}	0.1	3700	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH aromatic >C10-C12	2675	M	mg kg^{-1}	1	17000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aromatic >C12-C16	2675	M	mg kg^{-1}	1	36000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aromatic >C16-C21	2675	M	mg kg^{-1}	1	28000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aromatic >C21-C35	2675	M	mg kg^{-1}	1	28000	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
TPH aromatic >C35-C44	2675	N	mg kg^{-1}	1			< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

Total Petroleum Hydrocarbons	2675	N	mg kg-¹	10			< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Poly Aromatic Hydrocarbons (PAH)																				
Acenaphthene	2700	M	mg kg-¹	0.1	85000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	2700	M	mg kg-¹	0.1	84000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.15	< 0.1	0.15	< 0.1	< 0.1
Anthracene	2700	M	mg kg-¹	0.1	530000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.37	< 0.1	0.29	< 0.1	< 0.1
Benzo[a]anthracene	2700	M	mg kg-¹	0.1	90	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.75	< 0.1	< 0.1
Benzo[a]pyrene	2700	M	mg kg-¹	0.1	14	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.67	< 0.1	< 0.1
Benzo[b]fluoranthene	2700	M	mg kg-¹	0.1	100	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	1.1	< 0.1	< 0.1
Benzo[k]fluoranthene	2700	M	mg kg-¹	0.1	650	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.75	< 0.1	< 0.1
Benzo[g,h,i]perylene	2700	M	mg kg-¹	0.1	140	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	1.2	< 0.1	< 0.1
Chrysene	2700	M	mg kg-¹	0.1	140	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.84	< 0.1	< 0.1
Dibenzo[a,h]anthracene	2700	M	mg kg-¹	0.1	13	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.21	< 0.1	< 0.1
Fluoranthene	2700	M	mg kg-¹	0.1	23000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.73	< 0.1	1.1	< 0.1	< 0.1
Fluorene	2700	M	mg kg-¹	0.1	64000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.13	< 0.1	< 0.1	< 0.1	< 0.1
Indeno[1,2,3-cd]pyrene	2700	M	mg kg-¹	0.1	60	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.61	< 0.1	< 0.1
Naphthalene	2700	M	mg kg-¹	0.1	200	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.22	< 0.1	< 0.1
Phenanthrene	2700	M	mg kg-¹	0.1	22000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.54	< 0.1	< 0.1
Pyrene	2700	M	mg kg-¹	0.1	54000	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.89	< 0.1	< 0.1
Total (of 16) PAHs	2700	M	mg kg-¹	2			< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	9.3	< 2	< 2
MBTE & BTEX																				
Methyl tert-butylether	2760	N	µg kg-¹	1	7900000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	< 1.0	< 1.0
Benzene	2760	M	µg kg-¹	1	28000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	2760	M	µg kg-¹	1	870000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	2760	M	µg kg-¹	1	520000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m- & p-Xylene	2760	M	µg kg-¹	1	620000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	2760	M	µg kg-¹	1	480000	0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenols (total)	2920	M	mg kg-¹	0.3	3200	0	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Others																				
ACM type detected (Asbestos)	2190	U	None		Not Detected		Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	2010	M	pH units	0.1			7.2	7.2	5.9	6.3	6.6	6.5	6.4	5.8	6.8	6.5	5	8.1	7.2	6.8
Total Organic Carbon	2625	M	%	0.1			2.5	2.1	0.4	0.68	0.58	0.49	0.72	0.3	0.41	1.3	6.3	4.8	5.2	0.45
Moisture	2030	M	%	0.02			18	19.4	13.7	14.1	22.4	16.6	26.7	10.1	14.8	69.7	83.6	7.47	29.1	23
Stones content (>50mm)	2030	M	%	0.02			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PLM result	2190	U					0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes
The assessment criteria used are :
GACs developed using the Environment Agency / DEFRA Contaminated Land Exposure Assessment (CLEA) model, and published by authoritative sources (LQM / CIEH 2nd Edition July 2009 and EIC/ AGS/ CL: AIRE GAC December 2009).
SGVs published by the EA / DEFRA.
The newly published Category 4 Screening levels (C4SL) has been adopted for lead in the absence of a published SGV.

Appendix 7.2 Assessment of Impacts: Land Contamination (Pre-Mitigation)

Receptor		Importance of Receptor / Sensitivity	Phase	Potential Impact	Magnitude of Impact	Impact Assessment	Limitations / Remarks
Human Health	Acute Risks to Construction Workers	High	Construction	Harm to human health from soil and groundwater contamination and potential ground gases via: Dermal contact and ingestion Contaminated imported fill materials Inhalation of wind-blown contaminated dust and airborne asbestos fibres (if encountered) Inhalation of ground gases and asphyxiation when working in potential confined spaces	Negligible (based on no substantial soil or groundwater contamination recorded during recent GI) Moderate Adverse (if significant contamination is encountered during construction including asbestos and ground gases)	Imperceptible Significant / Moderate	The recent ground investigation did not record any contamination in soil and groundwater above assessment criteria. It is not known if any significant contamination will be uncovered during the construction works, therefore extent of construction worker's exposure cannot be determined
	Chronic risks to offsite users	High	Construction	Harm to human health from soil contamination via: Inhalation of wind-blown contaminated dust and airborne asbestos fibres (if encountered)	Negligible	Imperceptible	Impact is limited to the offsite users that will be using the road and surrounding areas during the time of construction works. Details of any planned road closure or isolation is not known at this stage.
	Chronic Risks to Site Users / Maintenance Workers	High	Operation	Harm to human health from soil contamination and potential ground gases via: Inhalation of ground gases and asphyxiation when working in potential confined spaces Dermal contact and ingestion	Negligible	Imperceptible	Potential for ground gases at the site for underlying peat . The nature and extent of future maintenance works on the proposed development is not known at this stage
Infrastructure	Infrastructures including piles, pipes, conduits and culverts	High	Operation	Degradation of structures as a result of aggressive ground conditions and accumulation of potentially explosive ground gases within confined spaces e.g. pipes, conduits and culverts	Small adverse Moderate Adverse	Moderate / Slight Significant / Moderate	Potential for aggressive ground conditions at the site from underlying peat and alluvial deposits.. Assessment of aggressive ground conditions not undertaken as part of this assessment and will require a seperate geotechnical assessment at the detailed design stage.

Appendix 7.3 Residual Impacts and Mitigation Measures: Land Contamination

Receptor		Importance of Receptor / Sensitivity	Phase	Impact Assessment (Pre - Mitigation)	Mitigation Measures	Impact Assessment (Post-Mitigation)
Human Health	Acute Risks to Construction Workers	High	Construction	Imperceptible Significant / Moderate	Risk to construction workers from contamination within the soil and groundwater could be mitigated by the application of control measures such as correct use of Personal Protective Equipment (PPE), adoption of good working practices and appropriate health and safety risk assessments. Appropriate response procedures should be developed in the EOP in the event that significant areas of contamination are identified through visual or olfactory evidence during the construction works. Representative samples should be taken and laboratory tested to determine the risk to receptors and potential for reuse within the proposed development or disposal off site. As a worst case, if significant contamination is found where ground works cannot be avoided, then the material may need to be taken off-site (for disposal in an appropriate waste treatment facility) and replaced with clean materials prior to any groundwork Appropriate response procedure should be developed in the EOP in the event that suspected asbestos is identified during construction works.	Imperceptible
	Chronic risks to offsite users	High	Construction	Imperceptible	Use of dust suppression during ground works Road closure or use of isolation barriers should be adopted particularly in any known contaminated areas	Imperceptible
	Chronic Risks to Site Users / Maintenance Workers	High	Operation	Imperceptible	Procedures for working in confined spaces should be developed as part of the health and safety risk assessment process.	Imperceptible
Infrastructure	Infrastructures including piles, pipes, conduits and culverts	High	Operation	Moderate / Slight Significant / Moderate	If peat and alluvial soils are to remain below proposed infrastructure then appropriate geotechnical investigation and risk assessment will be undertaken to identify potential risks and to implement required mitigation measures through geotechnical design.	Imperceptible

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number						13630472	13819549	13630473	13819547	13630474	13819550
Customer Sample Ref.			Drinking Water Regulations 2007			Well 06	Well 06	Well 07	Well 07	Well 08	Well 08
Sample Matrix				Table	Notes	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units									
Aluminium,Total as Al	WAS049	mg/l	0.2	B		<0.100	<0.100	0.504	<0.100	<0.100	<0.100
Arsenic, Total as As	WAS051	ug/l	10	C		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Barium, Total as Ba	WAS049	ug/l	-	-		38.1	22.3	27.7	12.1	11	8
Beryllium, Total as Be	WAS049	ug/l	-	-		<2.10	<2.10	<2.10	<2.10	<2.10	<2.10
Boron , Total as B	WAS049	ug/l	1000	B		<230	<230	<230	<230	<230	<230
Cadmium , Total as Cd	WAS049	ug/l	5	B		<0.600	<0.600	<0.600	<0.600	1.1	1.6
Chromium - Hexavalent	WAS031	mg/l	-	-		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium , Total as Cr	WAS049	mg/l	0.05	B		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Chromium III	CALC	mg/l	-	-		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper , Total as Cu	WAS049	ug/l	2000	B		<9.00	10.6	<9.00	<9.00	<9.00	<9.00
Iron, Total as Fe	WAS049	ug/l	200	C		<230	<230	297	<230	<230	<230
Lead , Total as Pb	WAS049	ug/l	10*	B		<6.00	<6.00	<6.00	<6.00	<6.00	<6.00
Manganese , Total as Mn	WAS049	ug/l	50	C		22.7	8.3	28.3	21	1730	1730
Mercury, Total as Hg	WAS013	ug/l	1	B		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel , Total as Ni	WAS049	ug/l	20*	B		<3.00	<3.00	<3.00	<3.00	<3.00	<3.00
Selenium, Total as Se	WAS051	ug/l	10	B		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Sodium , Total as Na	WAS049	mg/l	200	C		15.4	14.7	13.7	18.1	32.9	36.8
Vanadium, Total as V	WAS049	ug/l	-	-		<4.00	<4.00	5.8	<4.00	5.7	5.5
Zinc , Total as Zn	WAS049	ug/l	-	-		<18.0	<18.0	23.2	<18.0	<18.0	<18.0
pH	WAS039	pH units	>6.5 - <9.5	C		6.3	6.7	6.9	7.4	7.2	7.6
Conductivity- Electrical 20C	WAS039	uS/cm	2500	C		349	306	676	561	815	839
Alkalinity as CaCO3	WAS025	mg/l	-	-		127	99	146	172	292	318
Total Hardness as CaCO3	WAS049	mg/l	-	-		147	131	339	268	383	440
Turbidity	WAS066	NTU	1*	C		<0.24	0.26	12.2	0.56	3.52	1
Ammoniacal Nitrogen as N	WAS036	mg/l	-	-		<0.27	<0.27	<0.27	<0.27	<0.27	<0.27
Chloride as Cl	WAS036	mg/l	250	C		28.8	24.7	14.8	23.9	64.6	67.6
Nitrate as NO3	WAS067	mg/l	50*	B		16.9	24.2	8.2	13.7	<1.3	<1.3
Sulphate as SO4	WAS036	mg/l	250*	C		13.5	12.6	222	109	81	85.6
Dissolved Oxygen concentration	WAS052	mg/l	-	-		1.8	<0.5	7.7	N/S	1.3	<0.5
TOC as C	WAS005	mg/l	No Ab. Change	C		1	<0.7	2.2	<0.7	2.7	2.5
Phenols Mono (Phenol Index)	WAS019	mg/l				<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Methyl Tertiary Butyl Ether	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Benzene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Ethyl Benzene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aliphatic VPH >C5 - C6	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C6 - C8	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C8 - 10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C5 - C7	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C7 - C8	GEO45	ug/l				<10	<10	<10	<10	<10	<10

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number			Drinking Water Regulations 2007			13630472	13819549	13630473	13819547	13630474	13819550
Customer Sample Ref.						Well 06	Well 06	Well 07	Well 07	Well 08	Well 08
Sample Matrix				Table	Notes	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units									
Aromatic VPH >C8 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C10 - C12	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C12 - C16	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C16 - C35	GEO46	ug/l				<10	<10	12	<10	<10	<10
Aliphatic EPH >C35 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C10 - C44	GEO46	ug/l				<10	<10	12	<10	<10	<10
Aromatic EPH >C10 - C12	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C12 - C16	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C16 - C21	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C21 - C35	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C35 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C10 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
EPH >C10 - C44	GEO46	ug/l				<10	<10	12	<10	<10	<10
Aliphatic VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	12	<10	<10	<10
Aromatic VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	<10	<10	<10	<10
VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	12	<10	<10	<10
Acenaphthene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (a) anthracene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (g,h,i) perylene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (a) pyrene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (b) fluoranthene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (k) fluoranthene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz (a,h) anthracene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno (1,2,3) cd pyrene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	GEO19	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAH, Total	GEO19	ug/l	0.5	B		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,1-Trichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromodichloromethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Carbon Tetrachloride	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	GEO56	ug/l	10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total THM	GEO56	ug/l	100			0.4	<0.40	<0.40	<0.40	<0.40	<0.40
Trichloroethene	GEO56	ug/l	10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Propanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,1,2,2-Tetrachloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,2-Trichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number			Drinking Water Regulations 2007			13630472	13819549	13630473	13819547	13630474	13819550
Customer Sample Ref.						Well 06	Well 06	Well 07	Well 07	Well 08	Well 08
Sample Matrix				Table	Notes	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units									
Chloroform	GEO56	ug/l	6*		Dutch Target Value	0.4	<0.10	<0.10	<0.10	<0.10	<0.10
Diethylene Glycol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Ethylene Glycol	GEO39	mg/l				4.6	<2.00	<2.00	<2.00	<2.00	<2.00
m&p Xylene	GEO56	ug/l				<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Styrene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Xylenes	GEO56	ug/l				<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-butanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,3-propanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,4-butanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Clostridium Perfringens	SUBCON	cfu/100ml	0*			0	0	3	0	1	16
E-Coli Coliforms	SUBCON	cfu/100ml	0			0	0	>100	0	0	0
Qual Odour Stage1 With Cl2	WPM10	TEXT				0	0	0	0	1P	1Z
Total Coliforms	SUBCON	cfu/100ml	0			0	0	>100	0	0	0
Triethylene Glycol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
TVC22	SUBCON	cfu/ml				>300	57	>300	>300	76	42

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number			Drinking Water Regulations 2007	Table	Notes	13630437	13819551	13630438	13819552	13630439	13819548
Customer Sample Ref.						Well 02	Well 02	Well 03	Well 03	Well 06	Well 06
Sample Matrix						Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units				* Mains Water					
Arsenic, Total as As	WAS051	ug/l	10	C		<1.4	<1.4	<1.4	<1.4	<1.4	6.2
Barium, Total as Ba	WAS049	ug/l				<7.00	<7.00	56.7	33.6	19.9	18.5
Beryllium, Total as Be	WAS049	ug/l				<2.10	<2.10	<2.10	<2.10	<2.10	<2.10
Boron , Total as B	WAS049	ug/l	1000	B		<230	<230	<230	<230	<230	<230
Cadmium , Total as Cd	WAS049	ug/l	5	B		<0.600	<0.600	0.9	1.7	<0.600	0.7
Chromium - Hexavalent	WAS031	mg/l				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium , Total as Cr	WAS049	mg/l	0.05	B		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Chromium III	CALC	mg/l				<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Copper , Total as Cu	WAS049	ug/l	2000	B		26.5	<9.00	<9.00	<9.00	<9.00	<9.00
Lead , Total as Pb	WAS049	ug/l	10*	B		<6.00	<6.00	<6.00	<6.00	<6.00	<6.00
Mercury, Total as Hg	WAS013	ug/l	1	B		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel , Total as Ni	WAS049	ug/l	20*	B		<3.00	3.8	5.7	6	<3.00	<3.00
Selenium, Total as Se	WAS051	ug/l	10	B		<1.6	1.7	<1.6	<1.6	<1.6	<1.6
Vanadium, Total as V	WAS049	ug/l				<4.00	5.9	6.9	6.5	<4.00	<4.00
Zinc , Total as Zn	WAS049	ug/l				20	<18.0	<18.0	<18.0	<18.0	<18.0
pH	WAS039	pH units	>6.5 - <9.5	C		7.3	7.3	6.9	7.1	7.4	7.7
Conductivity- Electrical 20C	WAS039	uS/cm	2500	C		294	920	1120	860	821	817
Alkalinity as CaCO3	WAS025	mg/l				33.9	401	487	439	287	303
Total Hardness as CaCO3	WAS049	mg/l				26	519	460	485	277	313
Ammoniacal Nitrogen as	WAS036	mg/l				<0.27	<0.27	10.2	0.88	<0.27	0.29

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number			Drinking Water Regulations 2007	Table	Notes	13630437	13819551	13630438	13819552	13630439	13819548
Customer Sample Ref.						Well 02	Well 02	Well 03	Well 03	Well 06	Well 06
Sample Matrix						Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units				* Mains Water					
N											
Chloride as Cl	WAS036	mg/l	250	C		28.5	91.9	83.8	54.3	105	106
Nitrate as NO3	WAS067	mg/l	50*	B		<1.3	9.7	8.1	9.8	<1.3	<1.3
Dissolved Oxygen concentration	WAS052	mg/l				7.4	2	4.2	1	2.9	2.4
TOC as C	WAS005	mg/l	No Ab. Change	C		2.8	0.8	5.3	2.9	<0.7	<0.7
Phenols Mono (Phenol Index)	WAS019	mg/l				<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Methyl Tertiary Butyl Ether	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Dichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Benzene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Ethyl Benzene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aliphatic VPH >C5 - C6	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C6 - C8	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C8 - 10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C5 - C7	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C7 - C8	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C8 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aromatic VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
VPH >C5 - C10	GEO45	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C10 - C12	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C12 - C16	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C16 - C35	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C35 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic EPH >C10 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C10 - C12	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C12 - C16	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C16 - C21	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C21 - C35	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C35 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aromatic EPH >C10 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
EPH >C10 - C44	GEO46	ug/l				<10	<10	<10	<10	<10	<10
Aliphatic VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	<10	<10	<10	<10

						Jul-13	Dec-13	Jul-13	Dec-13	Jul-13	Dec-13
Laboratory Number			Drinking Water Regulations 2007	Table	Notes	13630437	13819551	13630438	13819552	13630439	13819548
Customer Sample Ref.						Well 02	Well 02	Well 03	Well 03	Well 06	Well 06
Sample Matrix						Ground waters	Ground waters	Ground waters	Ground waters	Ground waters	Ground waters
Analyte	Method	Units				* Mains Water					
Aromatic VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	<10	<10	<10	<10
VPH/EPH >C5 - C44	GEO45/GEO46	ug/l				<10	<10	<10	<10	<10	<10
PAH, Total	GEO19	ug/l	0.5	B		0.014	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,1-Trichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bromodichloromethane	GEO56	ug/l				22.7	<0.10	<0.10	<0.10	<0.10	<0.10
Bromoform	GEO56	ug/l				1.07	<0.10	<0.10	<0.10	<0.10	<0.10
Carbon Tetrachloride	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tetrachloroethene	GEO56	ug/l	10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	GEO56	ug/l				8.06	<0.10	<0.10	<0.10	<0.10	<0.10
Total THM	GEO56	ug/l	100			77.7	<0.40	<0.40	<0.40	<0.40	<0.40
Trichloroethene	GEO56	ug/l	10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-Propanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,1,2,2-Tetrachloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,1,2-Trichloroethane	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	GEO56	ug/l	6*/400*			45.9	<0.10	<0.10	<0.10	<0.10	<0.10
Diethylene Glycol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Ethylene Glycol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
m&p Xylene	GEO56	ug/l				<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Styrene	GEO56	ug/l				<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	GEO56	ug/l				0.12	<0.10	<0.10	<0.10	0.17	<0.10
Total Xylenes	GEO56	ug/l				<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-butanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,3-propanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
1,4-butanediol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Triethylene Glycol	GEO39	mg/l				<2.00	<2.00	<2.00	<2.00	<2.00	<2.00

Chemtest
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Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony
03 September 2013

Dear P Dunlop/D O'Mahony

Test Report Number **237423**
Your Project Reference **13-201 N69 Listowel Bypass Road Improvement Scheme**

Please find enclosed the results of analysis for the samples received 27 August 2013.

All soil samples will be retained for a period of one month and all water samples will be retained for 7 days following the date of the test report. Should you require an extended retention period then please detail your requirements in an email to customerservices@chemtest.co.uk. Please be aware that charges may be applicable for extended sample storage.

If you require any further assistance, please do not hesitate to contact the Customer Services team.

Yours sincerely

Darrell Hall, Director

UKAS TESTING
2183

Notes to accompany report:
- *The sign < means 'less than'*
- *Tests marked 'U' hold UKAS accreditation*
- *Tests marked 'M' hold MCertS (and UKAS) accreditation*
- *Tests marked 'N' do not currently hold UKAS accreditation*
- *Tests marked 'S' were subcontracted to an approved laboratory*
- *n/e means 'not evaluated'*
- *i/s means 'insufficient sample'*
- *u/s means 'unsuitable sample'*
- *Comments or interpretations are beyond the scope of UKAS accreditation*
- *The results relate only to the items tested*
- *All results are expressed on a dry weight basis*
- *The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, phenols*
- *For all other tests the samples were dried at < 37°C prior to analysis*
- *Uncertainties of measurement for the determinands tested are available upon request*
- *None of the test results included in this report have been recovery corrected*

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony

LABORATORY TEST REPORT

Results of analysis of 13 samples
received 27 August 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

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Report Date
01 November 2013

Login Batch No					237423					
Chemtest LIMS ID					AJ09759	AJ09760	AJ09761	AJ09762	AJ09763	AJ09764
Sample ID					BH101	BH102	BH103D	BH104S	BH104D	BH105BD
Sample No										
Sampling Date					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
Depth										
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*						
1010	pH	PH		U	7.5	7.3	7.5	7.3	7.9	8.0
1020	Electrical Conductivity	EC	µS cm^{-1}	U	600	720	570	720	770	520
1220	Alkalinity	ALK	mg CaCO3 l^{-1}	U	500	530	480	540	350	230
	Chloride	16887006	mg l^{-1}	U	47	56	44	56	72	45
	Ammoniacal Nitrogen	AMM_NITROG	mg l^{-1}	U	0.12	0.06	0.09	0.05	0.38	0.22
	Nitrate	14797558	mg l^{-1}	U	<0.50	1.7	0.59	1.1	<0.50	1.0
1610	Total Organic Carbon	TOC	mg l^{-1}	N	2.1	2.2	3.0	3.8	2.1	3.7
1270	Hardness	HARD_TOT	mg CaCO3 l^{-1}	U	260	310	230	310	250	190
1450	Arsenic	7440382	µg l^{-1}	U	1.4	<1.0	1.0	<1.0	180	5.7
	Boron	7440428	µg l^{-1}	U	700	760	680	620	760	600
	Barium	7440393	µg l^{-1}	U	15	7.4	11	6.3	49	5.8
	Beryllium	7440417	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cadmium	7440439	µg l^{-1}	U	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
	Chromium	7440473	µg l^{-1}	U	1.9	2.7	1.9	2.7	2.1	1.8
	Copper	7440508	µg l^{-1}	U	2.0	1.1	2.7	<1.0	1.3	2.4
	Mercury	7439976	µg l^{-1}	U	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
	Nickel	7440020	µg l^{-1}	U	2.0	<1.0	1.5	<1.0	<1.0	<1.0
	Lead	7439921	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium	7782492	µg l^{-1}	U	6.4	2.7	5.5	2.4	5.1	3.2
	Vanadium	7440622	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	<1.0	2.4
	Zinc	7440666	µg l^{-1}	U	26	11	14	4.3	1.3	1.7
1490	Chromium (trivalent)	16065831	µg l^{-1}	N	< 20	< 20	< 20	< 20	< 20	< 20
	Chromium (hexavalent)	18540299	µg l^{-1}	U	<20	<20	<20	<20	<20	<20
1675	TPH aliphatic >C5-C6		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

All tests undertaken between 27/08/2013 and 03/09/2013
* Accreditation status
This report should be interpreted in conjunction with the notes on the accompanying cover page.

Column page 1
Report page 1 of 3
LIMS sample ID range AJ09759 to AJ09771

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony

LABORATORY TEST REPORT

Results of analysis of 13 samples received 27 August 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

Chemtest The right chemistry to deliver results

Report Date
01 November 2013

Login Batch No					237423					
Chemtest LIMS ID					AJ09765	AJ09766	AJ09767	AJ09768	AJ09769	AJ09770
Sample ID					BH105S	BH106	BH107AD	BH108D	BH109	BH110
Sample No										
Sampling Date					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
Depth										
Matrix					*WATER*	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
SOP↓	Determinand↓	CAS No↓	Units↓	*						
1010	pH	PH		U	7.5	7.8	7.4	7.7	7.7	7.8
1020	Electrical Conductivity	EC	$\mu S\ cm^{-1}$	U	720	520	720	530	520	520
1220	Alkalinity	ALK	mg $CaCO_3\ l^{-1}$	U	110	230	120	220	230	220
	Chloride	16887006	mg l^{-1}	U	55	45	56	45	44	44
	Ammoniacal Nitrogen	AMM_NITROG	mg l^{-1}	U	0.06	0.20	0.05	0.17	0.16	0.19
	Nitrate	14797558	mg l^{-1}	U	1.7	1.8	2.4	4.0	3.8	3.4
1610	Total Organic Carbon	TOC	mg l^{-1}	N	2.3	3.8	2.3	3.7	3.8	3.6
1270	Hardness	HARD_TOT	mg $CaCO_3\ l^{-1}$	U	330	190	310	190	190	190
1450	Arsenic	7440382	µg l^{-1}	U	1.5	1.2	<1.0	1.1	<1.0	<1.0
	Boron	7440428	µg l^{-1}	U	730	630	690	630	630	590
	Barium	7440393	µg l^{-1}	U	6.5	<5.0	6.9	5.5	<5.0	<5.0
	Beryllium	7440417	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cadmium	7440439	µg l^{-1}	U	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080
	Chromium	7440473	µg l^{-1}	U	2.8	1.8	2.9	2.0	1.6	1.7
	Copper	7440508	µg l^{-1}	U	<1.0	2.1	<1.0	2.6	2.3	2.2
	Mercury	7439976	µg l^{-1}	U	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
	Nickel	7440020	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	3.6	<1.0
	Lead	7439921	µg l^{-1}	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Selenium	7782492	µg l^{-1}	U	2.0	2.5	1.9	3.1	2.8	2.7
	Vanadium	7440622	µg l^{-1}	U	<1.0	2.3	<1.0	2.6	2.5	2.5
	Zinc	7440666	µg l^{-1}	U	<1.0	6.8	4.7	3.5	7.3	1.9
1490	Chromium (trivalent)	16065831	µg l^{-1}	N	< 20	< 20	< 20	< 20	< 20	< 20
	Chromium (hexavalent)	18540299	µg l^{-1}	U	<20	<20	<20	<20	<20	<20
1675	TPH aliphatic >C5-C6		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page.

Column page 2
Report page 1 of 3
LIMS sample ID range AJ09759 to AJ09771

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony

LABORATORY TEST REPORT

Results of analysis of 13 samples
received 27 August 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

Chemtest
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Report Date
01 November 2013

SOP↓	Determinand↓	CAS No↓	Units↓	*	
	Login Batch No				**237423**
	Chemtest LIMS ID				AJ09771
	Sample ID				BH103D
	Sample No				Duplicate
	Sampling Date				22/8/2013
	Depth				
	Matrix				*WATER*
1010	pH	PH		U	7.7
1020	Electrical Conductivity	EC	µS cm-¹	U	590
1220	Alkalinity	ALK	mg CaCO3 l-¹	U	470
	Chloride	16887006	mg l-¹	U	44
	Ammoniacal Nitrogen	AMM_NITROG	mg l-¹	U	0.08
	Nitrate	14797558	mg l-¹	U	1.6
1610	Total Organic Carbon	TOC	mg l-¹	N	3.2
1270	Hardness	HARD_TOT	mg CaCO3 l-¹	U	230
1450	Arsenic	7440382	µg l-¹	U	1.1
	Boron	7440428	µg l-¹	U	720
	Barium	7440393	µg l-¹	U	12
	Beryllium	7440417	µg l-¹	U	<1.0
	Cadmium	7440439	µg l-¹	U	<0.080
	Chromium	7440473	µg l-¹	U	1.9
	Copper	7440508	µg l-¹	U	3.0
	Mercury	7439976	µg l-¹	U	<0.50
	Nickel	7440020	µg l-¹	U	1.9
	Lead	7439921	µg l-¹	U	<1.0
	Selenium	7782492	µg l-¹	U	5.1
	Vanadium	7440622	µg l-¹	U	<1.0
	Zinc	7440666	µg l-¹	U	20
1490	Chromium (trivalent)	16065831	µg l-¹	N	< 20
	Chromium (hexavalent)	18540299	µg l-¹	U	<20
1675	TPH aliphatic >C5-C6		µg l-¹	N	< 0.1

* Accreditation status

This report should be interpreted in conjunction with the notes on the accompanying cover page.

Column page 3
Report page 1 of 3
LIMS sample ID range AJ09759 to AJ09771

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony

LABORATORY TEST REPORT

Results of analysis of 13 samples received 27 August 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

Chemtest
The right chemistry to deliver results

Report Date
01 November 2013

					237423					
					AJ09759	AJ09760	AJ09761	AJ09762	AJ09763	AJ09764
					BH101	BH102	BH103D	BH104S	BH104D	BH105BD
					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	TPH aliphatic >C6-C8		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C8-C10		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C10-C12		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C12-C16		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C16-C21		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	100	< 0.1	< 0.1
	TPH aliphatic >C21-C35		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	130	< 0.1	< 0.1
	TPH aliphatic >C35-C44		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C5-C7		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C7-C8		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C8-C10		µg l⁻¹	N	< 0.1	14	< 0.1	< 0.1	7.6	< 0.1
	TPH aromatic >C10-C12		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C12-C16		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C16-C21		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	12	< 0.1	< 0.1
	TPH aromatic >C21-C35		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	11	< 0.1	< 0.1
	TPH aromatic >C35-C44		µg l⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Total Petroleum Hydrocarbons		µg l⁻¹	N	< 10	14	< 10	250	< 10	< 10
	Total Aliphatic Hydrocarbons		µg l⁻¹	N	< 5	< 5	< 5	230	< 5	< 5
	Total Aromatic Hydrocarbons		µg l⁻¹	N	< 5	14	< 5	23	8	< 5
1700	Naphthalene	91203	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthylene	208968	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthene	83329	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluorene	86737	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phenanthrene	85018	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Anthracene	120127	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	206440	µg l⁻¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All tests undertaken between 27/08/2013 and 03/09/2013
* Accreditation status
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Column page 1
Report page 2 of 3
LIMS sample ID range AJ09759 to AJ09771

Causeway Geotech Ltd.
8 Drumahiskey Road
Balnamore, Ballymoney
Co. Antrim
BT53 7QL

FAO P Dunlop/D O'Mahony

LABORATORY TEST REPORT

Chemtest
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Results of analysis of 13 samples
received 27 August 2013

Report Date
01 November 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

					237423					
					AJ09765	AJ09766	AJ09767	AJ09768	AJ09769	AJ09770
					BH105S	BH106	BH107AD	BH108D	BH109	BH110
					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1675	TPH aliphatic >C6-C8		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C8-C10		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C10-C12		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C12-C16		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C16-C21		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C21-C35		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C35-C44		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C5-C7		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C7-C8		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C8-C10		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C10-C12		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C12-C16		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C16-C21		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C21-C35		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C35-C44		µg l^{-1}	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Total Petroleum Hydrocarbons		µg l^{-1}	N	< 10	< 10	< 10	< 10	< 10	< 10
	Total Aliphatic Hydrocarbons		µg l^{-1}	N	< 5	< 5	< 5	< 5	< 5	< 5
	Total Aromatic Hydrocarbons		µg l^{-1}	N	< 5	< 5	< 5	< 5	< 5	< 5
1700	Naphthalene	91203	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthylene	208968	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Acenaphthene	83329	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluorene	86737	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Phenanthrene	85018	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Anthracene	120127	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Fluoranthene	206440	µg l^{-1}	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

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LABORATORY TEST REPORT

Chemtest
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Results of analysis of 13 samples
received 27 August 2013

13-201 N69 Listowel Bypass Road Improvement Scheme

Report Date
01 November 2013

					237423
					AJ09771
					BH103D
					Duplicate
					22/8/2013
					WATER
1675	TPH aliphatic >C6-C8		µg l-1	N	< 0.1
	TPH aliphatic >C8-C10		µg l-1	N	< 0.1
	TPH aliphatic >C10-C12		µg l-1	N	< 0.1
	TPH aliphatic >C12-C16		µg l-1	N	< 0.1
	TPH aliphatic >C16-C21		µg l-1	N	< 0.1
	TPH aliphatic >C21-C35		µg l-1	N	< 0.1
	TPH aliphatic >C35-C44		µg l-1	N	< 0.1
	TPH aromatic >C5-C7		µg l-1	N	< 0.1
	TPH aromatic >C7-C8		µg l-1	N	< 0.1
	TPH aromatic >C8-C10		µg l-1	N	< 0.1
	TPH aromatic >C10-C12		µg l-1	N	< 0.1
	TPH aromatic >C12-C16		µg l-1	N	< 0.1
	TPH aromatic >C16-C21		µg l-1	N	< 0.1
	TPH aromatic >C21-C35		µg l-1	N	< 0.1
	TPH aromatic >C35-C44		µg l-1	N	< 0.1
	Total Petroleum Hydrocarbons		µg l-1	N	< 10
	Total Aliphatic Hydrocarbons		µg l-1	N	< 5
	Total Aromatic Hydrocarbons		µg l-1	N	< 5
1700	Naphthalene	91203	µg l-1	U	<0.1
	Acenaphthylene	208968	µg l-1	U	<0.1
	Acenaphthene	83329	µg l-1	U	<0.1
	Fluorene	86737	µg l-1	U	<0.1
	Phenanthrene	85018	µg l-1	U	<0.1
	Anthracene	120127	µg l-1	U	<0.1
	Fluoranthene	206440	µg l-1	U	<0.1

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LIMS sample ID range AJ09759 to AJ09771

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					237423					
					AJ09759	AJ09760	AJ09761	AJ09762	AJ09763	AJ09764
					BH101	BH102	BH103D	BH104S	BH104D	BH105BD
					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1700	Pyrene	129000	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[a]anthracene	56553	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	218019	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[b]fluoranthene	205992	µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[k]fluoranthene	207089	µg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[a]pyrene	50328	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo[a,h]anthracene	53703	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno[1,2,3-cd]pyrene	193395	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[g,h,i]perylene	191242	µg l-¹	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Total (of 16) PAHs		µg l-¹	U	<2	<2	<2	<2	<2	<2
1760	Methyl tert-butylether	1634044	µg l-¹	N	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Benzene	71432	µg l-¹	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Toluene	108883	µg l-¹	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Ethylbenzene	100414	µg l-¹	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	m- & p-Xylene	1330207	µg l-¹	U	<1.0	11	<1.0	<1.0	2.3	<1.0
	o-Xylene	95476	µg l-¹	U	<1.0	6.1	<1.0	<1.0	7.1	<1.0
1790	Ethylene glycol	107211	mg l-¹	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1920	Phenols (total)		mg l-¹	N	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

All tests undertaken between 27/08/2013 and 03/09/2013
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LIMS sample ID range AJ09759 to AJ09771

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					237423					
					AJ09765	AJ09766	AJ09767	AJ09768	AJ09769	AJ09770
					BH105S	BH106	BH107AD	BH108D	BH109	BH110
					22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013	22/8/2013
					WATER	*WATER*	*WATER*	*WATER*	*WATER*	*WATER*
1700	Pyrene	129000	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[a]anthracene	56553	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chrysene	218019	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[b]fluoranthene	205992	µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[k]fluoranthene	207089	µg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[a]pyrene	50328	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dibenzo[a,h]anthracene	53703	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Indeno[1,2,3-cd]pyrene	193395	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Benzo[g,h,i]perylene	191242	µg l-1	U	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Total (of 16) PAHs		µg l-1	U	<2	<2	<2	<2	<2	<2
1760	Methyl tert-butyl ether	1634044	µg l-1	N	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Benzene	71432	µg l-1	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Toluene	108883	µg l-1	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Ethylbenzene	100414	µg l-1	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	m- & p-Xylene	1330207	µg l-1	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	o-Xylene	95476	µg l-1	U	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1790	Ethylene glycol	107211	mg l-1	N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1920	Phenols (total)		mg l-1	N	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

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					237423
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					Duplicate
					22/8/2013
					WATER
1700	Pyrene	129000	µg l-1	U	<0.1
	Benzo[a]anthracene	56553	µg l-1	U	<0.1
	Chrysene	218019	µg l-1	U	<0.1
	Benzo[b]fluoranthene	205992	µg l-1	N	<0.1
	Benzo[k]fluoranthene	207089	µg l-1	N	<0.1
	Benzo[a]pyrene	50328	µg l-1	U	<0.1
	Dibenzo[a,h]anthracene	53703	µg l-1	U	<0.1
	Indeno[1,2,3-cd]pyrene	193395	µg l-1	U	<0.1
	Benzo[g,h,i]perylene	191242	µg l-1	U	<0.1
	Total (of 16) PAHs		µg l-1	U	<2
1760	Methyl tert-butylether	1634044	µg l-1	N	<1.0
	Benzene	71432	µg l-1	U	<1.0
	Toluene	108883	µg l-1	U	<1.0
	Ethylbenzene	100414	µg l-1	U	<1.0
	m- & p-Xylene	1330207	µg l-1	U	<1.0
	o-Xylene	95476	µg l-1	U	<1.0
1790	Ethylene glycol	107211	mg l-1	N	<0.1
1920	Phenols (total)		mg l-1	N	< 0.03

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Column page 3
Report page 3 of 3
LIMS sample ID range AJ09759 to AJ09771

Receptor		Importance of Receptor / Sensitivity	Phase	Potential Impact	Magnitude of Impact	Impact Assessment	Limitations / Remarks
Surface & Ground Water	Shallow groundwater (within the Alluvial Deposits and Glacial Till)	Low - Medium	Construction	Degradation of groundwater quality via Accidental spillages Contaminated imported fill materials Pathways created by piling activities	Moderate Adverse M	Slight to Moderate	Construction materials storage solution not known at this stage. Piling methodology not known at this stage Integrity of current scheme drainage is unknown
		Low - Medium	Operation	Degradation of groundwater quality via Leaching of contaminants from contaminated re-used site won materials Leaching of contaminants from imported fill materials Leaching from concrete (including additives) from structures and piles Accidental spillages resulting from road the road use during operation.	Negligible/Small Adverse Negligible / Small Adverse Negligible / Small Adverse Moderate Adverse	Imperceptible / Slight Imperceptible / Slight Imperceptible / Slight Moderate	Source(s) and nature of proposed imported fill materials not known at this stage. Re-use potential for any site won material has not been determined Nature of concrete (and additives) to be used not known at this stage.
	Deeper Groundwater	Low - Medium	Construction	Degradation of groundwater quality via Migration of contaminants from shallow groundwater to the deeper aquifer via pathways created by piling activities	Moderate Adverse	Slight to Moderate	Sources and nature of materials to be imported to site not known at this stage. Piling methodology not known at this stage. Contractor's piling risk assessment not known at this stage. Nature of concrete (and additives) not known at this stage.
		Low - Medium	Operation	Degradation of groundwater quality via Migration of contaminants from shallow groundwater to the deeper aquifer via accidental spillages resulting from the road use during operation	Moderate Adverse	Slight to Moderate	Integrity of the existing drainage on the scheme is not known
	Private water supplies (PWS) located between 40m and 120m of the scheme	High	Construction	Degradation of potable water quality via Migration of contaminants present in both the shallow and deeper groundwater to the offsite PWS.	Small Adverse	Slight to Moderate	It is not known if there is hydraulic connection between the groundwater at the site and the offsite PWS
		High	Operation	Degradation of potable water quality via Migration of contaminants present in both the shallow and deeper groundwater to the offsite PWS.	Small Adverse	Slight to Moderate	It is not known if there is hydraulic connection between the groundwater at the site and the offsite PWS
	Surface waters (including River Feale, streams, drainages)	High	Construction	Degradation of surface water quality via Accidental spillages Dewatering discharges Sediment ingress Migration of contaminant in shallow groundwater to surface waters	Moderate Adverse	Slight to Moderate	Construction materials storage solution not known at this stage. Piling methodology not known at this stage Integrity of current scheme drainage is unknown Dewatering requirements not known at this stage.

Receptor		Importance of Receptor / Sensitivity	Phase	Potential Impact	Magnitude of Impact	Impact Assessment	Limitations / Remarks
		High	Operation	Degradation of surface water quality via Accidental spillages resulting from road use during operation Migration of contaminant in shallow groundwater to surface waters	Small Adverse Negligible	Slight/Moderate Imperceptible	Integrity of the existing drainage on the scheme is not known
Designated Site	Lower Shannon SAC	High	Construction	Soil and groundwater contamination at the site via excavation activities and piling for the proposed bridge structure	Small Adverse	Slight/Moderate	Piling methodology not known at this stage Impact is anticipated to be temporary during construction works.
		High	Operation	Soil and groundwater contamination at the site via excavation activities and piling for the proposed bridge structure	Negligible	Imperceptible	Impact is anticipated be negligible on completion of construction works.
Human Health	Acute Risks to Construction Workers	High	Construction	Harm to human health from soil and groundwater contamination and potential ground gases via: Dermal contact and ingestion Contaminated imported fill materials Inhalation of wind-blown contaminated dust and airborne asbestos fibres (if encountered) Inhalation of ground gases and asphyxiation when working in potential confined spaces	Negligible (based on no substantial soil or groundwater contamination recorded during recent GI) Moderate Adverse (if significant contamination is encountered during construction including asbestos and ground gases)	Imperceptible Significant / Moderate	The recent ground investigation did not record any contamination in soil and groundwater above assessment criteria. It is not known if any significant contamination will be uncovered during the construction works, therefore extent of construction worker's exposure cannot be determined
	Chronic risks to offsite users	High	Construction	Harm to human health from soil contamination via: Inhalation of wind-blown contaminated dust and airborne asbestos fibres (if encountered)	Negligible	Imperceptible	Impact is limited to the offsite users that will be using the road and surrounding areas during the time of construction works. Details of any planned road closure or isolation is not known at this stage.
	Chronic Risks to Site Users / Maintenance Workers	High	Operation	Harm to human health from soil contamination and potential ground gases via: Inhalation of ground gases and asphyxiation when working in potential confined spaces Dermal contact and ingestion	Small Adverse Negligible	Moderate / Slight Imperceptible	Presence of ground gases at the site is not known as no ground gas monitoring was undertaken as part of the recent ground investigation. The nature and extent of future maintenance works on the scheme is not known at this stage
Infrastructure	Infrastructures including piles, pipes, conduits and culverts	High	Operation	Degradation of structures as a result of aggressive ground gas conditions and accumulation of potentially explosive ground gases within confined spaces e.g. pipes, conduits and culverts	Small adverse Moderate Adverse	Moderate / Slight Significant / Moderate	Presence of ground gases at the site is not known as no ground gas monitoring was undertaken as part of the recent ground investigation. Assessment of aggressive ground conditions with respect to concrete classification not undertaken as part of this assessment (see geotechnical assessment).

Appendix 8.1 Baseline Water Quality Sampling Results Summary

Analyte	Units	EC Env Objective (Surface Water Regs 2009)	SW01 (Feale Upstream)		SW02 (Islandganniv_ North)		SW03 (Ballygrenane)		SW04 (Feale Downstream)		SW05 (Ballygrenane)		SW06 (Ballygrenane)		SW07 (Mill Stream)		SW08 (Mill Stream)		SW09 (Mill Stream)		SW10 (Mill Stream)	
pH		Soft Water 4.5< pH < 9.0 pH Hard Water 6.0< pH < 9.0	7.962	*	8.431		8.079	*	8.021	*	7.712	*	7.892	*	8.382	*	8.275	8.0	8.096	8.1	7.947	7.7
DO	mg/l	95%ile >80% saturation lower saturation saturation Limit 95%ile <120% saturation upper klimit	10.02	*	7.93		10.04	*	10.08	*	9.71	*	7.29	*	8.11	*	8.64	8.6	8.45	9.0	7.88	6.5
Conductivity	us/cm	N/A	218	*	656		371	*	187	*	570	*	423	*	490	*	481	235	477	371	481	336
Temperarure		Not greater than a 1.5□C rise in ambient temperature outside the mixing zone	4.1	*	7.0		5.5	*	5.6	*	7.2	*	7.5	*	5.0	*	5.6		5.5		6.2	
Copper, Filtered as Cu	ug/l	5 (water hardness ≤ 100) or 30 (water hardness < 100)	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00	<9.00
Zinc , Total as Zn	ug/l	8 (water hardness ≤ 10 mg/l) or 50 (water hardness > 10 mg/l ≤ 100 mg/l)100µg/l elsewhere	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	<18.0	22.8	<18.0	23.5	<18.0	<18.0	<18.0	<18.0
Total Hardness as CaCO3	mg/l	No Standard	39.2	64.7	297	258	146	100	35.3	43.5	259	220	175	109	213	93.5	202	114	200	166	195	152
Ammoniacal Nitrogen as N	mg/l	< 0.065	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27

Analyte	Units	EC Env Objective (Surface Water Regs 2009)	SW01 (Feale Upstream)		SW02 (Islandganniv_ North)		SW03 (Ballygrenane)		SW04 (Feale Downstream)		SW05 (Ballygrenane)		SW06 (Ballygrenane)		SW07 (Mill Stream)		SW08 (Mill Stream)		SW09 (Mill Stream)		SW10 (Mill Stream)	
Nitrate as N	mg/l	No Standard	0.4	0.8	2	2.1	<0.4	0.8	0.4	0.8	1.1	1.6	<0.4	0.9	<0.4	0.7	<0.4	1.0	<0.4	1.4	0.6	1.3
Phosphate, Ortho as P	mg/l	< 0.035	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Total Suspended Solids	mg/l	No Standard	2	6.00	3	4.00	3	4.00	1	10	3	8.00	2	3.00	1	16.0	2	16.0	1	6.00	12	8
EH >C6 - C40	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	16	<10	12	<10	<10	<10	60	<10	41	<10	<10	15	20
EH >C6 - C8	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EH >C8 - C10	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EH >C16 - C24	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	25	<10	21	<10	<10	<10	<10
EH >C24 - C40	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	35	<10	20	<10	<10	15	<10
EH >C10 - C16	ug/l	No Standard	<10	<10	<10	<10	<10	<10	<10	16	<10	12	<10	<10	<10	<10	<10	<10	<10	<10	<10	20
BODS + ATU	mg/l	< 1.5 mg/l or < 2.6 (95%ile) mg/l	<1	2.3	<1	1.4	<1	2.3	<1	2.3	<1	<10	<1	1.7	<1	3.1	<1	2.2	1.1	1.8	2.6	3.2

Note : In situ probe malfunction onsite

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N69 Listowel Bypass

Detailed Flood Risk Assessment Report

August 2014

Contents

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1 Introduction

Jacobs Engineering Ireland Ltd (Jacobs) has been commissioned by the Kerry National Road Design Office (KNRDO) to produce a Detailed Flood Risk Assessment to support the planning application for the proposed N69 Listowel Bypass in County Kerry.

The flood risk to the site has been assessed in accordance with the Guidelines for Planning Authorities 20: The Planning System for Flood Risk Management (GPA20) which defines the requirements for flood risk assessment in Ireland. Stage 1 and 2 assessments have been completed. The stage 2 initial flood risk assessment identified the need for a detailed flood risk assessment to quantify the potential level of flood risk. Therefore, the purpose of the assessment is to determine the risk of flooding to the Listowel Bypass and the impact of the Listowel Bypass on flood risk within the surrounding area. Mitigation measures will also be developed to manage any flood risk as a result of the proposed development.

This report considers fluvial flood risk in addition to other types of flood risks such as groundwater, surface water, sewer flooding and the failure of water management infrastructure.

1.1 Description of the Proposed Site

Listowel is an historic market town in the south west of Ireland. The town is located on the River Feale, a 75km river running north-eastwards from its source in the Mullaghareirk Mountains, through the urban areas of Abbeyfeale and Listowel before discharging into the Shannon Estuary close to Moneycashen.

The N69 is classified by the National Roads Authority (NRA) as a 'National Secondary Road', which stretches between the town of Tralee on the west coast of Ireland and the City of Limerick. From Tralee, the road crosses the River Feale approximately 700m south of Listowel town centre before running north through the town centre; the road exits the town to the east. The road is one of the main access routes between the east of Ireland and the south west of Ireland connecting County Kerry to the cities of Limerick, Galway and Dublin.

1.2 Description of the Proposed Development

Following a feasibility study commissioned by KNRDO in September 2006, it was concluded that a proposed bypass of Listowel, titled the N69 Listowel Bypass, would offer significant benefits in terms of improving road safety, easing traffic congestion and reducing travel times.

A route selection process undertaken by KNRDO, which examined various options and which included public consultation, identified the most favourable route to be a combination of Options C/D[1], presented in this report as the proposed development, and generally as illustrated in Figure 1-A where it is in the vicinity of the River Feale.

[1] Kerry County Council (2012) N69 Listowel Bypass, Route Selection Report.

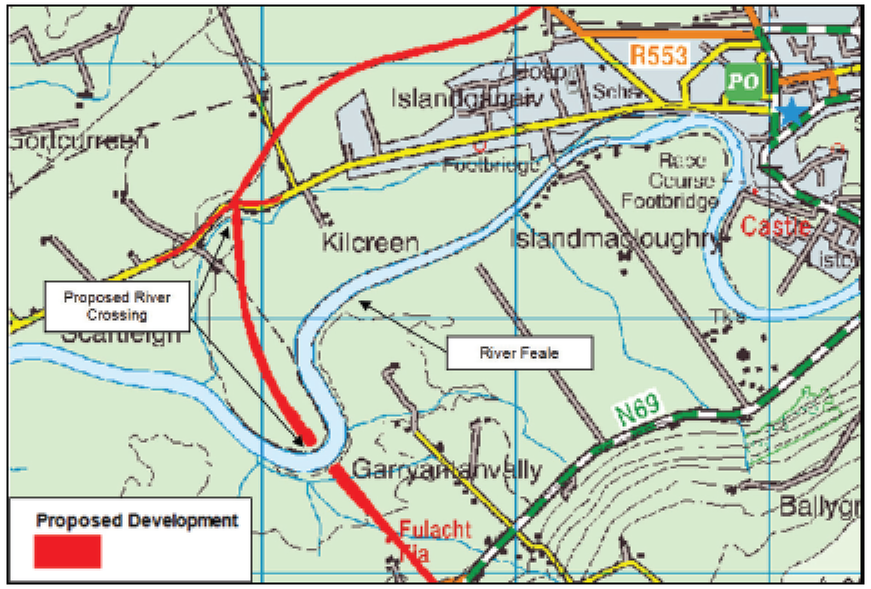

Figure 1-A Listowel Bypass Site Location

The proposed development essentially comprises the provision of a new single carriageway road which runs northwest, crossing both the River Feale and a separate river, titled the Mill Stream, to the west of Listowel before turning northeast and entering the town from the west. The bypass then merges with the John B. Keane Road (R553), after the Clieverargh Road junction.

The proposed development includes the following works:

- The new bypass road around the west of Listowel;
- A significant embankment raising the road across the River Feale floodplain, including the following structural features:
    - A road bridge across the River Feale
    - 8 new culverts for existing small watercourses
    - 3 underpasses for access to agricultural land, residential dwellings and to aid the movement of livestock
- Associated junctions and tie in improvement works;

A site plan can be found in Appendix A.

2 Background to the Flood Risk Assessment Process

This section provides an overview of the legislative background covering flood risk and development control in Ireland. It is intended to provide a basic understanding of the reasons for, and the objectives of, a Flood Risk Assessment exercise.

For full details of how flood risk is considered by Irish planning legislation, reference should be made to Guidelines for Planning Authorities 20: The Planning System for Flood Risk Management (GPA20).

2.1 The Flooding Problem

Flooding is a natural process that can happen at any time in a wide variety of locations. Flooding can come from rivers or the sea, as well as from prolonged or intense heavy rainfall which can cause sewer, overland flow and groundwater flooding. The frequency, pattern and severity of flooding are likely to increase as a result of climate change.

Flooding has significant impacts on human activities. People who live and work in areas at risk from flooding have to deal with the day to day threat of risk to life, property and belongings. Following a flood event, the clean-up and repairs to rectify the damage can take months or years. The impact in terms of health can be significant, even after the event. Studies have shown that the stress caused by flooding can have serious long-term health consequences.

For business and the economy, the impacts of flooding can be far-reaching. After a flood many businesses fail to reopen or re-locate to other areas.

Flooding to infrastructure often has an immediate risk to life. For example road traffic accidents as a result of flooding to roads can result in death. The disruption caused by damage to infrastructure can be extremely expensive to rectify. Furthermore, the inconvenience and disruption can have long-term impacts on local communities.

In the past, poor planning decisions have increased the level of flood risk by allowing new developments to be constructed in flood-prone areas without the necessary mitigation and resilience measures.

The planning system plays a major role in ensuring development is promoted and guided in a manner that is sustainable in economic, social, and environment terms and at an acceptable risk from flooding. The current guidelines for planning and flood risk are explained below.

2.2 Guidelines for Planning Authorities 20: The Planning System and Flood Risk Management

GPA20 emerged from the 2004 Report of the Flood Policy Review Group. The report highlighted the need to pro-actively manage flood risk and the important role that the planning system plays in avoiding and reducing flood risks to new developments.

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The Key principles of flood risk management laid out in GPA20 are:

- ***Avoid** development in areas at risk from flooding, unless there are proven wider **sustainability grounds** that justify development. Where this is the case development must be **appropriate** and flood risks must be effectively **managed** to reduce the level of risk.*
- *Adopt a **Sequential Approach** to flood risk management when assessing the locations for new development based on **avoidance**, **reduction**, and **mitigation** of risk.*
- *Incorporate flood risk assessment into planning application decisions and appeals*

2.3 The Sequential Approach

GPA20 Recommends that a Sequential Approach is taken for the flood risk management for new developments. This approach is summarised in Figure 2-A.

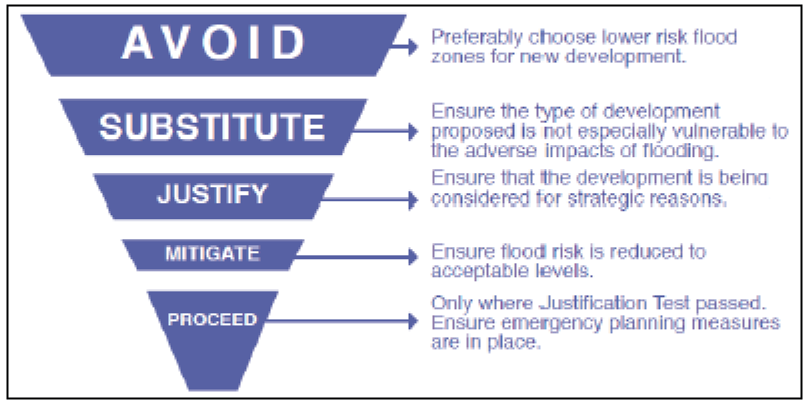

Figure 2-A Sequential Approach Principles in Flood Risk Management (GPA20 Section 3 Figure 3.1)

As shown in Figure 1-A in section 1, the proposed route of the N69 Listowel Bypass Road Improvement Scheme cuts across the River Feale and is potentially located in an area of flood risk.

At this stage of the scheme development, it is noted that the horizontal alignment of the proposed development will not vary significantly due to unavoidable construction and environmental related constraints and also cannot be relocated.

With reference to Table 3.1 of the GPA20, the proposed development falls under the following land use and type of development description:

"Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment and potential significant sources of pollution (SEVESO sites, IPPC Sites, etc.) in the event of flooding. "

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Therefore, in accordance with GPA20, the proposed scheme is classed as a 'Highly Vulnerable Development'.

Table 4 below has been extracted from GPA20 and illustrates the types of development that are considered appropriate to each flood zone and those that are required to meet the Justification Test.

	Flood Zone A (High Probability of Flooding)	Flood Zone B (Moderate Probability of Flooding)	Flood Zone C (Low Probability of Flooding)
Highly Vulnerable Development	Justification Test	Justification Test	Appropriate
Less Vulnerable Development	Appropriate	Appropriate	Appropriate
Water-Compatible Development	Appropriate	Appropriate	Appropriate

Table 4: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

With reference to Table 4, the N69 Listowel Bypass will need to meet the criteria of the Justification Test, as it passes through Flood Zones A and it is considered a Highly Vulnerable Development.

2.4 The Justification Test

Under the Justification Test, it is necessary first to demonstrate, in accordance with GPA20, that:

"The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these guidelines."

As stated in Section 1, the N69 Listowel Bypass has been identified as a national strategic road investment under national policy and is covered under the following development plans within County Kerry:

Kerry County Development Plan, 2009 – 2015

This Plan sets out the following national road policy objectives:

- Objective INF 8-15: *"Construct new National Roads along Route Options listed in Table 8.5"*;
- Objective INF 8-16: *"Prohibit development on lands which will be needed for the construction of the Route Options listed in Table 8.5 and/or identified on Maps 8.2 – 8.10"*.

It is noted that Table 8.5 of the Plan specifically refers to the N69 Listowel Bypass.

Listowel Town Council Development Plan, 2009 – 2015

This Plan sets out the following road policy objectives:

- Objective MAC 32: *"Reserve Land for and co-operate with Kerry County Council and the NRA in order to provide the Listowel N69 Bypass and to protect the Route Option Corridor for the Bypass from further development prior to the establishment of a final route".*

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Therefore, referring to these plans, it has been demonstrated that the lands necessary to construct the proposed development have been designated/zoned accordingly in the applicable Development Plans.

Further to demonstrating that the development is for strategic reasons, it is then necessary as part of the Justification Test that the flood risk assessment considers the mitigation measures and demonstrates that:

- *"The development proposed **will not increase flood risk elsewhere**, and, if practicable, will reduce overall flood risk"*
- *"The development proposal **includes measures to minimise flood risk** to people, property, the economy and the environment **as far as reasonably practicable**"*
- *"The development proposed includes measures to ensure that **residual risks to the area and/or development can be managed** to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access."*

Consequently, it is necessary to consider the risk of flooding to the proposed development, the risk that the development will increase risk elsewhere and provide mitigation of these risks as appropriate.

2.5 Assessing Flood Risk

GPA20 outlines the key principles that should be used to assess flood risk to proposed development sites.

It is recommended that a staged approach to flood risk assessment should be used:

- ***Stage 1 Flood Risk Identification** – to identify any flood risks that may warrant further investigation*
- ***Stage 2 Initial Flood Risk Assessment** – to confirm sources of flooding, to appraise the availability of existing information and to assess the potential for mitigation measures*
- ***Stage 3 Detailed Flood Risk Assessment** – to allow design of the proposed development and assess the effectiveness of proposed mitigation measures.*

2.6 Purpose of this Assessment

This FRA has been prepared to ensure that the proposed N69 Listowel Bypass meets the requirements of GPA20.

As previously stated, stage 1 and 2 flood risk assessments have been completed. The stage 2 initial flood risk assessment identified the need for a detailed flood risk assessment to quantify the potential level of flood risk.

This report represents a Stage 3 Detailed Flood Risk Assessment (see Section 2.5) and provides an overview of the potential flood risks to the proposed site and assesses the potential impact of the proposed development under consideration. It also proposes mitigation principles that should be considered as part of the design.

It provides an overview of the potential flood risks to the proposed site and assesses the potential impact of the proposed development. These impacts, where appropriate, have been quantified through the construction of a detailed hydraulic flood model.

3 Assessment of Flood Risk to the Proposed Development

During the Stage 2 initial flood risk assessment of the N69 Listowel Bypass, it was identified that some elements of the proposed development could be at risk of flooding from a range of different sources.

In this section the flood risks to the proposed development are identified and discussed.

3.1 Potential Sources of Flooding

There are several potential sources of flooding to the proposed development, these are listed below:

- **Coastal** – flooding from the sea;
- **Fluvial** – flooding from rivers and watercourses;
- **Estuarine** – flooding from a combination of fluvial and coastal sources;
- **Overland Flow** – flooding that is caused by runoff during extreme rainfall events;
- **Artificial Drainage Systems** - flooding that occurs as a result of surcharging or blockage of the drainage networks; and
- **Groundwater** – flooding when water normally stored below the ground rises above surface level or into below ground spaces (such as basements).

3.2 Flood Risk from Coastal Sources

Coastal flooding is caused by higher sea levels than normal, resulting in the sea overflowing onto the land. Coastal flooding is influenced by three main factors which often work in combination. These are:

- **High Tide Levels** – cause by normal, and predictable, astronomical factors;
- **Storm Surges** – where sea levels are artificially raised by areas of low barometric pressure such as depression weather systems; and
- **Wave Action** – this is dependent on wind speed and direction, as well as local topography and exposure.

The town of Listowel is situated approximately 25m above sea level and is located 10km from the Sharon Estuary. As such, the risk of flooding from coastal sources is considered to be negligible and has not been assessed.

3.3 Flood Risk from Fluvial Sources

Fluvial flooding refers to flooding from rivers, streams and other inland watercourses. Fluvial flooding is usually caused by prolonged or intense rainfall, generating high rates of runoff which overwhelm the capacity of the river or channel.

There is a high presence of watercourses within the study area. These are shown in Figure 3-A. The largest of these being the River Feale.

The Mill Stream, a smaller watercourse, represents a tributary of the River Feale and originates within an area of agricultural land to the west of Listowel. This watercourse comprises two small channels, Mill Stream East and Mill Stream West, which converge within a small section of culvert to form the Mill Stream

Watercourse. The watercourse travels west for 1.3km before discharging into the River Feale, refer to Figure 3-A. To the south of where the proposed development crosses the River Feale, the proposed development also crosses two small unnamed watercourses.

Fluvial flood risk is assessed using the Office of Public Works (OPW) National Flood Maps, although, a review of this dataset suggests that there is no mapping available for the area surrounding the development site. However, a proportion of the site is situated within an area classified as 'Benefitting Land' which is considered to be prone to flooding and is characterised by poor drainage, refer to Figure 3-B.

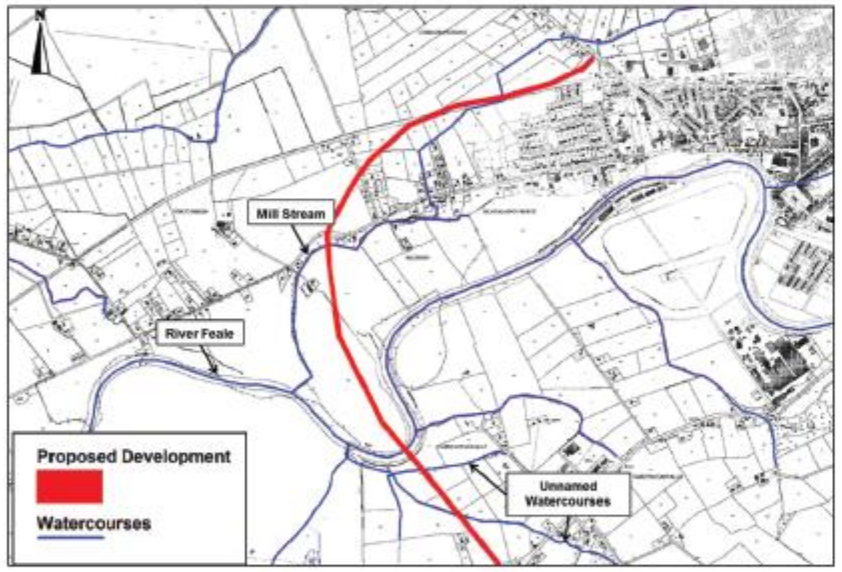

Figure 3-A Watercourses within the study area.

The proposed development will involve the construction of a new section of carriageway across the River Feale floodplain and will also involve crossing various smaller watercourses.

In order to assess the risk, detailed flood modelling has been undertaken to evaluate the impact of the River Feale and smaller watercourses on the proposed development.

The two unnamed watercourses to the south of the River Feale were not modelled. The flood risk from these watercourses is considered to be small in relation to that from the Mill stream and the River Feale. These watercourses are land drains and will have culverts designed so that the passage of flow will not be impeded.

The results of the modelling[2] indicate the proposed development cuts through Flood zone A[3], see Appendix C Figure C1-1, in certain locations. These locations can be described as Areas 1, 2 and 4, see Appendix C Figure C1-1.

[2] Technical details of the modelling approach taken can be found in the Modelling Report in Appendix B.

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In Area 1 and 2, the levels of the proposed development are dictated by an existing raised embankment on the south bank of the River Feale. Due to the required height of the road in this area the risk of flooding to the proposed development in the area is low.

In Area 4, North of the River Feale crossing, there is a risk of flooding to the proposed development from a fluvial source. Mitigation will be required to ensure the level of the proposed development is higher than the predicted water levels at this point.

The results of the modelling indicate that the proposed development has moderate risk of flooding from a fluvial source.

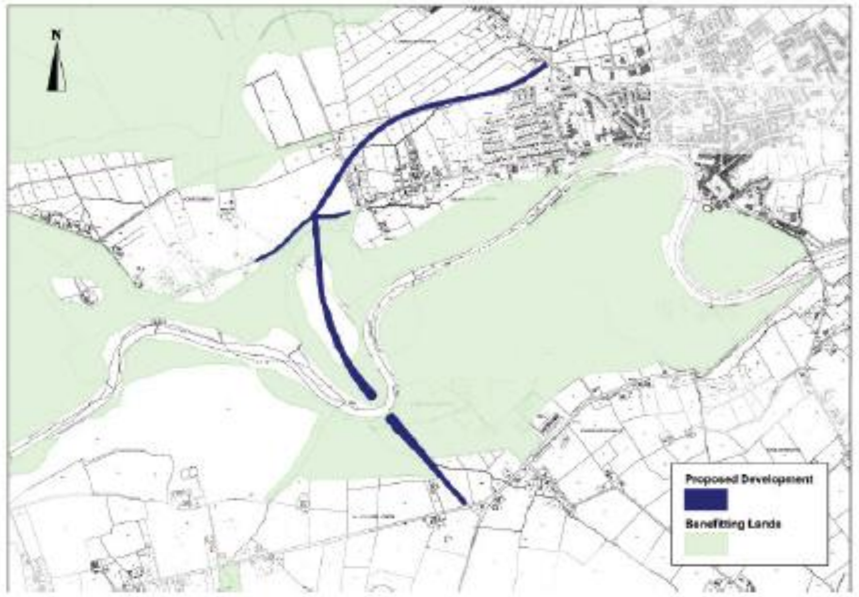

Figure 3-B Benefitting lands within the study area.

3 Flood Zone A is defined as where the probability of flooding from rivers is highest (greater than 1% or 1 in 100)

3.4 Flood Risk from Estuarial Flooding

As previously noted, the site is located approximately 10km from the Shannon estuary. Therefore the risk from estuarine flooding is negligible and has not been assessed.

3.5 Flood Risk from Overland Flow

Overland flow is defined as water flowing over the ground that has yet to enter a drainage channel or similar. It usually occurs as a result of an intense period of rainfall, which exceeds the infiltration capacity of the ground.

Typically, overland flow occurs on sloping land where the ground surface is relatively impermeable as a result of either natural conditions such as soil type or geology, or as a result of development which places a large area of impervious material over the ground surface (i.e. paving or roads).

In relation to new carriageway sections, there are limited areas adjacent to the proposed development which are hard standing and of low permeability. The majority of the lands adjacent to the proposed development are agricultural.

The topography as features on OS and topographic mapping suggests the surface water catchment is moderately sloping and the site is located at the bottom of the River Feale Valley, see Figure 3-C. As such, the area could potentially be affected by high velocity surface water flows which could result in the rapid inundation of the site.

Due to the topography of the surrounding area and the ability of the catchment to generate surface water flows, the site is considered to be at moderate risk of flooding from overland flow and mitigation will be required. This will be outlined in Section 5.3.

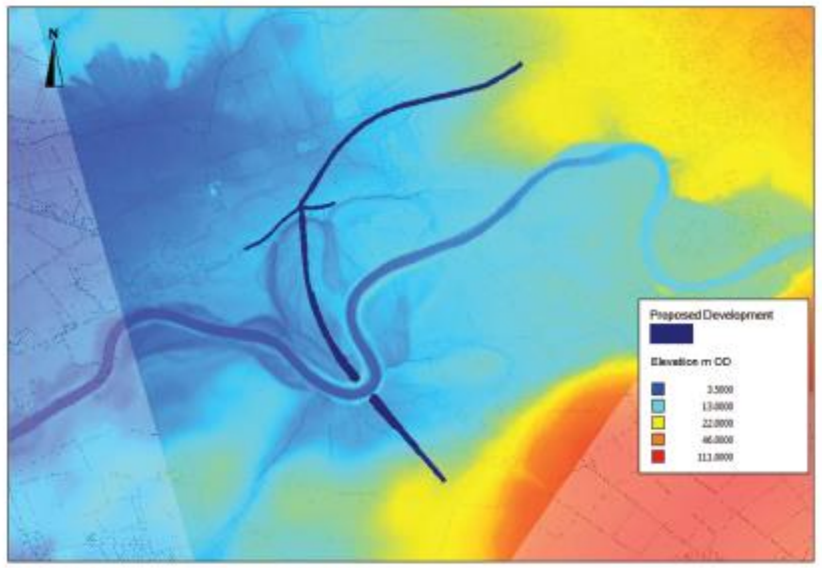

Figure 3-C Topography within the study area.

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3.6 Flood Risk from Artificial Drainage Systems

Water containment infrastructure such as canals or land drainage ditches can pose a risk of flooding, particularly where the infrastructure is at the same level or higher than the site. Flooding caused by the failure of infrastructure can occur with little or no warning.

3.6.1 Reservoir Failure

Reservoir failure is particularly dangerous as it causes the release of large volumes of water at high velocity, which can result in severely deep and widespread flooding. A review of OS Mapping suggests that the nearest reservoir is situated approximately 67km from the site on the River Shannon. In the event of breach or failure of the reservoir, flow is likely to be channelled along the watercourse and into the Shannon Estuary.

Additionally, reservoir inspection and design procedures are rigorous, such that the risk of failure is extremely low.

The site is considered to be at low risk from reservoir flooding should this ever occur and no mitigation is necessary.

3.6.2 Flood Risk from Drainage Infrastructure

The existing road network and urban development on the proposed site is served by surface water drainage systems. Should these systems block, or the capacity of these systems be exceeded during a rainfall event, flooding of the carriageway and surrounding areas could potentially occur.

As mentioned in Section 3.5 the surrounding topography could potentially channel overland flow towards the site from the northeast. However, it is unlikely that significant amounts of debris would be transported onto the carriageway by these flows, blocking the drainage network. Additionally, these drainage systems are maintained by Kerry County Council in order to ensure that they remain fully operational and free of blockages.

The risk of flooding from drainage infrastructure is therefore considered to be low and no mitigation is required.

3.7 Flood Risk from Groundwater

Groundwater flooding occurs where groundwater levels rise above the ground surface. Flooding can occur where local geology is dominated by permeable rocks, there is a high water table and the land is low lying relative to its surroundings.

In accordance with The Geological Survey of Ireland (GSI) Groundwater Aquifer Map, the proposed development is situated above three different aquifers. The majority of the site is situated above a regionally important karstified aquifer, with the remainder situated above a locally important aquifer and a poor aquifer.

Furthermore the proposed new bypass road will cross low lying River Feale floodplain; therefore there is the potential for high groundwater tables within the area.

Due to the low-lying nature of the proposed development site there is a potential for prolonged rainfall to raise the groundwater level within the aquifer and the overlying superficial deposits above ground level, resulting in flooding.

However, the majority of the proposed development, particularly through the River Feale floodplain, is to be raised above the existing ground level and constructed on embankments. The road will not be lowered below the current ground elevation anywhere along its length. The proposed raised road surface profile ensures that any potential groundwater flooding issues will not significantly affect the development.

Therefore the risk to the proposed development from groundwater flooding is considered to be low and no mitigation is required.

3.8 Summary of Flood Risks to the Proposed Development

Flood Risk	Summary of Risk to the Development Site	Notes	Mitigation Required
Coastal	Low	*The site is situated approximately 10km from the coast*	✗
Fluvial	Moderate	*Certain sections of the proposed development will be a risk of flooding from the 0.1% AEP flood event and mitigation is required*	✓
Estuarial	Low	*The proposed development is situated approximately 10km from the Shannon Estuary and is therefore not considered*	✗
Overland Flow	Moderate	*The proposed development will be at some risk from of flooding from overland flow and drainage systems will be required as mitigation*	✓
Land Drainage Infrastructure	Low	*Highway Drainage Systems are managed by the Kerry County Council and the risk of blockage is considered to be low*	✗
Groundwater	Low	*New sections of carriageway are situated above the extent of groundwater flooding and the highway is assumed to have adequate drainage systems*	✗

Table 3-A Summary of Flood Risks to the Proposed Development Site

4 Flood Risk from the Proposed Development

Whilst the development site can be at risk from flooding, it is also possible for development to cause changes to wider flooding patterns and mechanisms, which can result in an increase in the risk of flooding in other areas. This section examines the potential impacts the proposed bypass has in other areas.

4.1 Impacts on Coastal and Estuarial Flooding

As previously mentioned in Section 1.1 the proposed development is located approximately 10km from the Shannon Estuary and therefore the proposed development is unlikely to affect the risk of coastal or estuarial flooding elsewhere.

Therefore the impact from the proposed development on estuarial and coastal flooding is considered to be low.

4.2 Impacts on Fluvial Flooding

The development may increase the risk of flooding within the surrounding area through several mechanisms:

- Loss of floodplain – by the construction of embankments in areas at risk of flooding thereby reducing the volume of storage available
- Altered flow dynamics – through removal and replacement of channels and culverts
- Increased surface water discharge – as a result of additional surface water discharge from the new sections of highway which increase the total area of impermeable surfaces

The impacts of these mechanisms have been investigated in more detail and the findings are discussed below.

4.2.1 Results from Hydraulic Model

The results of the hydraulic model are displayed in Appendix C1; Figure C1-1 displays the existing flood risk while Figure C1-2 displays the post proposed development scenario. For comparison, a number of areas have been highlighted on the maps in Appendix C1 (Areas 1-4). The flood levels shown overleaf indicate the peak flood levels, derived from the hydraulic modelling for the 1% plus climate change Annual Exceedance Probability (AEP) event.

Location		Ground Level (m)	1% AEP + CC Flood Level (m)	
			Map 1 – Existing	Map 2 - Post Proposed development (difference)
Area 1	1A	9.80	10.32	+0.97
	1B	10.72	10.72	+0.57
	1C	9.14	10.13	-0.19
Area 2	2A	8.81	9.88	-0.01
	2B	8.50	9.88	-0.99
	2C	9.70	10.04	+0.42
	2D	9.63	9.94	+0.15
Area 3	3A	10.22	10.99	+0.1
	3B	10.63	10.98	+0.18
Area 4	4A	9.58	9.85	+0.58
	4B	9.41	9.67	-0.07

Table 4-A Flood Depths at Locations Shown on Maps 1 & 2

The existing flow paths of the floodplain will be altered by the construction of the proposed development. Generally, the raised carriageway of the road passes through areas of flood risk. This will remove a potential flow path and lead to loss of floodplain storage.

In Area 1, the flood depth is increased by 970mm from the existing scenario to the east of the proposed development at Point 1A. Flood waters are restrained in this area by the proposed development and to the west of the proposed development the flood depth is lower than the existing scenario.

Figure C1-1 and C1-2 show that the introduction of the proposed development provides a barrier to the flow of flood waters, which increases the flood depth at the North of Area 2, points 2C and 2D, by 420mm and 150mm respectively and reduces the flood depth at the South of Area 2, points 2A and 2B, by 10mm and 990mm respectively.

Once again in Area 3, the proposed development provides a barrier to flood flow. In this area, the capacity of the Mill stream is exceeded and there is "backing up" at an existing structure.

Figure C1-1 and C1-2 indicates for Area 4 that the proposed development is acting as a barrier to flood flow in this location, which causes an increase in flood depth and extent to the properties directly to the South of the proposed development at point 4A.

Without mitigation the potential impacts identified through hydraulic modelling are significant. The hydraulic modelling process has indicated that construction of the

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proposed development without any mitigation would lead to an increase of flood depth and extent to a number of properties.

Therefore, the risk of fluvial flooding to other areas as a result of the development is considered to be high and mitigation is required, refer to Section 5.1.

4.3 Impact on Overland Flow

New development can increase surface water generation within a particular area and alter existing flow-paths and drainage routes, potentially causing overland flow to flood areas that are not currently susceptible to flooding.

It is anticipated that the bypass road is likely to increase the volume of surface water runoff due to the creation of new impermeable surfaces. Additionally, following a review of the topography, the highway could potentially channel surface water flows towards residential areas situated either side of the carriageway.

Therefore the impact from the proposed development on overland flows is likely to be moderate and mitigation is required, refer to Section 5.1.

4.4 Flooding from Artificial Drainage Systems

Additional development on the site will increase the number of artificial drainage systems in operation. This could potentially increase the risk of flooding as a result of the failure of one of these systems.

The systems have been designed to HD 33/06 and will have trash screens where required and will be maintained by the local authority. Therefore flood risk from artificial drainage systems to the area from the proposed development is considered low.

4.5 Impact on Groundwater

Although parts of the proposed site are at risk of groundwater flooding, it is unlikely that the proposed development on this site would significantly impact on the risk of groundwater flooding from groundwater in other areas.

The majority of the proposed development will be elevated above ground level by an embankment that varies in height along the proposed development. Additionally, minor surface works do not significantly impact on groundwater aquifers and the proposed site does not involve significant excavations or large areas where below ground works are proposed.

It is considered that the potential for the proposed development to impact on groundwater flooding is considered to be low and flood risk from ground water sources from the development is considered to be low and no mitigation is required.

4.6 Summary of flood risk from the proposed development

Flood Risk	Summary of Risk from the Development Site	Notes	Mitigation Required
Coastal	Low	*The site is situated approximately 10km from the coast*	X
Fluvial	Medium	*Floodplain storage has been lost and a barrier to the flow of flood waters has been created. There is also increase in flood depth and extent to flooded properties*	✓
Estuarial	Low	*The proposed development is situated approximately 10km from the Shannon Estuary and is therefore not considered*	X
Overland Flow	Low	*Highway Drainage Systems are assumed to be adequate to manage flooding from overland flow*	✓
Land Drainage Infrastructure	Low	*Highway Drainage Systems are managed by the NRA and the risk of blockage is considered to be low*	X
Groundwater	Low	*New sections of carriageway are situated above the extent of groundwater flooding and the highway is assumed to have adequate drainage systems*	X

Table 4-B Summary of flood risk from the proposed development

5 Mitigation Measures

The analysis of flood risk to and from the proposed development has indicated that mitigation is required to reduce the risk from fluvial flow and overland flow from the proposed development and to reduce the risk of flooding to the proposed works from overland flow.

5.1 Mitigation of flood risk from fluvial sources to the proposed development

As discussed in Section 3.3, the proposed development cuts through 3 areas of flood risk. Due to the required elevation of the road the proposed development is not at risk of fluvial flooding in Areas 1 and 2. However, in Area 4 North of the River Feale crossing there is a risk of flooding to the proposed development from a fluvial source.

In providing mitigation measures in Area 4 to alleviate flood risk in the area from the proposed development, 6 No. 900mm diameter flood relief culverts will be provided, see Section 5.2 below. To allow for the flood relief culverts under the proposed development the road surface will be raised above the floodplain. This brings the level of the proposed development above the predicted water levels at this point. Therefore the risk of fluvial flooding to the proposed development at this point is low and no further mitigation measures are required.

5.2 Mitigation of flood risk from fluvial sources from the proposed development

As discussed in Section 4.2.1, the existing flow paths of the floodplain will be altered by the construction of the proposed development. The raised carriageway of the road passes through areas of flood risk and this will remove a potential flow path and lead to loss of floodplain storage.

The mitigation measures include the addition of a series of flood relief culverts as part of the proposed development. The flood relief culverts remove the barrier of the proposed development to the flow of flood waters. Additionally, localised profiling of the Mill Stream has been prescribed.

A location plan of the proposed mitigation measures are shown in Appendix C2 Figure C2-1. This figure also illustrates any areas of increased flood risk from the proposed development with mitigation measures in place.

In general the increase in predicted water levels, with the mitigation measures in place, range from 10mm to 500mm. The areas where there is an increase in predicted flood levels are also at risk of flooding in the existing scenario and no properties are affected.

5.2.1 Loss of floodplain and altered flow dynamics mitigation

The 1% AEP plus climate change event has been used for comparison purposes. In Area 1, the following flood mitigation measures are implemented:

- 10 No. 900mm diameter flood relief culverts;
- 4 No. 2100mm diameter flood relief culverts.

The flood relief culverts allow a flow path for flood water from the East of the proposed development to the West of the proposed development. With these mitigations measures in place, the predicted flood depth to the West of the proposed development remains at the same level as in the existing scenario, at point 1C, and the predicted flood depth to the East of the proposed development will marginally increase by 130mm.

In Area 2, the following flood mitigation measures are implemented:

- 3 No. 900mm diameter flood relief culverts;
- 6 No. 2100mm diameter flood relief culverts.

Following the introduction of the culverts in Area 2, there is no increase in flood levels at points 2A and 2B in comparison to the existing risk. Point 2C shows that the existing flood depth increased by approximately 40mm from a depth of approximately 340mm in the existing scenario. The property at point 2D shows no increase in flood level.

The following flood relief measure is implemented in Area 3:

- Local re-profiling of the Mill Stream embankments for approximately 2m directly to the East of the existing bridge at this location.

The results at points 3A and 3B show that the flood level is not increased from the existing scenario when the mitigation measures are introduced. It should be noted that the Mill Stream is currently maintained by the OPW. As part of the flood mitigation measures, the local re-profiling of the Mill Stream embankments will also need to be maintained.

In Area 4, the following flood mitigation measures are implemented:

- 6 No. 900mm diameter flood relief culverts
- Introduction of a land drain

The results at point 4A and 4B indicate that the flood levels are decreased from the existing scenario following the implementation of the above mitigation.

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5.2.2 Summary of Mitigation modelling results

In Appendix C2, the details and results of the mitigation measures are displayed. Figure C2-1 depicts the changes in flooding after the mitigation measures have been implemented. The existing and post proposed development flood levels are also shown in Table 5-A below for comparison (Figure C1-1 and Figure C1-2 respectively). All comparisons have been made using the 1% plus climate change AEP event.

Location		Ground Level (m)	Flood Level (m)		
			Figure C1-1 Existing Situation (m)	Figure C1-2 Risk from proposed development without Mitigation (difference in metres)	Figure C2-1 Risk from proposed development with Mitigation (difference in metres)
Area 1	1A	9.80	10.32	+0.97	+0.13
	1B	10.72	10.72	+0.57	0
	1C	9.14	10.13	-0.19	0
Area 2	2A	8.81	9.88	-0.01	0
	2B	8.50	9.88	-0.99	-0.02
	2C	9.70	10.04	+0.42	+0.04
	2D	9.63	9.94	+0.15	0
Area 3	3A	10.22	10.99	+0.1	0
	3B	10.63	10.98	+0.18	-0.02
Area 4	4A	9.58	9.85	+0.58	-0.05
	4B	9.41	9.67	-0.07	-0.02

Table 5-A: Flood Depths at Locations Shown on Figures C1-1,C1-2 and C2-1

The results of the modelling show, that following the provision of these mitigation measures, there is no increase in flood risk to receptors in the area. Although there is an increase in flood levels in some areas, due to the minimal nature of this increase it does not represent a significant increase in flood risk and there is no increase in the flood extent.

As the mitigation measures described above reduce the level of flood risk to an acceptable level no additional storage has been provided to compensate for the loss of floodplain storage from the proposed the development.

5.3 Mitigation of overland flow flood risk from, and to, the proposed development

As discussed in Section 3.5 due to the steep topography of the surrounding area and the ability of the catchment to generate surface water flows, the site is considered to be at moderate risk of flooding from overland flow.

As part of the proposed development, drainage systems will be provided. The highway drainage systems will be designed to HD 33/06 – Surface and Sub-surface Drainage Systems for Highways. Therefore any increase in surface water volumes resulting from the proposed development will be captured by the upgraded highway drainage systems. The systems will be managed and maintained by Kerry County Council.

With the drainage systems in place as a mitigation measure to overland flow, flow risk both to the development and from the development from overland flow will be reduced to low.

5.4 Summary of Flood Risk following Mitigation

Following mitigation, the risk of flooding from fluvial or overland flow is considered to be low. There is no increase in flood risk to receptors in the area.

6 Summary and Conclusions

6.1 Summary of Flood Risk

The assessment has found that the flood risk to the proposed development is low from all potential sources apart from fluvial and overland flow sources. Similarly risk from the proposed development from all potential sources, apart from fluvial and overland flow sources, was found to be low.

Detailed hydraulic modelling has been undertaken to assess the risk from fluvial sources. The existing flood risk has been assessed and compared to the effect of the construction of the proposed development. The proposed development built without mitigation has a significant effect on flooding in the area. The raised carriageway of the proposed development blocks floodwater flow across the existing floodplain and the construction of the proposed development will also lead to the loss of floodplain storage.

The mitigation described in the previous section reduces the level of flood risk to low. A series of culverts have been included to maintain the existing flow paths of flood waters. A land drain has also been introduced, along with localised re-profiling of the Mill stream. The predicted flood risk from fluvial sources to any receptors in the area has been completely removed by these mitigation measures. Although there is an increase in flood levels from fluvial flood sources in some areas, the level of this increase is negligible.

Road drainage has been provided along the proposed development to mitigate the potential flood risk from overland sources to and from the proposed development.

As the mitigation provided reduces the flood risk to acceptable levels the development meets the requirement of the Justification test for GPA20.

6.2 Conclusion

This report provides a detailed assessment of the flood risk issues that could affect the proposed development. The assessment has included investigations into the potential flood risks that could affect development on the site and also what impacts the development could have on the flood risk in the surrounding area. It was found that a number of mitigation measures are successful in reducing the overall risk to low.

In conclusion, the proposed N69 Listowel bypass is at low risk of flooding and will not significantly increase the risk of flooding elsewhere.

Appendix A Detailed Site Plan

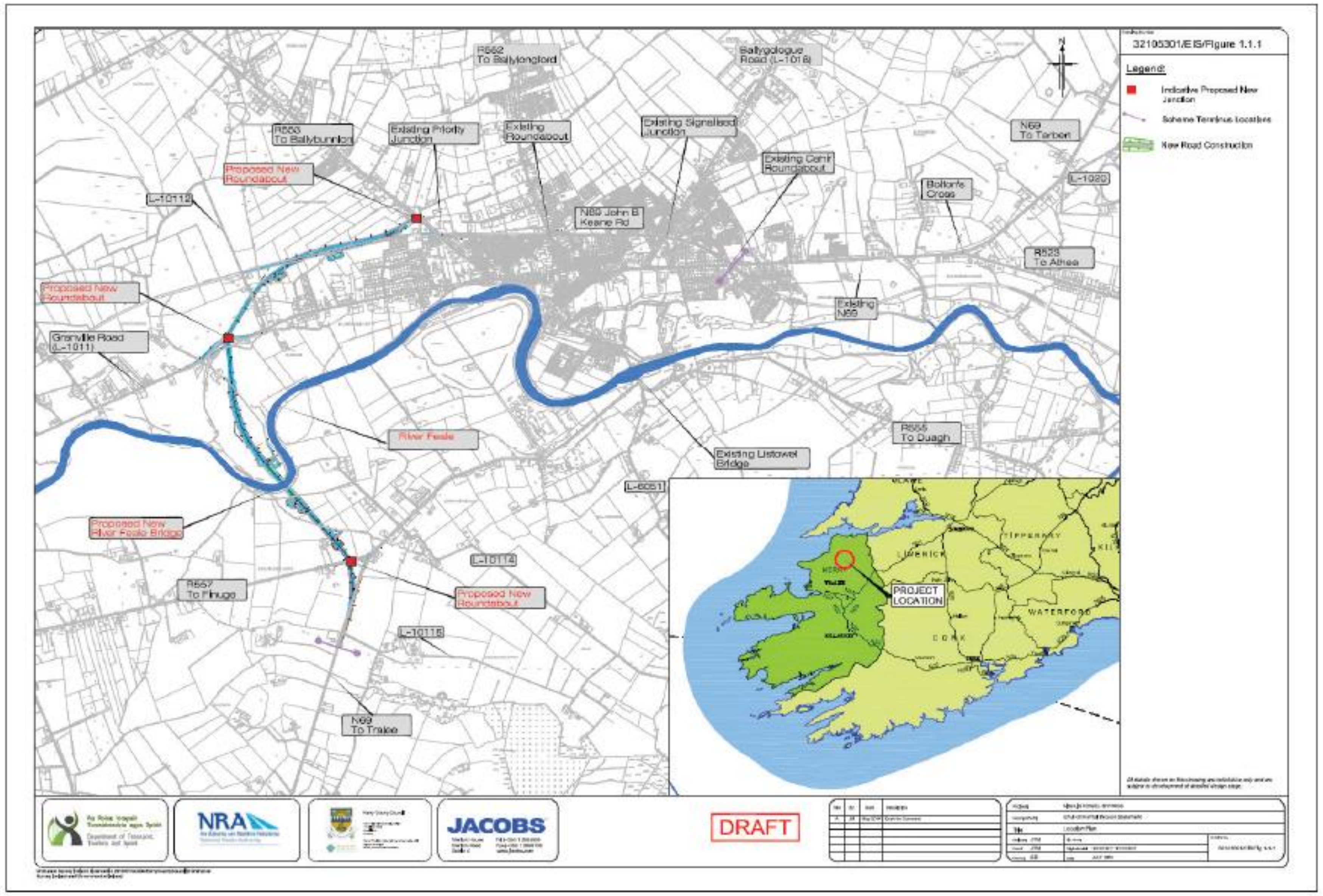

Figure A-1 Detailed Site Plan

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N69 Listowel Bypass
Hydraulic Modelling Report

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Contents

1 Introduction

1.1 Background and Objectives of the Hydraulic Modelling

A hydraulic modelling exercise has been undertaken to support the Detailed Stage 3 Flood Risk Assessment (FRA) for the N69 Listowel Bypass.The requirement for a detailed Stage 3 FRA, including hydraulic modelling, was identified in the 'Initial Assessment of Flood Risk' (Stages 1 & 2) FRA[1].

As part of the Stages 1 and 2 FRA and in accordance with the Office of Public Works (OPW) Guidelines for Planning Authorities (GPA) No. 20, it was determined that the proposed development, which comprises a bridge and associated embankments, is within areas of medium to high probability of river/fluvial flooding and is considered a Highly Vulnerable Development. Therefore, the development will be required to meet the Justification Test. As part of the Justification Test, it is necessary to assess the potential level of flood risk to the proposed development as well as the impact of the proposed development on the site and elsewhere. A site specific hydraulic model has been developed for this purpose. In addition, the model has been used to develop mitigation measures and assess residual risks.

This hydraulic modelling report discusses the hydraulic modelling methodology, assumptions and associated data used to develop the hydraulic model used in the Stage 3 FRA study. The report presents model results in terms of water levels, flows and flood extents and provides details on the flood alleviation options considered.

1.2 Software used and Modelling Approach

The hydraulic model developed for this study was constructed using the ISIS-TUFLOW link based on the combination of the one dimensional (1D) river modelling package ISISv3.6 and the two dimensional (2D) modelling software TUFLOW (version 2012-05-AE-iDP-w32).

The methodology adopted for the hydraulic modelling of the river system is based on the approaches described by the TUFLOW modelling manual. The user sets up a model as a combination of 1D network domain representing the river channel, dynamically linked to a 2D TUFLOW domain representing the adjacent floodplain, using the hydrodynamic programme to form one model.

The 1D and 2D domains can be linked by three separate methods which are as follows:

- Replace part of a 1D model by nesting a 2D domain inside a broader scale 1D model;
- Insert 1D networks underneath a 2D domain or through an embankment;
- Replace or carve a 1D channel through a 2D domain.

The latter option was the methodology adopted in this study.

A 1D ISIS model of the river channels was "carved" through the 2D TUFLOW model of the floodplain as schematised in Figure 1.1.

[1] N69 Listowel Bypass FRA Initial Assessment of Flood Risk, Jacobs, April 2013

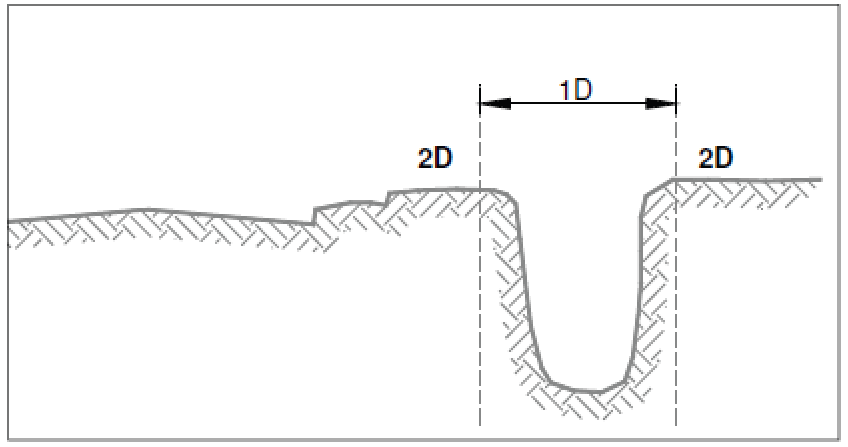

Figure 1.1: Modelling a river channel in one dimension and the floodplain in two dimensions (TUFLOW Manual, 2010)

The 2D domain was based on a regular grid comprising individual 5m x 5m square cells. Each cell was given characteristics relating to the topography such as ground elevation, bed resistance value and initial water level.

On either side of the modelled watercourse boundary lines were digitised along the bank crests to select 2D open flow boundary cells representing the dynamic links between the 1D network and the 2D TUFLOW domain. 2D cells falling within the 1D network domain are simply ignored by the model and considered as inactive.

At each 1D ISIS model node, the corresponding river cross sections was trimmed at bank top level to exactly match the 2D domain topography informed by the bank top survey information or failing that LiDAR data. The 1D model nodes were then connected to the 1D/2D boundary cells as shown on Figure 1.2. These allowed flood water to spill to and from the 2D domain when the calculated water level exceeded the banks crest elevation.

Overland flow in the 2D domain was modelled by a set of rules that determine when the grid cells may be wet or dry, which in turn is defined by the layout of the model topography (also named "Digital Terrain Model (DTM)") across the floodplain.

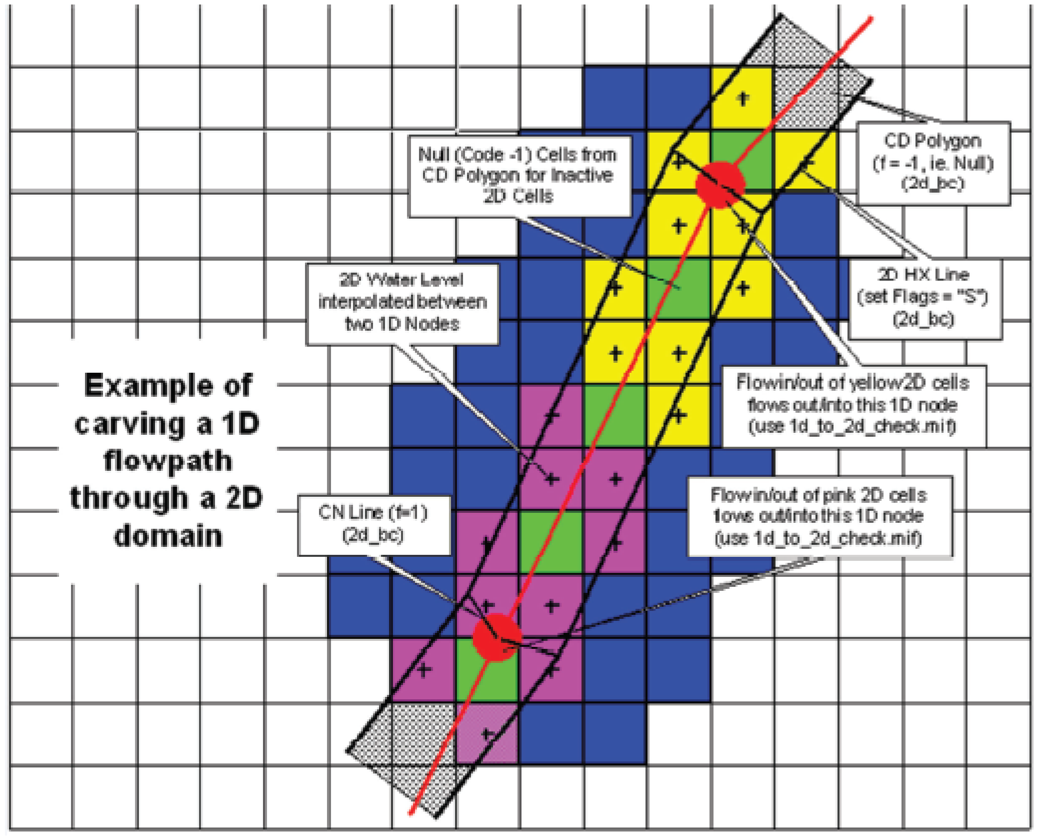

Figure 1.2: 1D/2D linking mechanism (TUFLOW Manual, 2010)

1.3 Modelled area

The extents of the hydraulic model are shown in the model schematisation Figure 2.1. It includes the following watercourses:

- Approximately 7km of the River Feale, from 1.8km upstream of the existing Listowel Bridge to downstream of the Kerry County Council Water Abstraction Point.
- Mill Stream, small right-bank tributary of the Feale (3.2km long for the East branch and 0.2km long for West branch).

2 Model Construction and Schematisation

2.1 Data Collection

The datasets used to construct the hydraulic model of the Listowel area are summarised in Table 2.1.

Table 2.1: Datasets used to build the hydraulic model

Data	Description	Source
Filtered LiDAR	Light Detecting And Ranging (LiDAR) digital terrain models at 2m resolution. The datasets were used to inform the hydraulic model with ground elevation information (see Section 2.3.2).	OSi
OS Map	Ordnance Survey Ireland Maps (NTF Vector maps, 5k, 25k and 50k) were used for background mapping as well as to inform the hydraulic model with landuse type and spatial distribution (see Section 2.3.2).	OSi
Topographic survey data	Cross-section profiles of River Feale and structures provided by the OPW (28.09.2012). Cross-section profiles of Mill stream and structures, provided by Kerry NRDO (29/05/2013). See Section 2.3.1).	OPW / Kerry NRDO
Bank top survey	Bank top survey was conducted along key (defended) sections of the River Feale. (19/10/2012)	OPW
Proposed Development design	Drawings of the proposed development design	Jacobs

2.2 Hydrology

To support the development of the hydraulic model, a hydrological assessment of the Feale River and Mill Stream was carried out using FSU techniques. The hydrological analysis provided inflow hydrographs to the hydraulic model for: 50% (Qmed, median of annual maximum flood), 1% and 1% plus Climate Change[2] Annual Exceedence Probabilities (AEP) design flood events at pre-determined inflow locations shownin the model schematisation Figure 2.1.

A summary of the peak flows associated with each inflow hydrograph is presented in Table 2.2.

[2] A 20% increase on flow was adopted as Climate Change allowance

Table 2.2 Peak flows of each hydrological inflow to the model

Nodes	50% AEP Qmed (m^3/s)	1%AEP (m^3/s)	1% AEP + Climate Change (m^3/s)
Feale, F1	369	815	979
Listowel Trib	2.0	4.3	5.2
Mill_Trib_West	2.3	5.1	6.2
Mill_Trib_East	0.9	2.1	2.5
Mill_Crossing	0.2	0.4	0.4
Mill_DS	0.2	0.4	0.5

2.3 Hydraulic Model Schematisation

As previously discussed, the hydraulic model consists of two interlinked models:

- An ISIS one dimensional model representing the in-bank channels;
- A TUFLOW two dimensional grid-based model representing the adjacent floodplain (Out of bank model).

2.3.1 River Channel Schematisation (1D ISIS model)

The ISIS one dimensional model was constructed using the river cross-section and hydraulic structure survey data detailed in Table 2.1.

There are a total of 14 hydraulic structures across the Feale River and Mill Stream that were included in the hydraulic model. Table 2.3 below details these structures and how they were represented within the ISIS model.

Table 2.3: Hydraulic structures included in the model

Model Reach	Name of Structure	ISIS Node	ISIS Unit
Feale	Listowel Bridge (Bridge Rd)	03FEL01331	Arch Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Bridge (near Listowel Castle)	03FEL00108	USBPR Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Bridge (Racecourse Rd)	02FEL04331	USBPR Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Weir (Kerry County Council Water Abstraction Point)	02FEL01280	Broad Crested Weir unit.
Mill	Bridge (off R553)	02MIL01414	Box Culvert. Spill to allow overtopping is represented in the 2D model.
	Bridge (R553)	02MIL01326	Box Culvert. Spill to allow overtopping is represented in the 2D model.
	Bridge (R553)	02MIL01313	Sprung Arch Culvert. Spill to allow overtopping is represented in the 2D

Model Reach	Name of Structure	ISIS Node	ISIS Unit
			model.
	Bridge (old railway)	02MIL00628	Arch Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Bridge (Greenville Road)	02MIL00113	Arch Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Obstruction by a 0.6m diameter crossing pipe	02MIL00109	Orifice and spill unit to allow overtopping.
	Circular Culvert (junction with East branch of Mill stream)	02MIL00050	Circular conduit unit. Spill to allow overtopping is represented in the 2D model.
	Bridge (Kilcrean House)	01MIL01110	Arch Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Bridge (unnamed rd)	01MIL00585	Arch Bridge unit. A spill unit is attached to the structure to allow overtopping.
	Double Flapped Circular Culvert (92m upstream of junction with River Feale)	01MIL00092	Orifice unit with flap option.

2.3.2 Floodplain Schematisation (2D TUFLOW model)

2.3.2.1 Linking 1D and 2D elements

The boundary linking the 1D model to the 2D domain was digitised using bank top survey, where available, and LiDAR. The 1D/2D boundary is represented by the bank top line in the model schematisation, Figure 2.1.

Due to an issue with model stability the downstream extent of the Mill Stream, at its confluence with the River Feale, has been modelled in 2D.

2.3.2.2 Grid

The 2D model is based on a grid comprising individual cells of 5m size. Each cell was given characteristics relating to the topography such as ground elevation using LiDAR data (2m horizontal resolution) and bed resistance value (hydraulic friction).

This allowed for adequate representation of features in the floodplain such as roads and buildings, while not becoming computationally cumbersome considering the size of the study area.

The maximum area covered by the 2D model is shown in Figure 2.2 and covers an area of approximately 9.2km².

2.3.2.3 Breaklines

Breaklines were used in the 2D domain to accurately represent any geographical features that have a significant impact on the propagation of the flood wave across the floodplain. It is particularly useful where the TUFLOW fixed grid discretisation (in our case 5m) does not guarantee that the crest along, for example, a narrow earth embankment, is picked up from the LiDAR data.

The main breaklines included into the 2D model are summarised in Table 2.4.

Table 2.4 Breaklines in the 2D domain

Breakline Type	Geographical Feature
Bank top	Right and Left bank crests along the modelled watercourses using bank top data from the topographical survey
Drains	Drains / ditches running in the modelled area and not implemented in the 1D model have been represented using breaklines to create continuous flow paths
Walls	Masonry walls running on the right bank of the Feale river upstream of the Listowel bridge.

2.3.2.4 1D Elements in the floodplain

An existing culvert under a road, located in the Mill stream floodplain, has been represented using an Estry 1D element along with a breakline. 1D-2D boundaries/links have been used to allow for flow connectivity between the 2D grid and the 1D element.

Underpasses and flood relief culverts for the model representing the proposed development situation were included as Estry 1D elements (see Section 6).

Figure 2.1 illustrates these breaklines along with the 1D element used to represent the culverted section

2.3.3 Proposed Development model

The baseline (existing) scenario was set up as outlined in the preceding sections. In order to assess the impact of the proposed development on flood risk, a version of the model was produced which includes a representation of the proposed bridge and embankment in the development. The baseline model was amended to include the proposed development. This version of the model includes the proposed flood risk mitigation measures that could be included in the development design. Full details of the design version of the model are provided in Section 6.

2.3.4 Hydraulic Friction

Hydraulic roughness, represented by Manning's coefficient "n" in the hydraulic model, is a means of accounting for the effect on the conveyance capacity of bed materials and size, surface irregularities, channel bed forms, erosional and depositional features, channel sinuosity, obstructions and vegetation.

Manning's n is a semi-empirical parameter and cannot be directly measured; however a number of established reference literatures such as Chow[3] give advice

[3] Chow, V.T., Open Channel Hydraulics, 1984, McGraw Hill , Singapore

on the selection of the roughness coefficient for river channels and floodplains. The values adopted for the Feale River and Mill Stream range from 0.04-0.05 for the river bed to 0.04-0.06 for the banks. A value of 0.02 has been adopted on engineered (concrete) sections of the channel.

To represent friction in the floodplain, geographical regions of different land use such as roads, buildings, urban areas and green spaces etc. were defined using OS NTF Vector Map coverage. The land use regions were processed and input into the 2D model grid so that each 2D grid cell carries a reference number. As shown in Table 2.5, Manning's "n" values were assigned to each of the land use reference numbers.

Table 2.5 Roughness Coefficients

ID	F Vector Map Feature Code	Landcover Group	Manning's n
0	618	General Rural	0.045 (set as default)
1	611	General Urban	0.06
2	532,537,538,534,531,536,539,533	Water	0.02
3	559	Rail	0.05
4	557, 556, 553, 551, 552	Roads /tracks /paths /roadside	0.025
5	526, 527, 528	Thick vegetation /trees	0.08
6	582, 589, 598, 600, 601	Buildings	0.1
7	574, 575, 583	Short grass/ parks/ sport grounds	0.035

Patches of high roughness (0.05 and 0.08) have been digitised along the banks of the Feale River to represent areas of dense vegetation

It should be noted that the use of filtered LiDAR data to populate the 2D model grid means that buildings were not physically represented in the models. Given the fact that any building is an obstruction to the flow and would have a major impact on the overland flow routes, a high roughness value has been attributed to each building/house to model the effect of the obstruction. The use of a high Manning's "n" value for a building effectively makes it "difficult" for water to enter / flow through a building, but it does not make it impossible, in contrast to representing a building as a solid "block", through which no water can flow.

2.3.5 Hydrological Inflows

The design flow hydrographs derived from the hydrological analysis of the River Feale and tributaries were used as flow inputs to the ISIS model at the upstream extent of the modelled reaches as well as lateral inflows at some points along the reaches (see Table 2.1 and Figure 2.2).

2.3.6 Downstream Conditions

Free flow boundaries were set at the downstream limits in the 1D ISIS model and the 2D domain.

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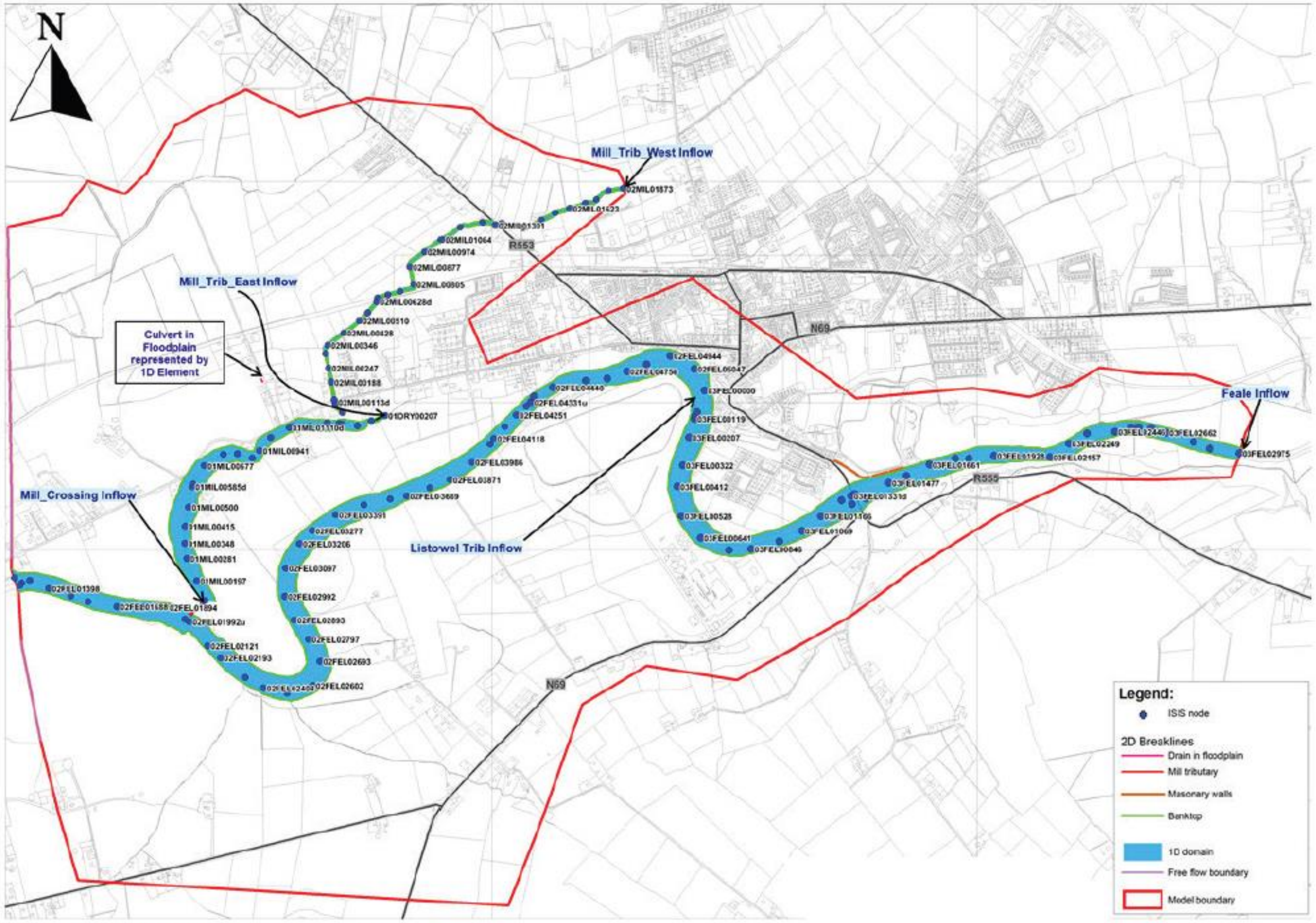


Figure 2.1: Overview of the 2D Model schematisation

3 Model Performance and Sensitivity Analysis

The following sections discuss the steps associated with the verification process and how information was used to check model performance. In addition, details relating to the additional runs carried out to test the sensitivity of the model to changes in key variables are also discussed.

3.1 Model Performance

TUFLOW hydraulic modelling software provides run performance guidance along with acceptable error ranges that should be achieved during each model run. The concept of an acceptable error range has been adopted by the developers of the software, as numerical errors occur due to the quality of the data used, limitations of the software and underlying equation solving processes.

Run performance has been monitored throughout the model build process and then during each simulation carried out, to ensure the optimum model convergence at any computed time step. In particular, the Cumulative Mass Balance Error reports associated with both 1D and 2D domains have been considered. In the ISIS model, convergence was carefully monitored through consultation of convergence plots and flow/water levels time series. For all the simulations undertaken, the model performance is within the recommended tolerance range.

Flood event data and high flow data for possible consideration as calibration and verification events were analysed. The results of this analysis concluded that no calibration or verification could be performed along the modelled extent of the River Feale or the Mill stream. Therefore the model has not been calibrated or verified to past historic flood events.

3.2 Sensitivity Analysis

A sensitivity analysis was carried out on the "Existing Situation" model in order to assess the sensitivity of the system to alterations in a number of key hydraulic parameters.

The result of the sensitivity analysis (as presented in Table 3.1) gives an indication of the level of confidence that can be placed in the water level predicted by the model.

It was decided that the existing situation with a 1% AEP event would be considered as the baseline case. All the sensitivity analysis results were compared to the baseline case.

The following tests were undertaken:

- Sensitivity to hydraulic roughness: Manning's "n" values were both increased and decreased by 20%. This was carried out to assess the sensitivity of the model results to changing site roughness. The roughness values in the 1D ISIS and the 2D Tuflow domain were altered.
- Sensitivity to the hydrological inflows: All of the 1% AEP inflows were increased and decreased by 20%, to investigate the model sensitivity to inflows.

- Sensitivity to the downstream boundary: The slope of the original normal depth (free flow) downstream boundary has been increased and decreased by 20% in the 1D ISIS model.

Table 3.1 Sensitivity test results

+20% Manning's n	Watercourse	Average Water level difference (mm)	Maximum water level difference (mm)	Cross-section / reach where the maximum difference occurs
	River Feale	+300	+440	03FEL02852
	Mill Stream before junction with East reach	+40	+65	02MIL01484
	Mill Stream after junction	+400	+1050	01MIL01184
-20% Manning's n	**Watercourse**	**Average Water level difference (mm)**	**Maximum water level difference (mm)**	**Cross-section where the maximum difference occurs**
	River Feale	-400	-560	02FEL02992
	Mill Stream before junction with East reach	-50	-140	02MIL01484
	Mill Stream after junction	-500	-625	01MIL01184
+20% inflows	**Watercourse**	**Average Water level difference (mm)**	**Maximum water level difference (mm)**	**Cross-section where the maximum difference occurs**
	River Feale	+300	+400	02FEL02893
	Mill Stream before junction with East reach	+40	+120	02MIL01810
	Mill Stream after junction	+360	+1180	01MIL01184
-20% inflows	**Watercourse**	**Average Water level difference (mm)**	**Maximum water level difference (mm)**	**Cross-section where the maximum difference occurs**
	River Feale	-400	-720	02FEL01398
	Mill Stream before junction with East reach	-50	-130	02MIL01810
	Mill Stream after junction	-650	-825	01MIL01184
Downstream conditions Normal Depth downstream boundary slope	The change to the downstream boundary condition has resulted in a decrease in maximum water level by 286mm at the downstream limit of the model (ISIS node 02FEL01256). The effect is diminishing rapidly going upstream. At the location of the proposed bridge (ISIS node 02FEL02602, 1.35km upstream of downstream limit) the decrease in maximum water level is only 26mm. On the Mill stream at the location of the proposed development crossing (ISIS node 01MIL00769) the decrease in maximum water level is only 40mm. The change in the boundary			

increased by 20%	condition has a negligible impact on the water level in the area of the proposed development.
Downstream conditions Normal Depth downstream boundary slope decreased by 20%	The change to the downstream boundary condition has resulted in an increase in maximum water level by 351mm at the downstream model limit (ISIS node 02FEL01256). The effect is diminishing rapidly going upstream. At the location of the proposed bridge (ISIS node 02FEL02602) the increase in maximum water level is only 29mm. On the Mill stream at the location of the proposed development crossing (ISIS node 01MIL00769) the increase in maximum water level is only 14mm. The change in the boundary condition has a negligible impact on the water level in the area of the proposed development.

The hydraulic model appears to be highly sensitive to the bed roughness and peak inflow parameters. For the 1% AEP flood event, the water starts to spill out of the banks in numerous locations along the Feale and Mill reaches (see description of flood mechanism in Section 5.2). As a result of which a relative increase or decrease of water level in the reaches (1D domain) leads to a variable amount of water spilling into the floodplain (2D domain) and thus resulting in variable flood extents.

The downstream part of the Mill stream (from the junction between the East and West branch to the junction with Feale) is indirectly highly sensitive. There is water spilling out of the right hand bank of the River Feale which reaches the Mill Stream through the floodplain. Therefore depending on the water level in the Feale River this amount of overflowing water can be small or very large leading to variable flood depth results around the Mill Stream.

The steeper and smaller upstream extent of the Mill stream is not sensitive to these parameters.

4 Key Model Assumptions and Limitations

The accuracy and validity of the model results is heavily dependent on the accuracy of the hydrological and topographic data included in the model. While the most appropriate available information has been used to construct the model to represent fluvial flooding mechanisms, there are uncertainties and limitations associated with the model. These include assumptions made as part of the model build process.

Efforts have been made to assess and reduce levels of uncertainty in each aspect of the modelling process.

The key sources of uncertainty in addition to the limitations associated with modelling undertaken for the Listowel model.

- It should be noted that small topographic features, for example kerbs are not explicitly represented within this hydraulic model. The 5m cell size of the model grid and the resolution of the LiDAR data (2m) mean that elevation differences between roads and kerbs are unlikely to be well represented in the model. As the modelled extent is mostly rural the use of the 5m grid is appropriate.
- The accuracy of the model results is highly dependent of the hydrological inflows.
- The model has not been calibrated or verified to past historic flood events due to lack of gauge data available.

5 Model results (Existing situation)

5.1 Model runs and outputs

Design hydrographs derived from the hydrological assessment of the watercourse catchments and corresponding to the 50% (Qmed), 1% and 1% plus Climate Change[4] AEP flood events were specified as inflows to the hydraulic model.

The hydraulic model was run to determine flow and water level distribution within the river channels and their adjacent floodplain that would be expected during these flood events in the existing situation.

The peak water levels at points of interest within the River Feale and Mill Stream predicted by the hydraulic model, in the 1% AEP plus Climate Change event, are tabulated in Figure 5.1. The existing situation assumed standard maintenance and full integrity of the river banks, hydraulic structures (bridges, culverts) and flood defences across the study area.

The model outputs for the existing scenario were reviewed to identify the likely flood mechanisms at key locations. The flood mechanisms are discussed in the next section.

5.2 Flood mechanisms in existing scenario

For the following locations, the relevant flood mechanisms discussed are specifically related to the 1% AEP plus climate change event. Refer to Figure 5.1, overleaf:

- River Feale at existing Listowel Bridge: Flood water spills out of the right hand bank of the River Feale upstream of the Listowel Bridge. The flood water builds up in an adjacent field before crossing Bridge Road and spreads westward in the urbanised area.
- River Feale, left hand bank, downstream of the Industrial estate: Overtopping first occurs immediately downstream of the Industrial estate then a second overtopping occurs 200m downstream, at the bridge. This large amount of water flows through the floodplain to the southwest. There are several points along the left bank where some of the water in the floodplain re-enters the channel, the majority upstream of the proposed N69 Listowel Bridge. A significant flow path continues on the left bank of the river Feale until the downstream extent of the model.
- River Feale at the Bridge (02FEL04331): Flood water spills out of the right hand bank. The water runs into the floodplain following the topography and enters the East Mill stream. In the case of a 1% AEP plus climate change event flow spills out of the right hand bank at a number of locations increasing importantly the flow in the Mill Stream.
- Junction between the River Feale and Mill Stream: the water from the River Feale backs up in the Mill Stream and extends in the natural floodplain. The double flapped culvert on the Mill Stream is closed.
- Mill stream: Overtopping occurs from the right and left bank at a number of locations, the water flows along the reach through the fields. An important

[4] A 20% increase on total rainfall depth was adopted as Climate Change allowance

volume of water spills out of the right hand bank of West Mill stream 200m upstream of the junction with the East Mill Stream.

- Mill Stream, 400m downstream of junction between East and West Mill Stream branches: Flood waters from the Mill stream extend in the left hand natural floodplain.

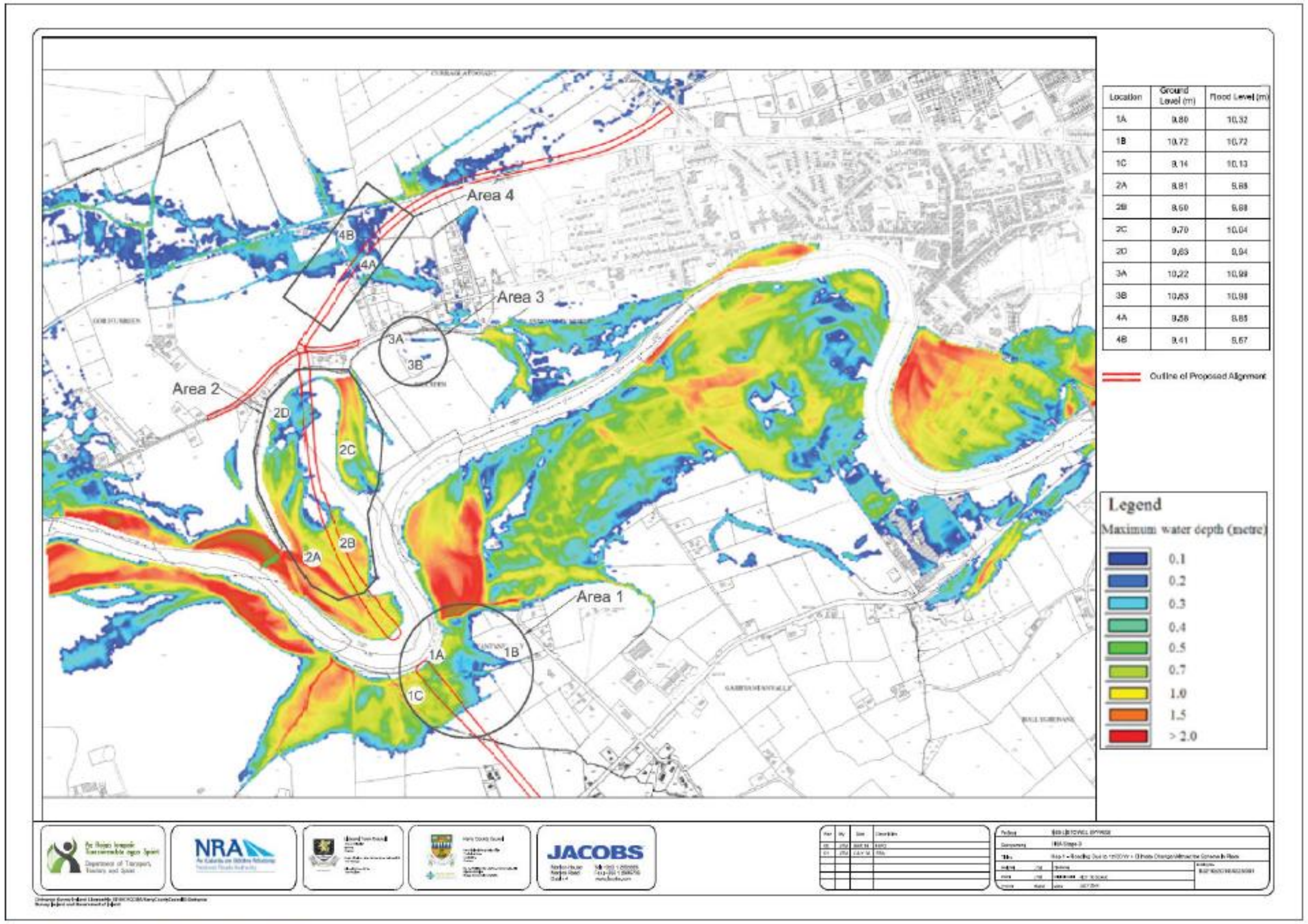


Figure 5.1 Existing flood risk during 1% AEP plus climate change

6 Mitigation modelling

To support the development of the scheme, mitigation scenarios were simulated within the hydraulic model. A number of flood mitigation options were considered as part of this process.

A design input statement was developed and the model schematisation was modified accordingly to assess the performance of each mitigation option.

6.1 Proposed Development

To assess the impact of the proposed development on the existing situation flood extents, changes were made to the topographic data input to the model. At the location of the proposed development, ground elevations in the model have been increased to represent the embankments of the road. It has been decided that the proposed development should not be overtopped by water for a 0.1% plus climate change AEP storm event; therefore the elevation of the road has been set up to an appropriate level.

6.1.1 Flood mechanisms -proposed development (no mitigation)

Generally, the raised carriageway of the road passes through areas of flood risk. This removes a potential flow path and leads to a loss of floodplain storage.

In Area 1, see Figure 6.2, the flood depth is increased by 970mm from the existing scenario to the east of the proposed development at Point 1A. Flood waters are restrained in this area by the proposed development and to the west of the proposed development the flood depth is lower than the existing scenario.

Figure 5.2 and 6.1 show that the introduction of the proposed development provides a barrier to the flow of flood waters, which increases the flood depth at the North of Area 2, points 2C and 2D, by 420mm and 150mm respectively and reduces the flood depth at the South of Area 2, points 2A and 2B, by 10mm and 990mm respectively.

Once again in Area 3, the proposed development provides a barrier to flood flow. In this area, the capacity of the Mill stream is exceeded and there is "backing up" at an existing structure.

Figure 5.2 and 6.1 indicates for Area 4 that the proposed development is acting as a barrier to flood flow in this location, which causes an increase in flood depth and extent to the properties directly to the South of the proposed development at point 4A.

Without mitigation the potential impacts identified through hydraulic modelling are significant. The hydraulic modelling process has indicated that construction of the proposed development without any mitigation would lead to an increase of flood depth and extent to a total of 32 properties.

6.2 Mitigation measures schematisation

The mitigation measures required include a series of flood relief culverts, introduction of a land drain and some widening of the mill stream. Further details are available in section 6.2.1.

The flood relief culverts have been schematised using Estry 1D elements, which have been included in the 2D model to represent underpasses and flood relief culverts under the projected road embankment allowing for the transfer of flow from one side of the structure to the other.

To represent the localised re-profiling of the mill stream (increase of channel width) cross sections in the ISIS 1D model have been updated appropriately.

A location plan of the proposed mitigations measures are shown in Figure 6.2. This figure also illustrates any areas of increased flood risk from the proposed development with mitigation measures in place.

In general the increase in predicted water levels, with the mitigation measures in place, range from 10mm to 500mm. The areas where there is an increase in predicted flood levels are already at risk of flooding in the existing scenario and no properties are affected.

6.2.1 Flood mechanisms - proposed development (with mitigation)

The 1% AEP plus climate change event has been used for comparison purposes. In Area 1, the following flood mitigation measures are implemented:

- 10 No. 900mm diameter flood relief culverts
- 4 No. 2100mm diameter flood relief culverts

The flood relief culverts allow a flow path for flood water from the East of the proposed development to the West of the proposed development. With these mitigations measures in place, the predicted flood depth to the West of the proposed development remains at the same level as in the existing scenario, at point 1C, and the predicted flood depth to the East of the proposed development will marginally increase by 130mm.

In Area 2, the following flood mitigation measures are implemented:

- 3 No. 900mm diameter flood relief culverts
- 6 No. 2100mm diameter flood relief culverts

Following the introduction of the culverts in Area 2, there is no increase in flood levels at points 2A and 2B in comparison to the existing risk. Point 2C shows that the existing flood depth increased by approximately 40mm from a depth of approximately 340mm in the existing scenario. The property at point 2D shows no increase in flood level.

The following flood relief measure is implemented in Area 3:

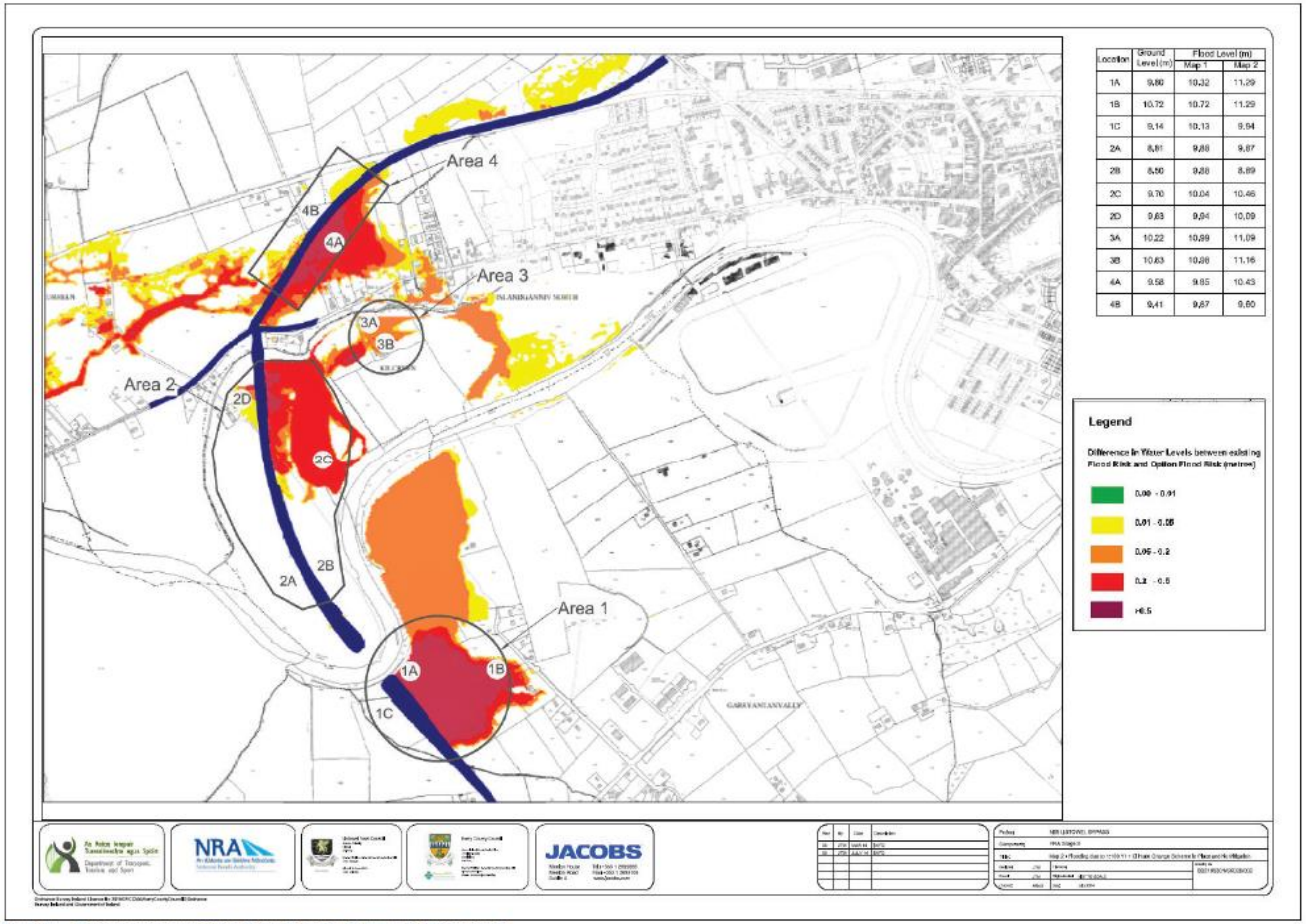
- Local re-profiling of the Mill Stream embankments for approximately 1-2m directly to the East of the existing bridge

The results at points 3A and 3B show that the flood level is not increased from the existing scenario when the mitigation measures are introduced. It should be noted that the Mill Stream is currently maintained by the OPW. As part of the flood mitigation measures, the local re-profiling of the Mill Stream embankments will also need to be maintained.

In Area 4, the following flood mitigation measures are implemented:

- 6 No. 900mm diameter flood relief culverts
- Introduction of a land drain

The results at point 4A and 4B indicate that the flood levels are decreased from the existing scenario following the implementation of the above mitigation.



Location	Ground Level (m)	Flood Level (m)	
		Map 1	Map 2
1A	9.80	10.32	11.29
1B	10.72	10.72	11.29
1C	9.14	10.13	9.94
2A	8.81	9.88	9.87
2B	8.50	9.88	8.89
2C	9.70	10.04	10.46
2D	9.83	9.94	10.09
3A	10.22	10.99	11.09
3B	10.63	10.98	11.16
4A	9.58	9.85	10.43
4B	9.41	9.87	9.80

Figure 6.1 Post proposed development flood risk during 1% AEP plus climate change

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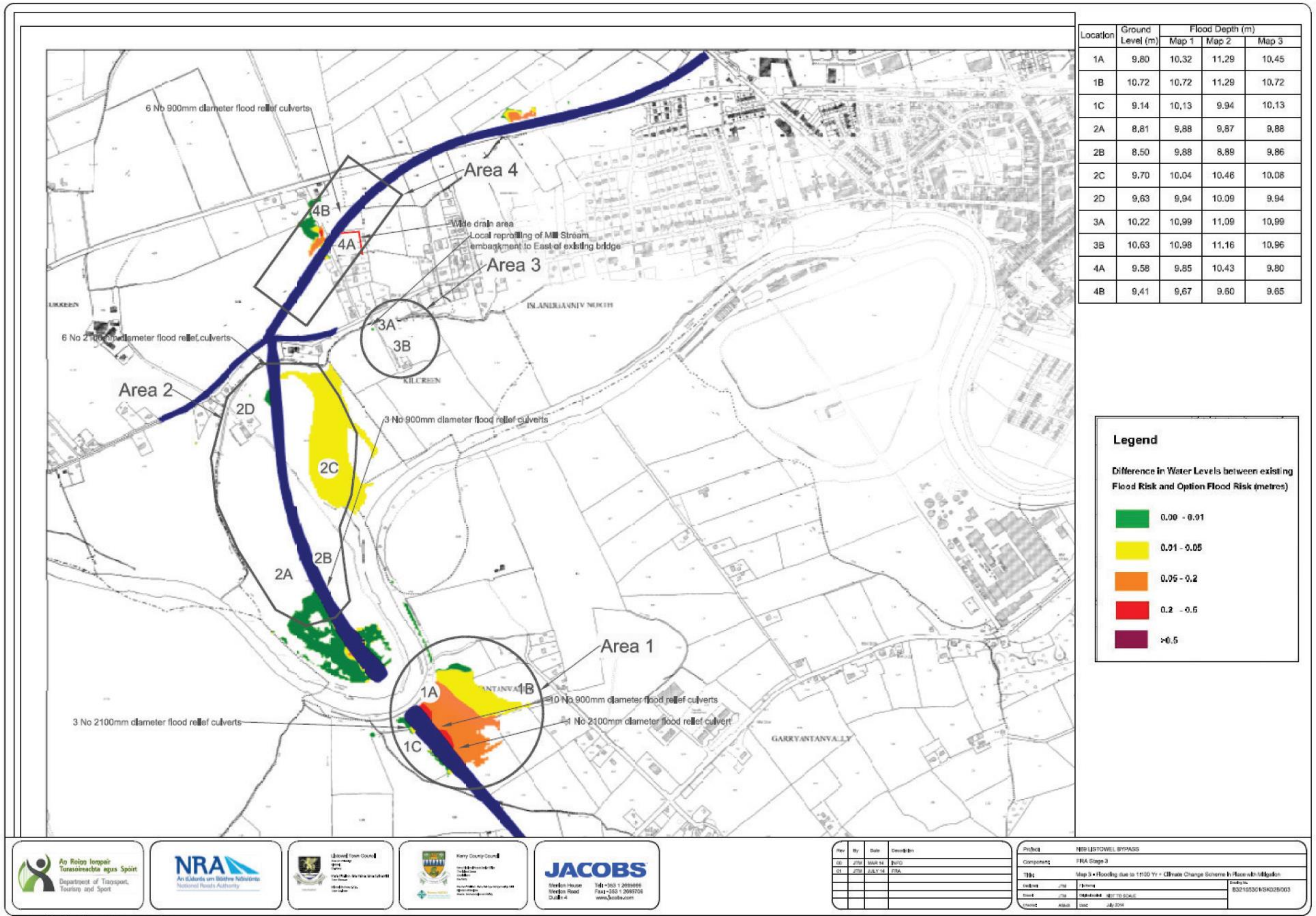


Location	Ground Level (m)	Flood Depth (m)		
		Map 1	Map 2	Map 3
1A	9.80	10.32	11.29	10.45
1B	10.72	10.72	11.29	10.72
1C	9.14	10.13	9.94	10.13
2A	8.81	9.88	9.87	9.88
2B	8.50	9.88	8.89	9.86
2C	9.70	10.04	10.46	10.08
2D	9.63	9.94	10.09	9.94
3A	10.22	10.99	11.09	10.99
3B	10.63	10.98	11.16	10.96
4A	9.58	9.85	10.43	9.80
4B	9.41	9.67	9.60	9.65

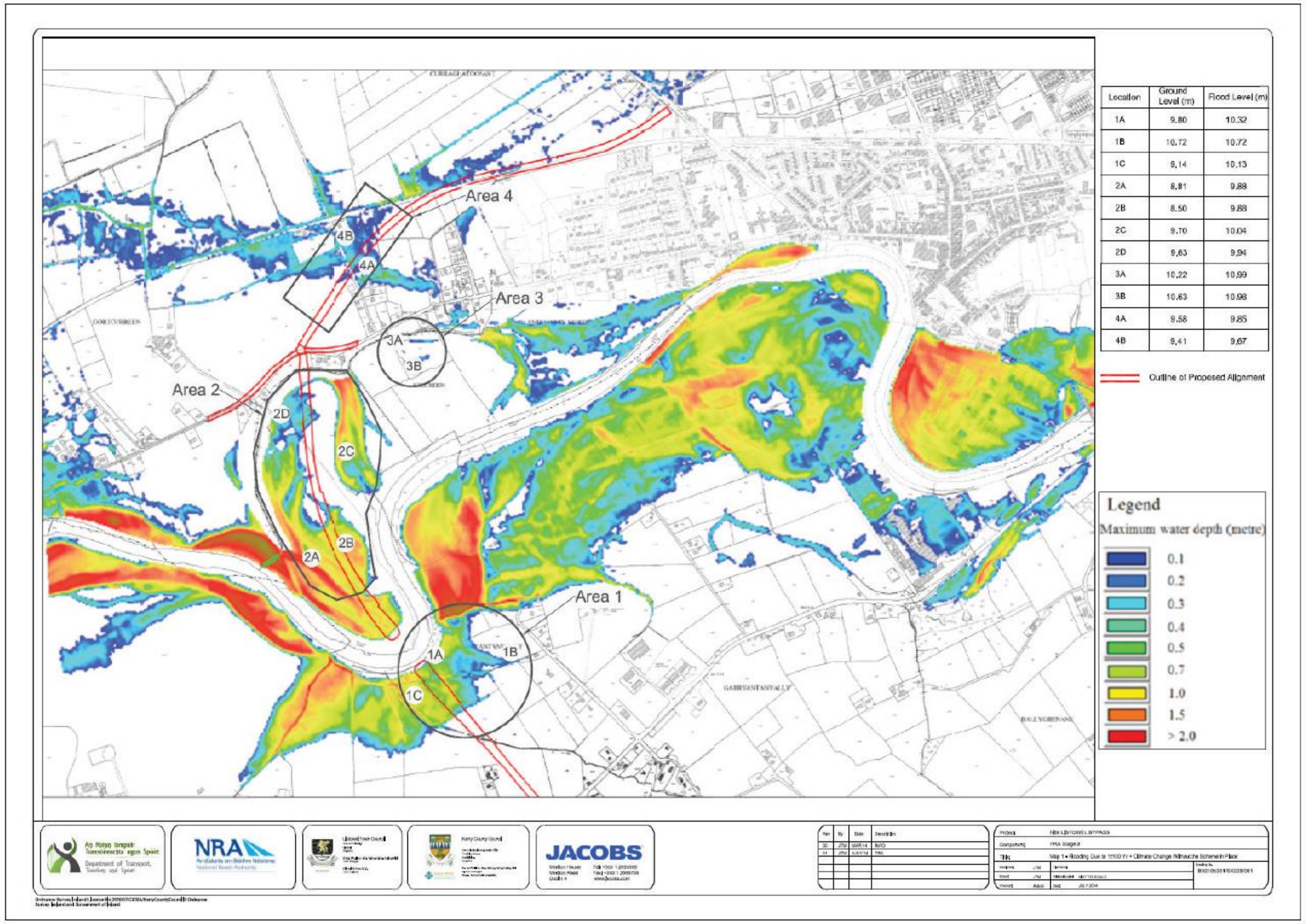
Figure 6.2 Post proposed development with mitigation measures flood risk during 1% AEP plus climate change

7 Conclusion

This study has used a new hydraulic model to investigate the flood risk associated with an extreme fluvial event for the existing conditions and the proposed development situations.

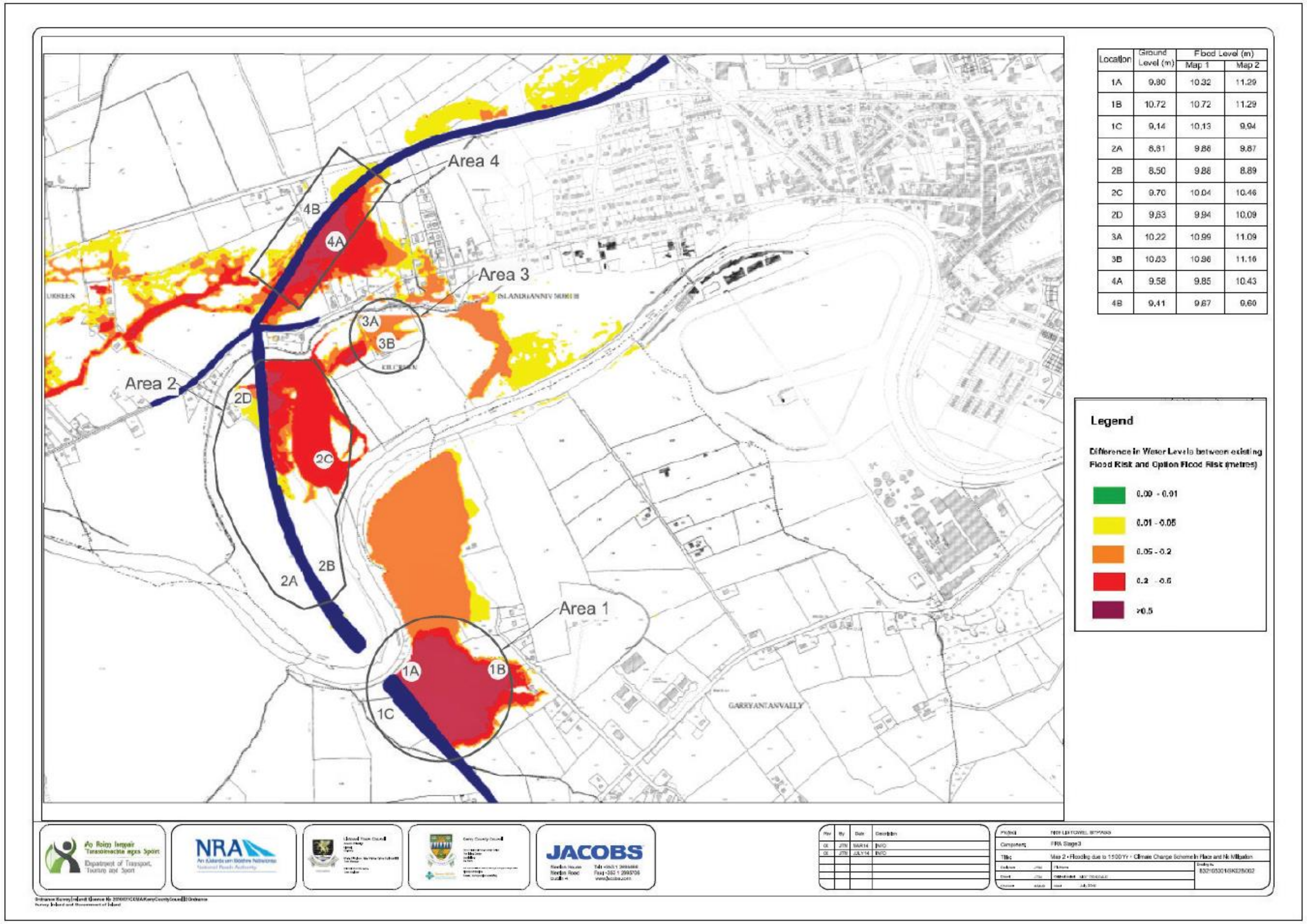
All across the study area, comparison of model predictions between the existing and the proposed development situation demonstrate that the proposed works do not increase the flood risk, following the implementation of the selected option. Peak water levels are broadly similar in both scenarios. Areas where there is an increase in water level have no impact on flood risk as there are no affected receptors in the area and no increase in flood extent.

Appendix C1 Flood Maps



Location	Ground Level (m)	Flood Level (m)
1A	9.80	10.32
1B	10.72	10.72
1C	9.14	10.13
2A	8.81	9.88
2B	8.50	9.88
2C	9.70	10.04
2D	9.63	9.94
3A	10.22	10.99
3B	10.63	10.98
4A	9.58	9.85
4B	9.41	9.67

Figure C1-1 Existing flood risk during 1% AEP plus climate change



Location	Ground Level (m)	Flood Level (m)	
		Map 1	Map 2
1A	9.80	10.32	11.29
1B	10.72	10.72	11.29
1C	9.14	10.13	9.94
2A	8.81	9.88	9.87
2B	8.50	9.88	8.89
2C	9.70	10.04	10.46
2D	9.63	9.94	10.09
3A	10.22	10.99	11.09
3B	10.63	10.98	11.16
4A	9.58	9.85	10.43
4B	9.41	9.67	9.60

Figure C2-2: Post proposed development flood risk during 1% AEP plus climate change

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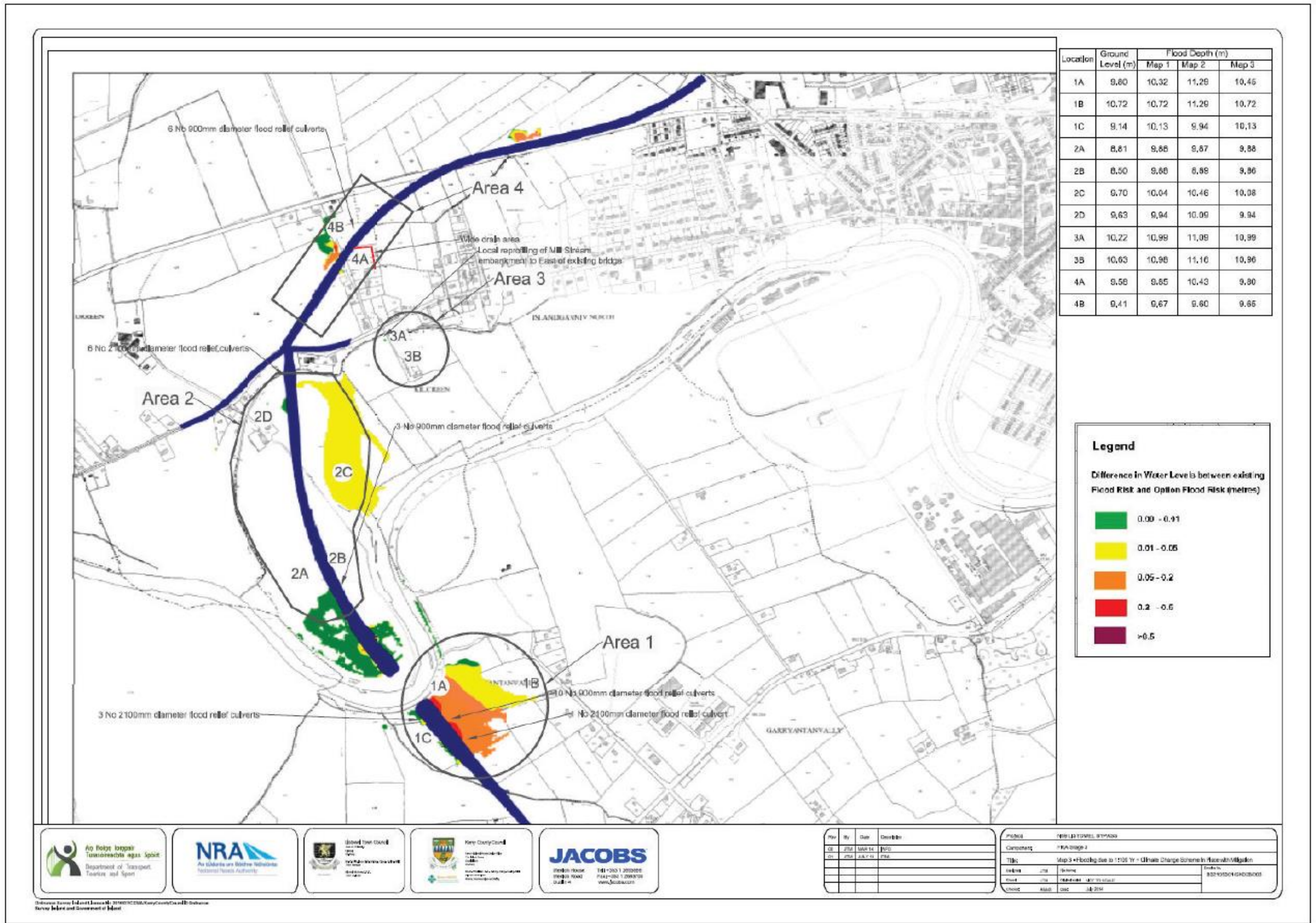
Appendix C2 Flood Map Post Mitigation Measures



Location	Ground Level (m)	Flood Depth (m)		
		Map 1	Map 2	Map 3
1A	9.80	10.32	11.29	10.46
1B	10.72	10.72	11.29	10.72
1C	9.14	10.13	9.94	10.13
2A	8.81	9.88	9.87	9.88
2B	8.50	9.88	8.89	9.86
2C	9.70	10.04	10.46	10.08
2D	9.63	9.94	10.09	9.94
3A	10.22	10.99	11.09	10.99
3B	10.63	10.98	11.16	10.96
4A	9.58	9.85	10.43	9.80
4B	9.41	9.67	9.60	9.65

Figure C2-1: Post proposed development with mitigation measures flood risk during 1% AEP plus climate change

Outfall - A1

Summary of predictions

Soluble - Acute Impact / **Sediment - Chronic Impact**

Prediction of impact	Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1 — Soluble (Copper, Zinc)

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	68.90	68.10
No. of exceedances/worst year	80	81
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	23.20	26.20
No. of exceedances/worst year	28	35
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1 — Sediment (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	80.70	105.20	1.80	18.90	60.30	18.90	16.10	34.20
No. of exceedances/worst year	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	2.1	1.5
No. of exceedances/worst year	4	2
No. of exceedances/summer	1.2	0.8
No. of exceedances/worst summer	3	2
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0.3
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0.1
No. of exceedances/worst summer	0	1
Annual average concentration (ug/l)	0.76	2.76
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	2.31	7.59
90%ile	6.70	19.19
95%ile	11.32	33.65
99%ile	23.72	94.29

Step 2

Velocity 0.06 m/s — Tier 2 is used for the calculation

DI 227.06

% settlement needed 56 %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.70	0.80
No. of exceedances/worst year	2	2
No. of exceedances/summer	0.4	0.2
No. of exceedances/worst summer	1	1
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.10
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.61	2.21
	(ug/l)	(ug/l)
Thresholds hresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	1.84	6.07
90%ile	5.36	15.35
95%ile	9.06	26.92
99%ile	18.97	75.44

DI 99.91

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfall – A2

Summary of predictions

Soluble - Acute Impact / **Sediment - Chronic Impact**

Prediction of impact	Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1 — Soluble (Copper, Zinc)

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	68.90	68.10
No. of exceedances/worst year	80	81
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	23.20	26.20
No. of exceedances/worst year	28	35
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1 — Sediment (Toxicity Threshold)

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	80.70	105.20	1.80	18.90	60.30	18.90	16.10	34.20
No. of exceedances/worst year	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	3	1.9
No. of exceedances/worst year	6	3
No. of exceedances/summer	1.7	0.9
No. of exceedances/worst summer	6	2
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.2	0.3
No. of exceedances/worst year	1	1
No. of exceedances/summer	0.1	0.1
No. of exceedances/worst summer	1	1
Annual average concentration (ug/l)	1.01	3.65
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	2.96	9.73
90%ile	8.82	25.66
95%ile	13.99	42.56
99%ile	27.02	114.02

Step 2

Velocity 0.10 m/s — Tier 2 is used for the calculation

DI -

% settlement needed - %

In River (with mitigation)

Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.90	0.90
No. of exceedances/worst year	2	2
No. of exceedances/summer	0.5	0.3
No. of exceedances/worst summer	1	1
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.70	2.52
	(ug/l)	(ug/l)
Thresholds hresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	2.05	6.72
90%ile	6.08	17.70
95%ile	9.65	29.37
99%ile	18.65	78.68

DI -

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfall – A3

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Soluble - Acute Impact: Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**68.90**	**68.10**
No. of exceedances/worst year	80	81

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**23.20**	**26.20**
No. of exceedances/worst year	28	35

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	26.56	85.29
	90%ile	51.08	171.67
	95%ile	69.13	259.02
	99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold	1	1	1	1	1	1	1	1
	80.70	**105.20**	**1.80**	**18.90**	**60.30**	**18.90**	**16.10**	**34.20**
	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.00	0.00

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	0.00	0.02
	90%ile	0.01	0.03
	95%ile	0.02	0.06
	99%ile	0.07	0.24

Step 2

Velocity 0.03 m/s — Tier 1 is used for the calculation

DI 5.82

% settlement needed 0 %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**-**	**-**
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**-**	**-**
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-
Annual average concentration (ug/l)	-	-

		Copper (ug/l)	Zinc (ug/l)
Thresholds hresholds	RST24	21	60
Thresholds	RST6	42	120
Event Statistics	Mean	-	-
	90%ile	-	-
	95%ile	-	-
	99%ile	-	-

DI -

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfall - A4

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Soluble - Acute Impact: Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**68.90**	**68.10**
No. of exceedances/worst year	80	81

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**23.20**	**26.20**
No. of exceedances/worst year	28	35

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	26.56	85.29
	90%ile	51.08	171.67
	95%ile	69.13	259.02
	99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold	1	1	1	1	1	1	1	1
	80.70	**105.20**	**1.80**	**18.90**	**60.30**	**18.90**	**16.10**	**34.20**
	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**1.6**	**1.1**
No. of exceedances/worst year	4	2
No. of exceedances/summer	1	0.5
No. of exceedances/worst summer	2	2

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0.3**
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0.1
No. of exceedances/worst summer	0	1
Annual average concentration (ug/l)	0.65	2.38

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	2.01	6.65
	90%ile	5.76	16.71
	95%ile	10.16	29.85
	99%ile	21.74	80.57

Step 2

Velocity 0.06 m/s — Tier 2 is used for the calculation

DI 238.17

% settlement needed 59 %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.90**	**0.90**
No. of exceedances/worst year	3	2
No. of exceedances/summer	0.5	0.3
No. of exceedances/worst summer	2	1

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.10**
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.60	2.19

		Copper (ug/l)	Zinc (ug/l)
Thresholds hresholds	RST24	21	92
Thresholds	RST6	42	184
Event Statistics	Mean	1.85	6.12
	90%ile	5.30	15.37
	95%ile	9.35	27.46
	99%ile	20.00	74.13

DI 97.65

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfall – A5

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff — Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	68.90	68.10
No. of exceedances/worst year	80	81
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	23.20	26.20
No. of exceedances/worst year	28	35
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	80.70	106.20	1.80	18.90	60.30	18.90	16.10	34.20
No. of exceedances/worst year	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	1.7	1.3
No. of exceedances/worst year	4	2
No. of exceedances/summer	1.1	0.7
No. of exceedances/worst summer	3	2
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0.3
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0.1
No. of exceedances/worst summer	0	1
Annual average concentration (ug/l)	0.70	2.56
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	2.15	7.09
90%ile	6.23	17.74
95%ile	10.84	32.06
99%ile	22.85	86.95

Step 2

Velocity 0.06 m/s — Tier 2 is used for the calculation

DI 256.14

% settlement needed 61 %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.00	0.10
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.00
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.30	1.07
	(ug/l)	(ug/l)
Thresholdshresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	0.90	2.98
90%ile	2.62	7.45
95%ile	4.55	13.46
99%ile	9.60	36.52

DI 99.90

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfall – A6

Summary of predictions

Prediction of impact	Soluble - Acute Impact: Copper	Zinc	Sediment - Chronic Impact: Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Step1										
Step2										
Step3										

DETAILED RESULTS

In Runoff — Step 1

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	68.90	68.10
No. of exceedances/worst year	80	81
RST6		
Allowable Exceedances/year	1	1
No. of exceedances/year	23.20	26.20
No. of exceedances/worst year	28	35
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold								
Allowable Exceedances/year	1	1	1	1	1	1	1	1
No. of exceedances/year	80.70	105.20	1.80	18.90	60.30	18.90	16.10	34.20
No. of exceedances/worst year	91	123	5	30	67	30	24	47
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515
Event Statistics Mean	339	1125	1	11143	1928	1850	118	521
90%ile	768	2648	1	28184	4876	4679	299	1319
95%ile	970	3476	2	56234	9729	9335	596	2632
99%ile	1430	5840	4	112202	19411	18626	1189	5251

In River (no mitigation) — Step 2

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	1.9	1.4
No. of exceedances/worst year	4	2
No. of exceedances/summer	1.1	0.8
No. of exceedances/worst summer	3	2
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0	0.3
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0.1
No. of exceedances/worst summer	0	1
Annual average concentration (ug/l)	0.73	2.66
	(ug/l)	(ug/l)
Thresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	2.23	7.35
90%ile	6.50	18.56
95%ile	11.13	32.93
99%ile	23.31	90.79

Step 2

Velocity 0.06 m/s — Tier 2 is used for the calculation

DI 260.30

% settlement needed 62 %

In River (with mitigation) — Step 3

	Copper	Zinc
RST24		
Allowable Exceedances/year	1	1
No. of exceedances/year	0.70	0.90
No. of exceedances/worst year	2	2
No. of exceedances/summer	0.4	0.3
No. of exceedances/worst summer	1	1
RST6		
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	0.00	0.10
No. of exceedances/worst year	0	1
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0
Annual average concentration (ug/l)	0.61	2.21
	(ug/l)	(ug/l)
Thresholdshresholds RST24	21	92
Thresholds RST6	42	184
Event Statistics Mean	1.85	6.10
90%ile	5.39	15.41
95%ile	9.24	27.33
99%ile	19.35	75.35

DI 98.91

Details of the chosen rainfall site	
SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

Outfalls - A1 & A2

Summary of predictions

		Soluble - Acute Impact		Sediment - Chronic Impact							
		Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact	Step1										
	Step2										
	Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**68.90**	**68.10**
No. of exceedances/worst year	80	81

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**23.20**	**28.20**
No. of exceedances/worst year	28	35

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184

Event Statistics	Copper	Zinc
Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold	1	1	1	1	1	1	1	1
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	316	3.5	16770	875	2355	246	515

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**5.4**	**2.9**
No. of exceedances/worst year	8	5
No. of exceedances/summer	3.1	1.4
No. of exceedances/worst summer	7	2

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.8**	**0.7**
No. of exceedances/worst year	2	2
No. of exceedances/summer	0.3	0.2
No. of exceedances/worst summer	1	1

	Copper	Zinc
Annual average concentration (ug/l)	1.43	5.15

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	92
Thresholds	RST6	42	184

Event Statistics	Copper	Zinc
Mean	4.01	13.20
90%ile	11.74	34.82
95%ile	18.27	58.11
99%ile	32.67	149.66

Step 2

Velocity m/s

Tier 1 is used for the calculation

DI

% settlement needed %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0.70**	**0.90**
No. of exceedances/worst year	2	2
No. of exceedances/summer	0.3	0.4
No. of exceedances/worst summer	1	2

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0.00**	**0.00**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

	Copper	Zinc
Annual average concentration (ug/l)	0.73	2.62

		Copper (ug/l)	Zinc (ug/l)
Thresholdshresholds	RST24	21	92
Thresholds	RST6	42	184

Event Statistics	Copper	Zinc
Mean	2.05	6.73
90%ile	5.99	17.76
95%ile	9.32	29.63
99%ile	16.66	76.33

DI

Details of the chosen rainfall site

SAAR (mm)	1111.7
Altitude (m)	9
Easting	3178
Northing	1773
Coastal distance (km)	4.25

Outfalls – A3 & A4

Summary of predictions

		Soluble - Acute Impact		Sediment - Chronic Impact							
		Copper	Zinc	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Prediction of impact	Step1										
	Step2										
	Step3										

DETAILED RESULTS

In Runoff

Step 1

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**68.90**	**68.10**
No. of exceedances/worst year	80	81

RST6	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**23.20**	**26.20**
No. of exceedances/worst year	28	35

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120

Event Statistics	Copper	Zinc
Mean	26.56	85.29
90%ile	51.08	171.67
95%ile	69.13	259.02
99%ile	120.65	446.84

Step 1

	Copper	Zinc	Cadmium	Total PAH	Pyrene	Fluoranthene	Anthracene	Phenanthrene
Toxicity Threshold	1	1	1	1	1	1	1	1
	(mg/kg)	(mg/kg)	(mg/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Toxicity Threshold	197	315	3.5	16770	875	2355	245	515

In River (no mitigation)

Step 2

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**0**	**0**
No. of exceedances/worst year	0	0
No. of exceedances/summer	0	0
No. of exceedances/worst summer	0	0

	Copper	Zinc
Annual average concentration (ug/l)	0.00	0.01

		Copper (ug/l)	Zinc (ug/l)
Thresholds	RST24	21	60
Thresholds	RST6	42	120

Event Statistics	Copper	Zinc
Mean	0.01	0.05
90%ile	0.03	0.07
95%ile	0.05	0.16
99%ile	0.17	0.58

Step 2

Velocity m/s

Tier 1 is used for the calculation

DI

% settlement needed %

In River (with mitigation)

Step 3

RST24	Copper	Zinc
Allowable Exceedances/year	1	1
No. of exceedances/year	**-**	**-**
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-

RST6	Copper	Zinc
Allowable Exceedances/year	0.5	0.5
No. of exceedances/year	**-**	**-**
No. of exceedances/worst year	-	-
No. of exceedances/summer	-	-
No. of exceedances/worst summer	-	-

	Copper	Zinc
Annual average concentration (ug/l)	-	-

		Copper (ug/l)	Zinc (ug/l)
Thresholdshresholds	RST24	21	60
Thresholds	RST6	42	120

Event Statistics	Copper	Zinc
Mean	-	-
90%ile	-	-
95%ile	-	-
99%ile	-	-

DI

Details of the chosen rainfall site

SAAR (mm)	1111.7
Altitude (m)	9
Easting	3176
Northing	1773
Coastal distance (km)	4.25

N69 Listowel Bypass											
						Design Year 2032					
Network	Outfall	Receiving Watercourse	RL length (km)	SS	Response time < 1 hour	AADT	% HGVs	Probability of accident (Pspl) - Note 1	Probability / year (PInc/year) Note 2	1 in years	Probability of accident %
1	A1	WF4	1.22	3.09	0.60	9412	3	0.00039	0.00023	4286	0.023%
2	A2	WF5	0.59	0.29	0.60	9412	3	0.00002	0.00001	94837	0.001%
3	A3	River Feale	0.79	0.29	0.60	9412	3	0.00002	0.00001	70677	0.001%
4	A4	WF1	1.60	3.09	0.60	9537	3	0.00052	0.00031	3220	0.031%
5	A5	N/A	0.53	0.29	0.60	9537	3	0.00002	0.00001	103446	0.001%
6	A6	WF0	1.24	0.29	0.60	9537	3	0.00004	0.00002	44310	0.002%

Spillage Rate (SS)

Ppol

Note 1 $$P_{SPL} = RL \text{ x } SS \text{ x } (AADT \text{ x } 365 \text{ x } 10^{-9}) \text{ x } (\%HGV/100)$$

Note 2 $$P_{INC} = P_{SPL} \text{ x } P_{POL}$$

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

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

N69 Listowel Bypass

Appendix 8.5: Preliminary Erosion and Sediment Control Plan

JACOBS

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JACOBS

Contents

1 Introduction

1.1 Overview

The Kerry National Road Design Office (KNRDO) has developed proposals for a bypass of Listowel Town; see full details in Chapter 1 of Volume 2 of the N69 Listowel Bypass Environmental Impact Statement (EIS).

During construction of the proposed development there is the potential for the release of sediment into watercourses in the study area including into the River Feale. The purpose of this preliminary Erosion and Sediment Control Plan (pESCP) is to describe the mitigation, control, monitoring and emergency measures that will be implemented during the construction of the proposed development i.e. the N69 Listowel Bypass in relation to erosion and sediment control.

This pESCP is intended to be a working document and will be updated by the contractor to form the detailed Erosion and Sediment Control Plan (dESCP) which will form part of the contractors Environmental Operating Plan (EOP) for the construction of the proposed development.

1.2 Principal Objectives of Erosion and Sediment Control

The principal objectives of erosion and sediment control as outlined in the Construction Industry Research and Information Association (CIRIA) C648 Control of Water Pollution from Linear Construction Projects: Technical Guide (Murnane et al. 2006) are:

- *Minimise erosion and potential for soiled water to be generated by minimising runoff;*
- *Install drainage and runoff controls before starting site clearance and earthworks;*
- *Minimise the area of exposed ground;*
- *Prevent natural clean runoff entering the works area / site;*
- *Provide appropriate control and containment measures on site;*
- *Monitor and maintain erosion and sediment controls throughout the project; and*
- *Establish vegetation as soon as practicable on all areas that have been exposed.*

1.3 Contract Procurement

The contract procurement is expected to be design and build. Although this plan is preliminary it should be considered a demonstration of the level of control which is required. The dESCP will be more detailed and may incorporate alternative details provided it can be demonstrated that it provides the same performance criteria (or higher) than those outlined in this preliminary plan.

1.4 Content of the Plan

This pESCP contains the following information:

- *Details of the characteristic of the site;*
- *Details of the Source - Pathway - Receptor relationship;*
- *Erosion and Sediment control measures;*
- *Details of monitoring and auditing requirements; and*
- *Details on emergency procedures.*

1.5 Consultation

Consultation has been undertaken with the National Parks and Wildlife Service (NPWS); The Office of Public Works (OPW); and Inland Fisheries Ireland (IFI) during the development of the EIS for the proposed development. The recommendations from this consultation that related to the construction phase of the proposed development have been incorporated into this pESCP.

The IFI, NPWS, OPW and Irish Water (the Kerry Water Services Division) will be informed when: works are about to commence on site, prior to works in the vicinity of the River Feale and/or as outlined within this pESCP. These organisations will be provided with sufficient time to allow inspection in addition to the ongoing monitoring of the control measures that will be undertaken by KCC under the contract.

2 Site Characteristics

2.1 Surface Water Features

The proposed development lies within the Shannon River Basin District (RBD), Hydrometric Area (HA) 23 within the Feale Water Management Unit (WMU). The catchment of this HA is drained by the River Feale (the main surface water feature within the study area) with all associated watercourses entering tidal water in the Cashen/ Feale Estuary to the north-west of Listowel.

The River Feale is the main surface water feature that could be impacted by the proposed development. The River Feale forms part of the Lower River Shannon candidate Special Area of Conservation (cSAC). It is also designated a Salmonid water under the European Communities (Quality of Salmonid Waters) Regulations, 1988, and it is considered to be a nationally important river system for Atlantic salmon and Brown trout. Any impact associated with increased sediment and silt release during construction could potentially impact the designated features of this watercourse. The River Feale is also the source of drinking water for Listowel Town. Water is abstracted from the River Feale at Scartleigh to serve the Dromin water works, which is connected to the main County Council water supply and this plant serves approximately 5,000 – 6,000 people. The abstraction point is located 1.3 km downstream of the proposed development crossing of the River Feale. Any increased sediment release or accidental spill during construction could potentially have an impact on this public water supply.

In addition, there are a number of minor watercourses and unnamed drainage ditches that flow within close proximity to the proposed development. The minor watercourses in the study area are detailed in Table 2-1 below and shown in Figure 8.1.1-8.1.6 of Volume 3 of the EIS. Further detailed descriptions of the watercourses are provided in Chapter 8; Hydrology, Geomorphology & Hydromorphology in Volume 2 of the EIS.

Table 2-1 Minor Watercourses in the Study Area

No.	Water Feature	Description of Minor Watercourses
WF0	Mill Stream Upper	• Located north of the River Feale and joins the Mill Stream Lower at Kilcreen.
WF1	Mill Stream Lower	• The mill stream follows the path of the historical River Feale and enters the River Feale at Scartleigh.
WF2	Finuge	• Lies south west of the study area and enters the River Feale at Finuge.
WF3	Coolnaleen - Lower	• Lies south west of the study area and enters the Ballygrenane before it enters the River Feale at Coolnaleen
WF4	Ballygrenane	• Lies south of the study area and enters the River Feale at Finuge
WF5	Garryantanvally	• Lies south of the study area and flows east to west to join the Ballygrenane Stream before it enters the River Feale at Finuge
WF6	Islandganniv - North	• Lies south of the study area and flow east to west to enter the River Feale at Garryantanvally.
WF7	Kilcreen	• Lies in the south of the study area and flows north to enter the River Feale at Islandmacloughry.
WF8	Dromin Lower	• Lies to the east of the study area in the townland of Dromin and Ballinruddery enters the Rive Feale at two locations.
WF9	Dromin Upper	• Lies to the north east of the study are in the townland of Ballygowloge where it enters the River Feale. However, it is likely that this water course is culverted through Listowel as no evidence of this was seen on the surface but the entry point to the River Feale was observed.
WF10	Derra West stream	• Lies to the north east of the study are in the townland of Derra West. It enters the Galey River to the West in the townland of Dromloughra.

2.2 Water Quality

The current Water Framework Directive (WFD) status of the River Feale and its estuary is "good" and neither water body is classed as a heavily modified. The Environmental Protection Agency (EPA) also assesses the water quality of rivers and streams across Ireland using a biological assessment method. The EPA assigns biological river quality (biotic index) ratings from Q5 – Q1 to watercourse sections. Q5 denotes a watercourse with good water quality and high community diversity, whereas Q1 denotes very low community diversity and a bad water quality. There are two monitoring stations in the study area and the status is Moderate (Q3-4).

In addition to regular monitoring carried out by the EPA, baseline water quality monitoring was undertaken for the proposed development in 2013 as part of the EIS at various locations along the River Feale and surrounding watercourses, as shown in Figure 8.1.1-8.1.6 of Volume 3 of the EIS. Where available, these results are compared to the standards in the European Communities Environmental Objective (Surface Water) Regulations, S.I. 272 of 2009. Physico-chemical analysis results for the water samples show few exceedances of the guideline limits and there is no indication of pollution within the watercourses based on the parameters analysed. Suspended solids results are were all under the 25 mg/l annual average [1]for salmonid waters.

Further detail on water quality is provided in Chapter 8; Hydrology, Geomorphology & Hydromorphology in Volume 2 of the EIS.

2.3 Flooding

Listowel Town is one of the areas under assessment in the Shannon Catchment Flood Risk Assessment and Management Study (CFRAMS) and is therefore considered to be potentially at risk from flooding. The OPW have a recorded flood event at Greenville which is in the immediate vicinity of the study area. The OPW have recorded a flood event north of the existing N69 at Curraghatoosane. A Flood Risk Assessment (FRA), in line with the OPW Guidelines for Planning Authorities (GPA) 20: The Planning System and Flood Risk Management (OPW, 2009), has been conducted for the proposed development. Further detail on flooding is provided in Chapter 8; Hydrology, Geomorphology & Hydromorphology in Volume 2 and Appendix 8.2; Detailed Flood Risk Assessment in Volume 4 of the EIS.

2.4 Surface Topography

Overland flow is defined as water flowing over the ground that has yet to enter a drainage channel or similar. It usually occurs as a result of an intense period of rainfall, which exceeds the infiltration capacity of the ground. Typically, overland flow occurs on sloping land where the ground surface is relatively impermeable as a result of either natural conditions such as soil type or geology, or as a result of development which places a large area of impervious material over the ground surface (i.e. paving or roads). In relation to the study area there are limited areas adjacent to the offline section of the proposed development which are hard standing and of low permeability. The majority of the lands adjacent to the offline section of the proposed development are agricultural. Figure 1 below outlines the topography adjacent to the offline sections of the proposed development and demonstrates that the elevation reduces with proximity to the River Feale.

1 S.I. No. 293/1988 European Communities (Quality of Salmonid Waters) Regulations, 1988

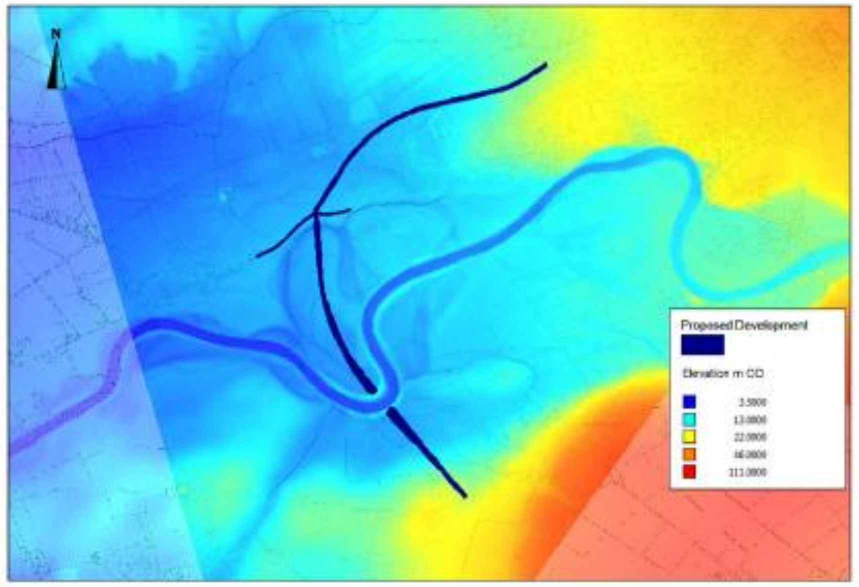

Figure 1 Topography within the study area (Offline sections only)

2.5 Natural Drainage Ways

The proposed development will cross the River Feale and numerous small watercourses as follows, see also Figure 8.1.1-8.1.6 of Volume 3 of the EIS:

- *Between approx. chainage (ch.) 0 and 1550 the proposed development crosses the Ballygrenane watercourse (WF4) at ch.1300, a drainage ditch of the Ballygrenane watercourse (WF5) at ch.1300 and 1400 and the Garryantanvally watercourse at ch.1550 prior to the crossing of the River Feale. Runoff from the area south of the River Feale would make its way to the River Feale via the watercourses crossed by the proposed development.*
- *From approx. ch. 1550 to 1750 the proposed development crosses the River Feale. Runoff from the area surrounding the proposed bridge would make its way directly to the River Feale.*
- *From ch. 1750 to 2700 the proposed development crosses the Mill Stream Lower (WF1) at ch.2700. Runoff from the area north of the River Feale crossing would make its way to the River Feale via the Mill Stream Lower (WF1) or via a low lying area to the east, see Figure 2.*
- *From ch. 2700 to 5000 the proposed development crosses unnamed drainage ditches at 4 locations between ch.3200 and ch.3600. This stream is not hydrologically connected to the Mill Steam Upper (WF0). The proposed road developedment crosses the Mill Stream Upper (WF0) between ch.3800-4000 and crosses a number of drainage ditches of WF0 between ch. 4300 and 4600. Runoff from the area north of tRoundabout 2 would make its way to the River Feale via the Mill Stream Upper and associated unnamed drainage ditches.*
- *From ch. 5000 to 7000 the proposed development is online and does not cross any watercourses. The carriageway runoff from the existing road is believed to discharge through a series of kerbs, gullies and pipes via three main drainage lines until it reaches the River Feale discharging via three outfalls within Listowel Town north of the River Feale. It is not believed that this discharge is attenuated or treated prior to discharge to the River Feale.*

In the location of the works the River Feale has maintained OPW embankments[2] on both its northern and southern banks as seen with the area of higher ground in Figure 2. Therefore, locally runoff in the area is not directly connected to the River Feale and is via a system of local streams which enter the River Feale via a series of flapped outfalls. The drainage paths and approximate connection points with the River Feale are shown in Figure 2 below.

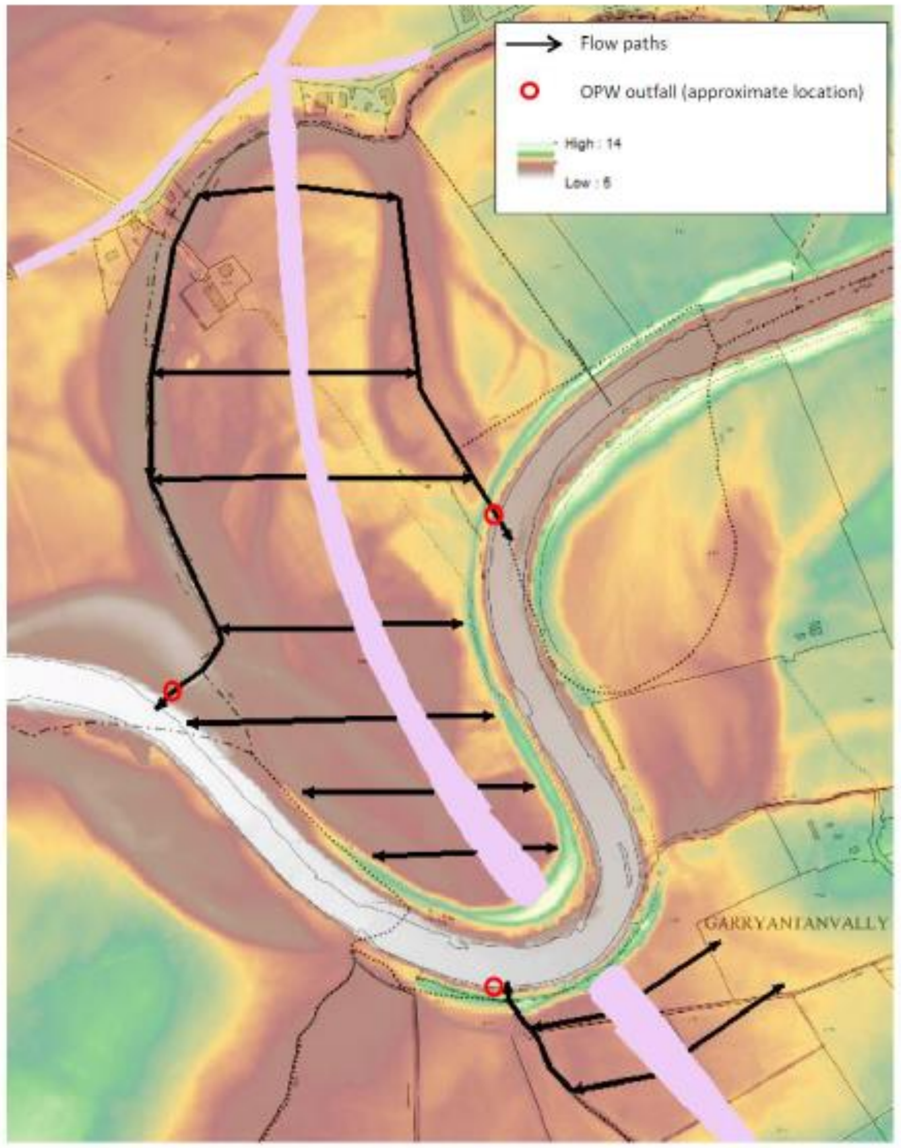

Figure 2 Drainage paths and approximate connection points with the River Feale

[2] Under Section 37 of the Arterial Drainage Act 1945, the OPW is statutorily obliged to maintain all rivers, embankments and urban flood defences on which it has executed works since the 1945 Act

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2.6 Soils

The following information is taken from Chapter 6: Geology, Soils and Hydrogeology of Volume 2 of the EIS and further information on soils and geology are contained within that chapter.

Table 2.2 shows the runoff potential for the different soil classes as indicated in CIRIA C648.

Table 2-2 Soil Classes and Runoff Potential (source: CIRIA C648)

No.	General Description	Runoff Potential
1	Well-drained, sandy, loamy or earthy peat soils	Very low
2	Very permeable soils (e.g. gravel, sand with shallow groundwater or rock)	Low
3	Very fine sands, silts and clays. Permeable soils with shallow groundwater in low-lying areas	Moderate
4	Clayey or loamy soils	High
5	Wet uplands, shallow, rocky soils on steep slopes, peats with impermeable layers at shallow depth	Very High

The ground investigation encountered topsoil, peat deposits, made ground, alluvial deposits and glacial till at the site. Topsoil, including occasional peaty topsoil, was encountered in most of the ground investigation trial pit locations at a thicknesses ranging between 0.1 m – 0.6 m see Figure 7.1.4 to 7.1.7 in Volume 3 of the EIS for borehole (BH) and trial pit (TP) locations.

Alluvial deposits (which comprised gravelly sandy silt and sandy silt over sands and gravels) were encountered in most locations at depths ranging from 0.1 metres below ground level (mbgl) to 6.10 mbgl. The maximum thickness recorded was approximately 5.9 m.

Glacial till was encountered in most of the locations at depths ranging from 0.15 mbgl to 19 mbgl. The maximum thickness recorded was approximately 18.8 m. Occasional limestone boulders were encountered within the glacial till in some locations (BH105D, BH106, BH107D, and BH108D).

From approx. ch. 3000 to 5000 peat deposits were encountered below the topsoil in nine locations (TP22 – TP26, TP28, TP29, TP40 and TP41) at thickness ranging between 0.1 m and 1.49 m.

Made ground, which comprised slightly sandy very gravelly silt and gravelly fine to coarse sand, was encountered in two locations (TP16 and TP27 at thicknesses of 0.2 m and 0.6 m respectively), and was associated with the old railway embankment in TP27. No olfactory evidence of contamination was observed within the made ground or other locations during the ground investigation.

The run-off potential is likely to range from very low to moderate within the study area.

3 Source - Pathway – Receptors

3.1.1 Construction Area Units

The construction works shall proceed within predetermined construction areas on a phased basis. These areas will be determined by the contractor during Phase 5 of the NRA Project Management Guidelines (PMG) and detailed in their dESCP.

3.1.2 Potential Sources of Pollution (including sediment and silt)

The potential pollution sources are outlined below.

Earthworks - The most significant area of concern regarding erosion and sediment control on any road construction project is soil, subsoil and peat surfaces which are exposed during the earthworks operations. Typically these surfaces are exposed during:

- *The initial site clearance works;*
- *Excavation of cut slopes;*
- *Construction of embankments;*
- *Excavation and backfilling of soft spots underneath proposed embankments;*
- *Construction of haul roads for earthworks operations; and*
- *Stockpiling of acceptable, unacceptable and import earthworks material for use, reuse or removal offsite.*

The material to be excavated during the earthworks will include topsoil, peat deposits, made ground, alluvial deposits (largely sand and gravels) and glacial till. Approximately 64,000 m^3 of material will be removed as part of the site topsoil strip works. It is anticipated that most excavated material will be suitable for re-use within the proposed development, either as road embankment or landscaping materials.

The majority of the proposed development is offline between ch. 0 – 5000. The approximate reusable and required earthwork volumes (not including the topsoil strip) for the proposed development are shown in Table 3-1.

Table 3-1 Material Balance

Section	Cut (m^3)	Fill (m^3)	Net (m^3)
Section A	1,693	1,028	-664
Section B	2,143	160,288	158,145
Section C	92	41,380	41,299
Section D	NA	NA	NA
Total	**3,928**	**202,696**	**198,780**

Transportation - The will be a requirement for transportation of plant, personnel and material during the proposed development. This can result in material build-up on the public road system and subsequent sediment laden runoff from the road.

The contractor will be permitted to haul on the National and Regional Road Network including the N69, R553 and R557 in the vicinity of Listowel.

Without the prior agreement of the Local Authority the contractor will not be permitted to haul along other local roads in the vicinity of Listowel. Access for works to construct the realignment of Local Roads will be from the mainline, unless otherwise agreed by the Local Authority. The use of the Greenville Road (L1011) west of the proposed

development may be necessary depending on material sources and would be permitted upon agreement with the Local Authority. In all events the contractor is restricted from hauling along the Forge Road (L10112) or across Finuge Bridge (L6050) as these roads are not suitable for Heavy Good Vehicles (HGVs). Haulage along other local roads as necessary between the location of the source of the material and the permitted routes will be subject to prior agreement with the Local Authority. If the contractor proposes to use the local road network he should be required to assess the environmental impact of same in advance of any agreement.

The proposed development off-line sections would be used as a main haul route during the construction phase. The haul routes will be created by stripping the topsoil and replacing with capping material to create a hard standing surface suitable for heavy goods and off-road vehicles.

Watercourse Crossings - There are numerous minor watercourse crossings (see Section 2.5) associated with this proposed development and one major crossing of the River Feale which is a sensitive watercourse (cSAC, Salmonid and used as a drinking water source). All minor watercourses crossed with the exception of the drainage ditch between at ch. 3200 and 3600 ultimately discharge to the River Feale.

Watercourse Realignment – There are two watercourse realignments required as part of the proposed development as listed below:

- *Upper Mill Stream (WF0) has a realignment of approx. 200 m between ch. 3800-4000; and*
- *Ballygrenanae (WF4) has a realignment of approx. 45 m at ch. 1300.*

Structures & Concrete – There are a number of structures and culverts required for the proposed development as detailed in Table 3-2, full details are provide in Chapter 2 of the EIS. Concrete, grout and other cement-based products which would typically be used in the construction of structures are highly alkaline and corrosive and can have detrimental effect upon water quality if released.

Table 3-2 Structures and Culverts

Structure / Culvert Purpose	Structure Number	Approximate Mainline Chainage (m)	Approximate Dimensions
Accommodation	ST11	1,095	3.5 m wide, 3.0 m high, 20.0 m long
Ballygrenane Stream	ST13	1,270	2.1 m diameter, 20.0 m long
Stream	ST14	1,390	2.1 m diameter, 25.0 m long
Flood Relief Culvert	ST14A	1,395	2.1 m diameter, 25.0 m long
Stream	ST15	1,525	2.1 m diameter, 50.0 m long
Flood Relief Culvert	ST15A	1,530	2.1 m diameter, 50.0 m long
Flood Relief Culvert	ST15B	1,535	2.1 m diameter, 50.0 m long
Flood Relief Culvert	ST15C	1,540	2.1 m diameter, 50.0 m long
River Feale	ST17	1,650	Width of deck = 16.3 m Main span = 69.0 m Back span = 45.0 m
Accommodation	ST18	1,820	4.5 m wide, 4.5 m high (min), 20.0 m long
Accommodation	ST24	2,440	3 m wide, 2.1 m high, 22.5 m long
Flood Relief Culvert	ST27A	2,660	2.1 m diameter, 22.5 m long
Flood Relief Culvert	ST27B	2,663	2.1 m diameter, 22.5 m long
Flood Relief Culvert	ST27C	2,668	2.1 m diameter, 22.5 m long
Mill Stream Lower	ST27	2,670	3.0 m wide, 2.8 m high, 22.5 m long

Structure / Culvert Purpose	Structure Number	Approximate Mainline Chainage (m)	Approximate Dimensions
Flood Relief Culvert	ST27D	2,672	2.1 m diameter, 22.5 m long
Flood Relief Culvert	ST27E	2,677	2.1 m diameter, 22.5 m long
Flood Relief Culvert	ST27F	2,680	2.1 m diameter, 22.5 m long
Mill Stream Upper	ST39	3,880	2.1 m diameter, 35.0 m long
Flood Relief Culvert	C15A-C15J (10 No)	1,410 – 1,580	0.9 m diameter
Flood Relief Culvert	C21, C21A & C21B	2,080 – 2,090	0.9 m diameter
Culvert Ditch	C33A	3,285	0.9 m diameter
Culvert Ditch	C33B*	3,285	0.9 m diameter
Culvert Ditch	C33C	3,010	0.9 m diameter
Flood Relief Culvert	C33D-C33I (6 No)	3,330 – 3,390	0.9 m diameter
Culvert Ditch	C42**	4,240	0.9 m diameter

Structures (ST) and Culverts (C)

Construction Compounds including machinery Re-fuelling/lubrication, Laydown and Material Storage – Construction compounds are a potential source of pollution due to storage of fuels and stockpiles and other material storage and potential vandalism. The construction compound will potentially be located to the Northwest of Listowel in an area of approx. 10,000m^2 to the east of the R533 at Curraghatoosane, see Appendix 1. This is located approx. 500m from the River Feale (at its closest point) but there are some minor watercourses in the vicinity of the compound area. The exact location and construction arrangements will be determined by the contractor during Phase 5 of the NRA PMG, with the agreement of the Local Authority.

3.1.3 Potential Pathways of Pollution

The potential pathway link is the flow path from an area of exposed ground to an adjacent watercourse. This might include for example excavations, sheet flow over the edge of an exposed embankment which subsequently has a route via the ground topography to enter into adjacent land drains discharging to watercourses. Additionally there is potential for pathways to be exacerbated by the potential for flooding which has been identified in some areas including the proposed River Feale Bridge Crossing. In general, potential pathways have been examined based on:

- *An examination of mapped watercourses;*
- *Site Surveys to identify additional ditches not mapped;*
- *An examination of the topography of the area in the vicinity of the proposed development using detailed Digital Terrain Model (DTM) information; and*
- *An examination of the FRA carried out for the proposed development.*

3.1.4 Potential Receptors of Pollution

The key receptor in terms of pollution, erosion and sediment control are:

- *The River Feale which forms part of the Lower Shannon candidate Special Area of Conservation (cSAC),* Figure 8.1.1-8.1.6 of Volume 3 of the EIS*;*
- *Other minor watercourses in the study area that drain to the Rive Feale , see Section 2.1 of this pESCP and Figure* 8.1.1-8.1.6 of Volume 3 of the EIS*;*
- *Aquatic ecology and fisheries particularly associated with the River Feale, see Chapter 6* of Volume 2 of the EIS*; and*
- *The source of raw water for the Dromin water treatment plant is the River Feale, with the abstraction point located a distance of 1.3km from the proposed River Feale Bridge crossing.*

4 Erosion and Sediment Control Measures

4.1 Principal Avoidance Measures

The protection of watercourses from pollution by construction works is achieved by avoidance in the first instance. In this regard, the following avoidance measures will be implemented during the construction phase:

- *Site clearance involving topsoil stripping will not be carried out over large areas in advance resulting in these areas being exposed for long periods of time.*
- *The earthworks construction period will be as short as possible to minimise the length of time that open ground is exposed.*
- *Transportation and journey lengths will be minimised to reduce the opportunity for material to be spilled on the road that could enter the water system via road runoff.*
- *Having an efficient earthworks operation that allows material to be removed and replaced in the minimum amount of time thus reducing the ingress of water into the construction works and reducing the amount of dewatering required.*

4.2 Principal Control Measures

All construction works will be completed in line with the recommendations of the following guidelines:

- *'Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes' (NRA, 2005);*
- *CIRIA C648 Control of Water Pollution from Linear Construction Projects: Technical Guide (Murnane et al. 2006); and*
- *CIRIA C649 Control of Water Pollution from Linear Construction Projects: Site Guide (Murnane et al. 2006); and*
- *'Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors' (CIRIA, 2001).*
- *Inland Fisheries Board Guidance Document (formerly developed by Eastern Fisheries Board) "Requirements for the protection of fisheries habitat during Construction and development works at river Sites";*
- *UK Environment Agency:*
  - *PPG5 Pollution Prevention Guidelines Works and Maintenance in/ or near Water;*
  - *PPG21 Incident Response Planning;*
  - *PPG22 Dealing with Spills; and*
  - *PPG26 Drums and Intermediate Bulk Containers.*

This section outlines the principal control measures that will be provided for the proposed development. The control measures for specific construction tasks and in relation to particular features such watercourse crossings are outlined in Section 4.3 to 4.9.

The Local Authority shall employ an Environmental Assurance Officer (EAO) will form part of the Employer's Site Representative Team. The EAO shall have suitable environmental qualifications.. The Local Authority will ensure that the EAO is delegated sufficient powers under the construction contract so that he/ she will be able to instruct the contractor to stop works and to direct the carrying out of emergency mitigation/ clean-up operations. The EAO will also be responsible for consultation with environmental bodies including the NPWS and IFI. The EAO shall be responsible for carrying out regular monitoring of the Contractor's EOP on behalf of the Local Authority.

Before works commence on site the contractor will prepare an EOP in accordance with the Guidelines for the Creation and Maintenance of an EOP (National Roads Authority, 2007). Responsible personnel and communication lines should be established and documented in the EOP prior to the commencement of on-site works. The EOP will be implemented and maintained by the contractor as a system of documenting compliance with environmental commitments and requirements during the construction of the proposed development.

The contractor will be required to prepare a dESCP for the proposed works. The Plan will be based on and build upon the measures to prevent or reduce the amount of sediment and silt released into watercourses outlined in this pESCP.

The contractor shall consult with the NPWS and IFI in relation to the control measures in the dESCP.

The contractor's detailed method statements shall account for the requirements of the dESCP.

The contractor should ensure that all sub-contractors and site supervisors are aware of the environmental commitments made in relation to the proposed development.

The contractor will liaise with the Kerry Water Services Division and/or Irish Water on a weekly basis for the duration of the following works:

- *Site clearance works, earthworks movements and stockpiling;*
- *Excavations including those associated with the provision of drainage works;*
- *Construction of the River Feale Bridge; and*
- *Construction works within and adjacent to watercourses including provision of culverts and watercourse realignments.*

Contact will be made with the Kerry County Council Water Services and Environment Division and Irish Water immediately in the event of a spillage or other pollution risk to the River Feale. This shall be detailed in the contractor's Emergency Response Plan (ERP) and will include contact names and telephone numbers. The ERP will form part of the overall contractor's EOP.

In-stream works will not be carried out in watercourses frequented by salmon or trout during the Annual Close Season[3]. The duration of the season varies regionally within the period from the beginning of October to the end of February. The timing of these works will be agreed with the IFI, in advance of the works.

4.3 Measures for the Construction Compound(s)

The construction compound are expected to be sited on farmland adjacent to proposed Roundabout 3, this area is the most northerly extent of the proposed development , see Appendix 1. However, the exact location of the construction compounds will be determined by the contractor. The following text describes the control measures that will be put in place for the construction compound(s):

- *The construction compounds will not be located within 100m of the Lower River Shannon cSAC.*
- *The main construction compounds will be located on dry land and set back from waterbodies, and outside of any ecologically sensitive areas and the floodplain.*

3 The River Feale is designated a Salmonid water under S.I. No. 293 of 1988 — European Communities (Quality of Salmonid Waters) Regulations, 1988 and it is considered to be a Nationally important river system for Atlantic salmon and Brown trout

- *The impermeable area within compounds will be minimised to limit surface runoff.*
- *Any watercourses that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5 m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound does not discharge directly to the watercourse.*
- *Storage of fuels, other hydrocarbons and other chemicals within the construction compounds will not be permitted within 50m of a waterbody.*
- *All surface water runoff will be intercepted and directed to treatment systems for the removal of pollutants prior to discharge.*
- *All compounds will have security to deter vandalism, theft and unauthorised access.*

4.4 Measures for Transportation

The following principal controls will be put in place by the contractor with regard to transportation:

- *Construction will be managed by the contractor so as to minimise journey lengths.*
- *Where any excavated material is "wet" and presents a risk of splashing over the top of the trucks, the capacity of the trucks will be limited to 75% of the height of the lowest side of the truck.*
- *HGVs shall be covered, treated or secured to prevent the escape of materials.*
- *HGVs leaving and entering the site will do so via a stabilised construction entrances.*
- *Wheel washing systems will be installed at the exit of the construction compound(s) and all trucks leaving the compound will be required to pass through this facility.*
- *Road cleaning will be carried out at least daily to ensure that there is no build-up of sediment on public roads.*
- *Runoff from the haul route or temporary crossing will be directed to the temporary site drainage system and to the settlement pond (or other) treatment system.*

4.5 Measures for Stockpiling

The following measures will be put in place by the contractor with regard to stockpiling of material:

- *Temporary stockpiles will be located away from drains and watercourses. Stockpiles will not be located within 10m of a non-sensitive watercourse or within 50m of a sensitive watercourse (i.e. the River Feale).*
- *Management of stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be required with the final measures to be determined by the contractor in consultation with the EAO, these may include the following:*
    - *Allowing the establishment of vegetation on the exposed soil.*
    - *Providing silt fences or straw barriers at the toe of the stockpile to mitigate runoff during rain events.*
    - *Surrounding stockpiles with cut-off ditches to contain runoff.*
    - *Directing any runoff to the site drainage system and to the settlement pond (or other) treatment systems.*
    - *Providing earth bunds or another form of diversion to keep runoff from entering the stockpile area.*

4.6 Measures for the Vegetation/Topsoil Strip

The following measures will be put in place by the contractor during the vegetation / topsoil strip:

- *Topsoil stripping over large areas will not be permitted. It will be restricted to the minimum required for efficient earthworks.*
- *Top soil stripping in proximity to the River Feale (at least 200m) will be undertaken as far as practical in dry weather conditions.*
- *Prior to top soil stripping in proximity to the River Feale (within 100m) silt fencing will be placed between the River Feale and the stripping area to prevent siltation of watercourse systems through runoff during rainstorms.*

4.7 Measures for Earthworks

The following measures will be put in place by the contractor during the earthworks:

- *Before earthworks commence the temporary site drainage, erosion control and sediment control measures must be in place and functioning.*
- *As far as is practicable, where treatment measures (e.g. settlement ponds) are being provided they shall be located at the locations identified for the operational stage attenuation/ treatment systems at each of the proposed road drainage outfalls.*
- *Runoff from the earthworks including the embankments will be directed to the temporary site drainage system and to the settlement pond (or other) treatment system.*
- *Provision of exclusion zones and barriers (sediment fences, interceptor drains) between earthworks and watercourses to prevent sediment washing into the watercourses, the contractor will be required to confirm these locations in the dESCP.*
- *Where pumping out of the excavation or any dewatering is necessary water will be directed to the temporary site drainage system and to the settlement pond (or other) treatment system.*
- *In the unlikely event of intercepting contaminated groundwater, the contaminated groundwater will removed off site to a suitably licenced facility.*

4.8 Measures for Working in or Near Watercourses

The proposed development will cross the River Feale and a number of minor watercourses (see Section 2.5), all of which will be culverted beneath the new road. Six drainage outfalls will be required, one within the River Feale and five within minor watercourses. In addition, six attenuation/ treatment ponds will be constructed adjacent to each of these watercourses, prior to the proposed outfalls, see Figure 2.1.1 -2.1.5 of Volume 3 of the EIS.

The following sections outline the control measures that will be put in place to protect these water bodies and any designated/ protected features from pollution events or sediment and silt during construction.

4.8.1 Minor Watercourses - Provision of Temporary Crossing, Culverts, Ponds and Outfalls

There are nine minor watercourses and a number of unnamed drainage ditches in the vicinity of the proposed development. Culverts will be provided for all minor watercourse crossings. The following watercourses will be crossed: Mill Stream Upper (WF0), Mill Stream Lower (WF1), Ballygrenane (WF4) and Garryantanvally (WF5) and a number of unnamed drainage ditches. The following control measures will be implemented during the construction of the proposed development:

- *Works within and adjacent to watercourses will only be conducted during forecast low flow periods.*
- *In-stream works should not be carried out in watercourses frequented by salmon or trout during the Annual Close Season. The duration of the season varies regionally within the period from the beginning of October to the end of February. The timing of works should always be considered on a site specific basis and in agreement with the IFI because some rivers have late spawning salmonids.*
- *Operation of machinery in-stream should be kept to an absolute minimum. All construction machinery operating in-stream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery should be cleaned and checked prior to commencement of in-stream works.*
- *The design of the culverts, outfalls and ponds and the construction method statements for their installation shall be agreed with IFI prior to construction.*
- *The area of disturbance of the watercourse bed and bank will be the absolute minimum required for the installation of the culvert/outfall.*
- *Any dewatering flows directed to the construction drainage system and to the settlement pond (or other) treatment system.*
- *A sediment mat/silt trap or similar will be located immediately downstream of the works within and adjacent to the minor watercourse. These should be inspected daily, maintained and cleaned regularly during the course of site works. This applies to the following locations and works:*
  - *Ballygrenane Watercourse (WF4) - for the installation of haul roads/ temporary watercourse crossings, Culvert ST13, Pond A1 and Outfall A1,* sediment mat *or similar should be placed downstream within the watercourse the as far as practical from the River Feale having regard to the Lands Made Available (LMA).*
  - *Garryantanvally Watercourse (WF5) - for the installation of haul roads/ temporary watercourse crossings, Culvert ST15, Pond A2 and Outfall A2,* sediment mat *or similar should be placed downstream within the watercourse prior to the confluence with the Ballygrenane Watercourse having regard to the LMA.*
  - *Mill Stream Lower (WF1) - for the installation of haul roads/ temporary watercourse crossings, Culvert ST27, Pond A4 and Outfall A1,* sediment mat *should be placed as far as practical from the River Feale having regard to the LMA.*
  - *Drainage Ditch west of the Mill Stream Upper (WF0) (but not hydrologically connected to the Mill Stream) - for the installation of haul roads/ temporary watercourse crossings, Culvert C34, C33A-C, Pond A5 and Outfall A5.*
  - *Mill Stream Upper (WF0) - for the installation of haul roads/ temporary watercourse crossings, Culvert ST39, Pond A6 and Outfall A6,* sediment mat *should be placed as far as practical from the River Feale having regard to the LMA.*
- *Subject to the agreement of the OPW additional silt control measures (sediment mat or similar) will be placed in the Mill Stream Lower (WF1) and in the Garryantanvally (WF5) for the duration of the works in the location of the OPW flapped outfalls prior to their confluence with the River Feale.*

4.8.2 Watercourse Realignments - Minor Watercourses

Watercourse realignments are proposed for the Mill Stream Upper (WF0) and Ballygrenane (WF4). In addition to the principal control measures described in Section 4.8.1, the following control measures will be implemented during the watercourse realignments:

- *Channel realignments will be minimised as far as possible to reduce the exposure of bare ground, reducing the amount of fine sediment released into the channel.*
- *The design of the watercourse realignments and construction method statements for their installation shall be agreed with IFI prior to construction.*
- *The creation of the new watercourse channels should be carried out in the dry, in isolation from the existing watercourses.*
- *Diversion of water to and from temporary or permanent channels should only take place during the period March to September or as agreed with the IFI.*
- *Small check dams will be constructed in the cut-off watercourse to trap any sediment and a sediment trap will be provided immediately downstream of the diversion to existing watercourses.*
- *Where in-stream bed material is to be removed, coarse aggregates, if present, should be stockpiled at least 10 m away from the watercourse for replacement in the reformed or new channel.*

4.8.3 River Feale - Bridge Crossing & Provision of Ponds/Outfalls

The River Feale is the main surface water feature within the study area and is considered sensitive. The proposed development will require the installation of a bridge structure over the River Feale. In addition, there is a requirement to provide an attenuation/treatment pond A3 and associated direct outfall A3 to the River Feale, see Figure 2.1.1 -2.1.5 of Volume 3 of the EIS.

The principal control measures described in above sections will be applicable to construction works in and adjacent to the River Feale. In addition, the following text describes measures that are specific to the River Feale.

Before works commence on site drainage, erosion control and sediment control measures must be in place and functioning.

The construction of outfall A3 in the River Feale will be undertaken in the dry to avoid sediment entering the river. To facilitate this construction a small cofferdam will be constructed using an impermeable material (to be specified by the contractor). There is still likely to be some level of water ingress thereforethis water will be removed using a water pump and directed to the temporary site drainage system and to the settlement pond (or other) treatment system prior to discharge. The cofferdam will be removed carefully and prior to removal a silt curtain will be installed around the perimeter of the cofferdam to prevent any disturbed material from entering the River Feale.

Appendix 2 of this plan outlines the River Feale temporary work and the River Feale Bridge construction sequencing. There will be a requirement to remove ground material in order to install the southern abutment however, a high point will remain between the construction area and the River Feale and this will act as a barrier to sediment between the southern abutment (near ch. 1600) and the River Feale. In addition a silt fence will be placed between the southern pier construction area and the River Feale.

The construction of the norther pier and abutment (near ch. 1700) of the River Feale Bridge crossing is expected to require the following elements; however, it is noted that the final bridge design and construction sequencing will be up to the appointed construction contractor:

- *The installation of temporary sheet piles on the northern bank to allow for the installation of the northern pier wall to enable the pier construction;*
- *Excavation behind temporary sheet piles*
- *Piling to bedrock for the installation of the north and south abutment and the northern pier;*
- *Casting of the northern pier and abutment;*
- *Ground profiling on the northern bank of the river to allow for crane access;*
- *Placement of bridge beams;*
- *Casting of the bridge deck and diaphragm; and*
- *Backfilling and finishes for the bridge.*

The northern pier (near ch. 1700) which is located within the cSAC will be constructed during low flow periods to minimise the risk of water pollution, as per the consultation response from IFI. A temporary impervious barrier will be installed prior to any excavation works to ensure that there is no hydraulic connectivity between the temporary works area and the River Feale during construction. In addition, this barrier will protect all works associated with the bridge pier construction at the River Feale against a 1:100 year return period flood event, see Appendix 2. In addition, a silt fence will be placed (prior to the installation of the impervious barrier) between the northern pier construction area and the River Feale. The temporary impervious barrier will be removed carefully and the silt fence will remain in place post removal until the area has been stabilised. This will prevent any disturbed material from entering the River Feale

Where bank material including gravel is to be removed it should be stockpiled at least 50m away from the River Feale.

The river banks, above and below the crossing, should not be disturbed unless directly associated with the bridge/ road structure. The extent of bank-side interference and vegetation removal should be agreed, identified, documented and demarcated with appropriate fencing in advance of undertaking any construction works.

The River Feale in the location of the works has flood embankments managed by the OPW to the north and south therefore, local runoff in the area is not directly connected to the River Feale, runoff in the area flows into a system of local back drains before flowing into the River Feale via flapped outfalls. To act as a second level of defence during the construction works the contractor with the agreement of the OPW will install sediment trap/mats or similar upstream of these outfalls.

4.9 Measures for Concrete Works

The use and management of concrete in or close to watercourses must be carefully controlled to avoid spillage. The following control measures will be employed to reduce the risks associated with concreting works near or within watercourses:

- *Only precast concrete pipes/ units will be used in the installation of the culverts.*
- *Pouring of concrete should be carried out in the dry and allowed to cure for 48 hours before re-flooding.*
- *Pumped concrete will be monitored to ensure no accidental discharge into the watercourse.*
- *Mixer washings and excess concrete will not be discharged to surface water.*
- *Cement will be stored temporarily on site within the contractors' compounds.*
- *Hydrophilic grout and quick-setting mixes or rapid hardener additives shall be used to promote the early set of concrete surfaces exposed to water.*
- *Care will be exercised when slewing concrete skips or mobile concrete pumps over or near surface waters.*
- *Placing of concrete in or near watercourses will be carried out in consultation with the EAO.*
- *Any concrete spills will be contained immediately.*
- *Concrete waste and wash-down water will be contained and managed on site to prevent pollution of surface watercourses.*
- *On-site concrete batching and mixing activities will not be allowed within 50 m of the Rive Feale.*
- *Washout from lorries, with the exception of the chute, will not be permitted on site.*
- *Chute washout will be carried out at designated locations only. These washout locations will be signposted. The concrete plant and all delivery drivers will be informed of their location both within the order information and upon arrival on site.*
- *The designated chute washout locations will be on an impermeable surface and treatment facilities will be provided, including adequately sized settlement tanks. The water from the settlement tanks shall be pH corrected prior to discharge or alternatively disposed of as waste in accordance with the contractor's Waste Management Plan (WMP) included in the EOP.*
- *A temporary impervious barrier will be installed to ensure that there is no hydraulic connectivity between the temporary works and the River Feale during construction. This will prevent cement from the piling works entering this watercourse.*

5 Monitoring and Audit

5.1 Introduction

A monitoring programme will be required at the pre-construction and construction stage.

This pESCP will be developed by the contractor into the dESCP and will form part of the EOP. The dESCP will be sent to the IFI for approval. In addition, consultation on the dESCP will be carried out with the NPWS. The minimum requirements shall include all of the controls, measures, mitigation and monitoring described in this document. The monitoring of all aspects of the EOP, including the dESCP, will be carried out by the contractor as the responsible party. The responsibilities of the Employer will be discharged by the Employer's Site Representative Team and in particular the EAO.

5.2 Monitoring and Audit

5.2.1 General

Pre-construction Monitoring

Pre-construction water quality monitoring will be undertaken once a week for a 6 month period, prior to the commencement of the construction works. Samples will be taken for total suspended solids (TSS), turbidity, pH, temperature, dissolved oxygen (DO) and hydrocarbons up and downstream of the proposed crossing points (River Feale, Mill Stream Upper, Mill Stream Lower, Ballygrenane and Garryantanvally) to build upon the baseline monitoring carried out at the EIA stage and in order to further establish the baseline water quality conditions prior to construction. Samples for turbidity, pH, DO and temperature will be taken in situ; samples for TSS and hydrocarbons will be sent to an accredited laboratory for analysis.

Construction Monitoring

Weekly during construction the construction contractor will monitor the levels of TSS, turbidity, pH, temperature, DO and hydrocarbons at the same locations up and down stream once a week for the duration of the following works:

- *Site clearance works, earthworks movements and stockpiling;*
- *Excavations including those associated with the provision of drainage works;*
- *Construction of the River Feale Bridge; and*
- *Construction works within and adjacent to watercourses including provision of culverts and watercourse realignments.*

The construction monitoring results will be compared with those results established in pre-construction monitoring. In the event of an elevation above pre-construction levels an investigation will be undertaken by the contractor and remediation measure will be put in place if it is ascertained that the works have caused the elevation.

In addition, real-time telemetric monitoring will be used by the contractor to measure turbidity up and down stream of the River Feale Crossing. The turbidity level recorded downstream shall not exceed the upstream level by 10%. In the event of an exceedance, an investigation will be carried out to determine the cause and contact will be made with the Kerry Water Services and the Irish Water Environment Division immediately.

In addition, daily visual inspections of the surface drainage and sediment control measures and the watercourses will be undertaken by the contractor. Indicators that water pollution may have occurred include the following:

- *Change in water colour;*
- *Change in water transparency;*
- *Increases in the level of silt in the water;*
- *Oily sheen to water surface;*
- *Floating detritus; or*
- *Scums and foams.*

These inspections shall be recorded. In the event that such indicators are observed, notify the EAO, who may instruct works to cease. Sampling will be immediately undertaken as described for the weekly monitoring and an investigation of the potential cause will be undertaken by the contractor in consultation with the EAO.

Where the works are identified as the source causing the exceedance the following will apply:

- *Contact will be made with the EAO Kerry Water Services and/ or Irish Water, the NPWS and IFI.*
- *Works capable of generating sediment and all discharges shall be stopped immediately.*
- *The contractor will be required to take immediate action to implement measures to ensure that such discharges do not re-occur.*

The above monitoring will alert the contractor to any detrimental effects that particular construction activities may be having on water quality in order that appropriate remedial action can be taken as quickly as possible; and allow the contractor to demonstrate the success of the mitigation measures employed in maintaining any sediment release within the trigger values established.

5.2.2 Contractor

The procedures, monitoring and audit regime outlined in this section shall be used by the contractor to ensure and demonstrate the effective operation of the avoidance, control and mitigation measures for sediment and silt control. It will help the contractor to target any issues that may arise.

The following are the main procedures that will be followed:

- *The contractor will undertake a full day training course for all site staff immediately before works commence on site on the EOP, and in particular the dESCP.*
- *Environmental Checklists shall be prepared for each operation. Responsibility or completion of these checklists will be assigned to individual members of the contractor's staff. The following operations will also require an Approval -to –Work before operations can commence. These must be counter signed by the EAO:*
  - *Any in-stream works;*
  - *Placing of concrete in or within 50m of watercourse*
  - *Completion of sediment removal facilities prior to initial discharge to watercourse*
  - *Restart of works following any pollution incident.*

- *All environmental monitoring and checklists shall be recorded and added to the EOP on a daily basis.*
- *The EOP shall assign particular responsibility and monitoring duties to particular named staff and the Site Agent/ Manager shall ensure that this is implemented in full. Training for each member of staff on their specific area of responsibility shall be carried out before the commencement of that operation. A record of all training carried out shall be maintained in the EOP and a further copy issued to the EAO.*
- *Monitoring shall be undertaken as described in Section 5.2.1.*
- *All mitigation/ control measures shall be inspected daily by designated contractor staff and maintenance and repairs carried out immediately.*

5.2.3 Environmental Assurance Officer (EAO)

Separate from the on-going and detailed monitoring carried out by the contractor as part of the EOP; the EAO shall carry out the inspection/ monitoring regime described below on behalf of the employer. The results will be stored in the EAO's monitoring file and will be available for inspection/ audit by the client, NPWS or IFI staff. All inspections/ monitoring/ results will be recorded on standard forms.

- *Inspect the Principal Control Measures on a weekly basis. Report findings to the Contractor.*
- *Inspect surface water treatment measures (ponds, silt fences, sandbags etc.) on a daily basis and obtain turbidity readings.*
- *Inspect all outfalls to watercourses on a daily basis and obtain turbidity readings. Where excavation, pumping out or concreting works are on-going in the vicinity obtain turbidity readings three times per day.*
- *Daily visual inspection of watercourses to which there is a discharge from the works and those where there is construction works in the vicinity.*
- *Wheel wash facilities shall be inspected on a weekly basis.*
- *Stockpiles shall be monitored on a daily basis while being filled or emptied, and otherwise on a weekly basis.*
- *Control measures for works at or near water bodies shall be inspected on a daily basis.*
- *Concrete operations at or near watercourses shall be supervised and designated chute washing point facilities shall be inspected on a daily basis.*
- *All site compounds shall be inspected on a weekly basis.*
- *The contractor's EOP monitoring results shall be audited on a frequent basis (six times per quarter at a minimum).*
- *Any and all exceedance of the investigatory level for turbidity shall be reported to the NPWS and IFI and shall be investigated thoroughly by the EAO and the contractor.*
- *Where the EAO considers that the risk of a sediment release is high, he/ she shall inform the contractor and request protective action to be taken. Where the contractor does not take immediate action the EAO shall instruct the contractor to take action and this shall be reported to the Contract Manager and the Client.*
- *The EAO will be delegated powers under the contract sufficient for these instructions to be issued and for an instruction to stop works or carry out emergency works.*

6 Emergency Procedures

6.1 Introduction

Prior to commencing the works, the Contractor shall prepare an Emergency Response Plan (ERP) based on a thorough risk assessment. The ERP shall detail the procedures to be undertaken in the event of the release of any sediment into a watercourse, serious spillage of chemical, fuel or other hazardous wastes (e.g. concrete), non-compliance incident with any permit or licence, or other such risks that could lead to a pollution incident, including flood risks.

6.2 Resources and Training

Relevant staff shall be trained in the implementation of the ERP and the use of any spill kit/ control equipment, as necessary. The contractor shall provide a list of all such staff to the Employer's Site Representative detailing the name, contact number and training received, and the date of the training.

The Contractor shall provide a full list, including the exact locations, of all pollution control plant and equipment to the Employer's Site Representative. All such plant and equipment shall be maintained in place and in working order for the duration of the works.

The following training measures will be carried out to prepare site personnel for pollution/ impact control:

- *Training to raise environmental awareness and pollution control awareness during inductions and toolbox talks.*
- *Comprehensive training in emergency response and spill management for key personnel.*
- *Training of an emergency response team to carryout both reactive and proactive mitigation on pollution control. This team will carry out other duties but their primary role will be environmental response.*
- *Environmental Emergency Response Drills will be carried out at a minimum of every six months.*

6.3 Spill Response

The ERP shall include a simplified Spill Response Procedure with the following as a minimum:

- *Instruction to stop work;*
- *Instruction to contain the spill;*
- *Details of spill clean-up material location;*
- *Name and contact details of all responsible staff;*
- *Measures particular to the location and the activity;*
- *Instruction to contact the EAO (including Name and Contact Details).*

This Spill Response Procedure shall be displayed at several locations throughout the site and at all sensitive locations.

Emergency equipment/spill kits to facilitate the implementation of the ERP will be made available in secured locations within the area.

The EAO shall decide on whether or not the NPWS/ IFI should be notified and shall also determine if and when works may proceed once corrective actions have been completed.

The main objectives of the ERP are as follows:

- *Identify the personnel required to take control of an environmental incident.*
- *Maintain a state of preparedness to prevent or reduce negative impacts on the environment as a result of an environmental incident on the site.*
- *Provide factual and timely communications to employees, regulatory authorities/prescribed bodies and the public (if required) during an incident.*

7 References

- Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes' (NRA, 2005).
- CIRIA C648 Control of Water Pollution from Linear Construction Projects: Technical Guide (Murnane et al. 2006).
- CIRIA C649 Control of Water Pollution from Linear Construction Projects: Site Guide (Murnane et al. 2006).
- Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan: National Roads Authority (NRA, 2007).
- Inland Fisheries Board Guidance Document (formerly developed by Eastern Fisheries Board) "Requirements for the protection of fisheries habitat during Construction and development works at river Sites.
- N69 Listowel Bypass Environmental Impact Statement.
- Other EIS's for similar projects.

8 Appendices

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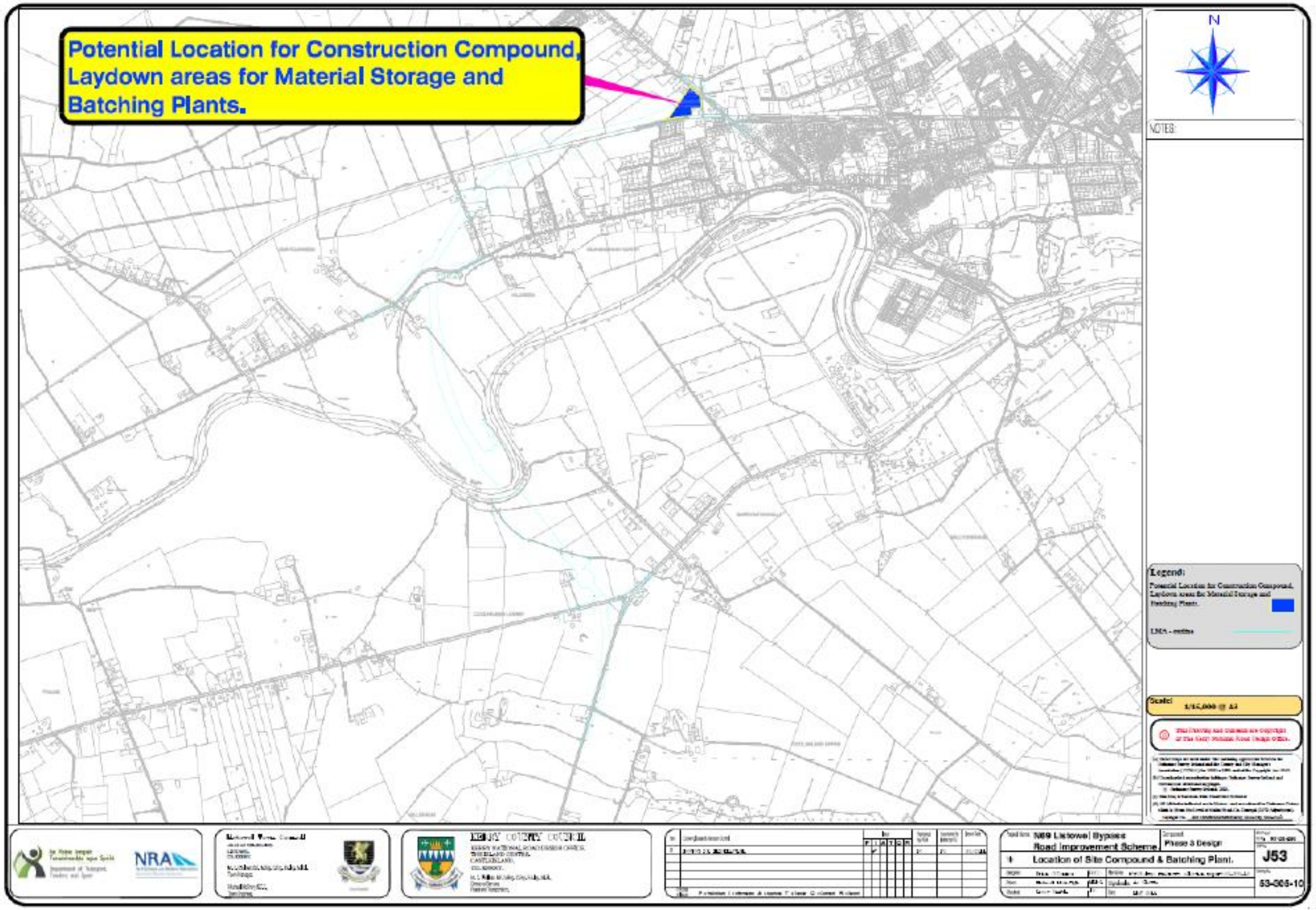
Appendix 1: Potential Construction Compound Location

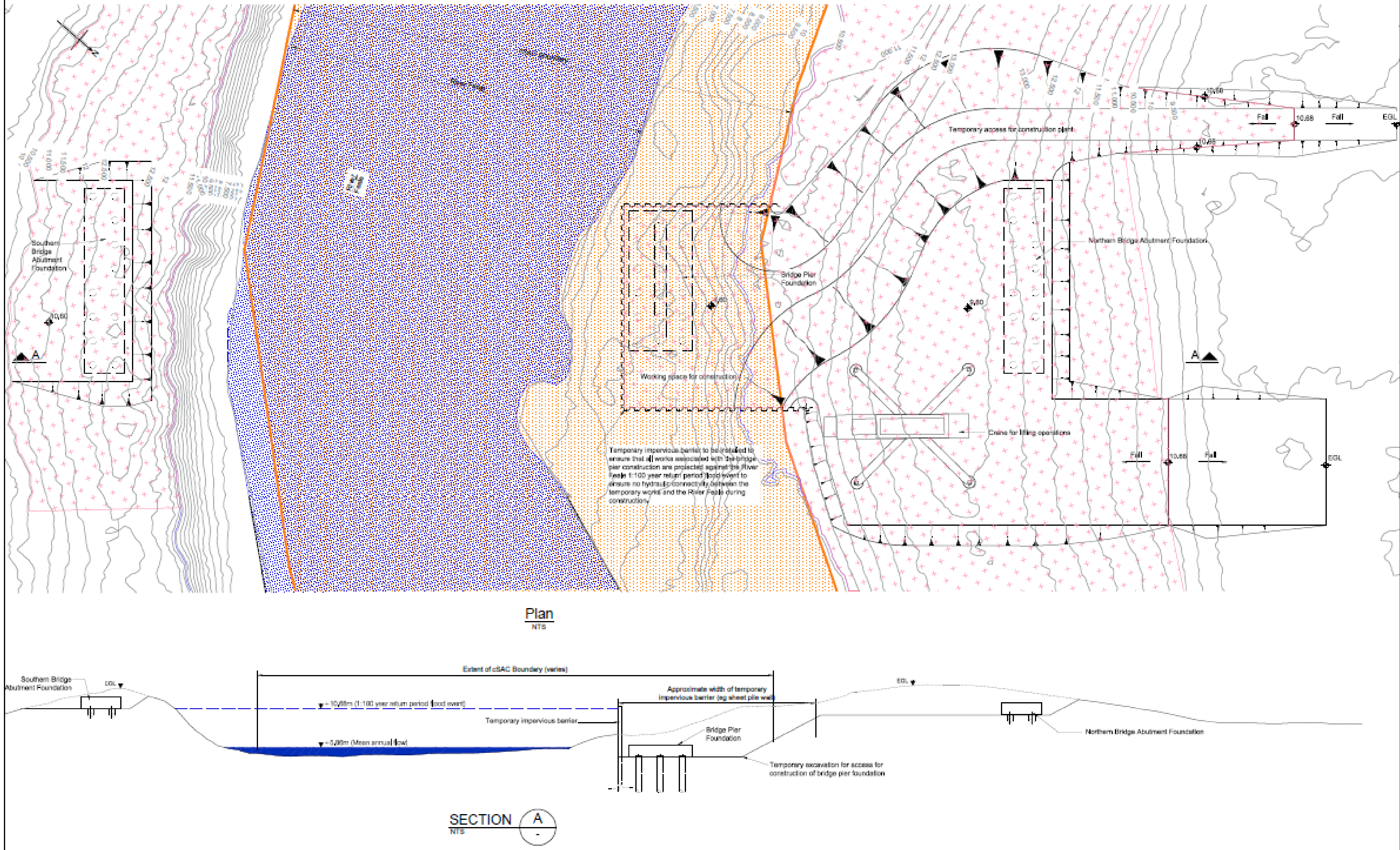

Potential Location for Construction Compound, Laydown areas for Material Storage and Batching Plants.
N
NOTES:
Legend:
Scale:
N69 Listowel Bypass
Road Improvement Scheme
Phase 3 Design
Location of Site Compound & Batching Plant.
J53
53-305-10
NRA

19

Appendix 2: River Feale - Temporary Works and Bridge Construction Sequencing

Drawing Number

32105301/NIS/Figure 8



NOTES:

- cSAC Boundary
- Temporaray Works Zone for River Feale Bridge construction above or protected from River Feale 1:100 year return period flood event.

All details shown on this drawing are indicitative only and are subject to development at detailed design stage.

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TII Bonneagar Iompair Éireann / Transport Infrastructure Ireland

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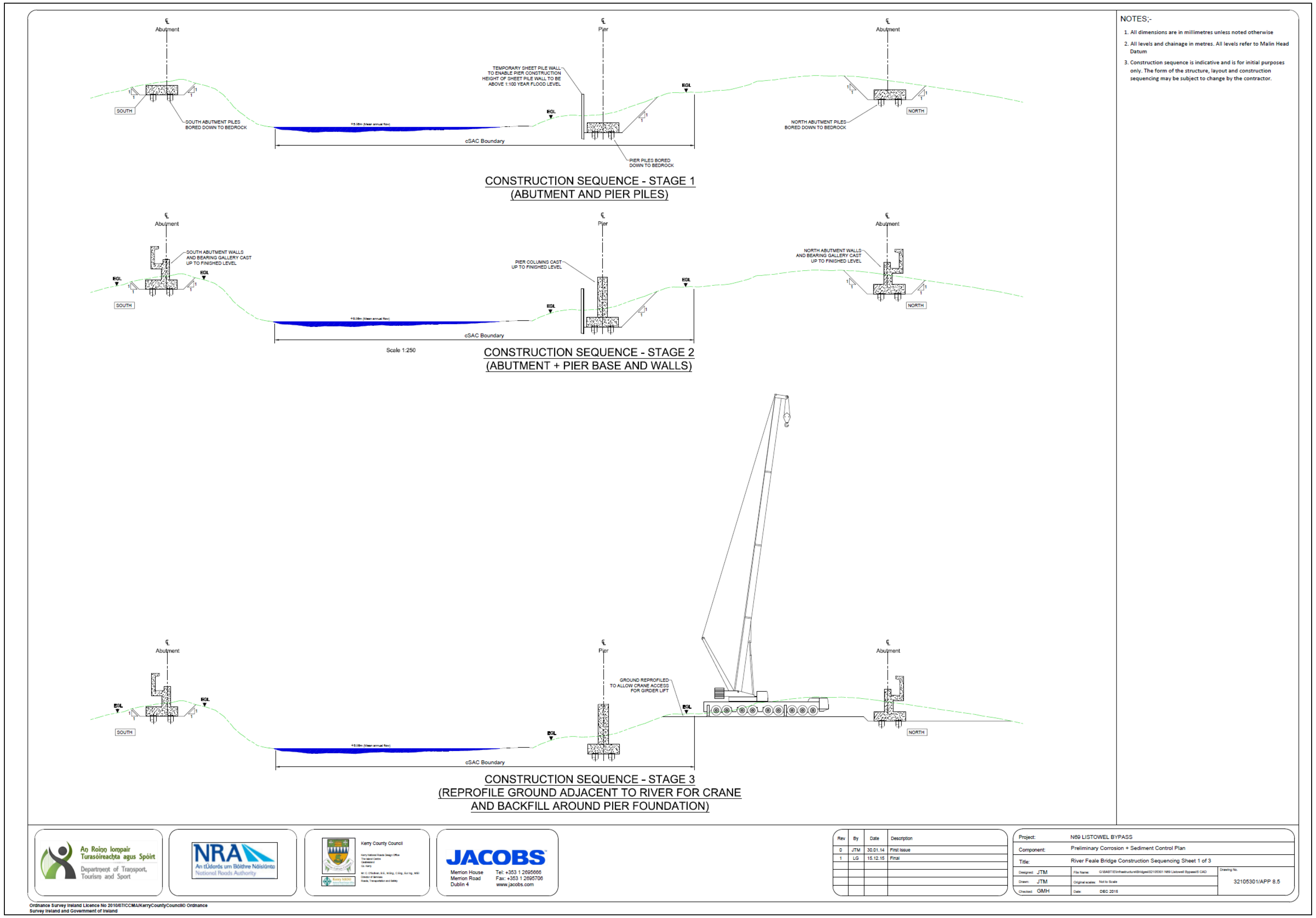
Rev	By	Date	Description
0	JTM	April 2017	For Publication

Project:	N69 LISTOWEL BYPASS
Component:	Natura Impact Statement
Title:	River Feale Temporary Works
Designed: JTM	File Name:
Drawn: MW	Original scale: NTS
Checked: GMH	Date: August 2014
Drawing No.	32105301/NIS/Fig 8



Abutment
Pier
Abutment
TEMPORARY SHEET PILE WALL TO ENABLE PIER CONSTRUCTION HEIGHT OF SHEET PILE WALL TO BE ABOVE 1:100 YEAR FLOOD LEVEL
SOUTH
NORTH
SOUTH ABUTMENT PILES BORED DOWN TO BEDROCK
NORTH ABUTMENT PILES BORED DOWN TO BEDROCK
cSAC Boundary
PIER PILES BORED DOWN TO BEDROCK
CONSTRUCTION SEQUENCE - STAGE 1
(ABUTMENT AND PIER PILES)
SOUTH ABUTMENT WALLS AND BEARING GALLERY CAST UP TO FINISHED LEVEL
PIER COLUMNS CAST UP TO FINISHED LEVEL
NORTH ABUTMENT WALLS AND BEARING GALLERY CAST UP TO FINISHED LEVEL
Scale 1:250
CONSTRUCTION SEQUENCE - STAGE 2
(ABUTMENT + PIER BASE AND WALLS)
GROUND REPROFILED TO ALLOW CRANE ACCESS FOR GIRDER LIFT
CONSTRUCTION SEQUENCE - STAGE 3
(REPROFILE GROUND ADJACENT TO RIVER FOR CRANE
AND BACKFILL AROUND PIER FOUNDATION)
NOTES;-
1. All dimensions are in millimetres unless noted otherwise
2. All levels and chainage in metres. All levels refer to Malin Head Datum
3. Construction sequence is indicative and is for initial purposes only. The form of the structure, layout and construction sequencing may be subject to change by the contractor.
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0 | JTM | 30.01.14 | First Issue
1 | LG | 15.12.15 | Final
Project: N69 LISTOWEL BYPASS
Component: Preliminary Corrosion + Sediment Control Plan
Title: River Feale Bridge Construction Sequencing Sheet 1 of 3
Designed: JTM
Drawn: JTM
Checked: GMH
File Name: G:\BABTIE\Infrastructure\Bridges\32105301 N69 Listowel Bypass\5 CAD
Original scales: Not to Scale
Date: DEC 2015
Drawing No. 32105301/APP 8.5
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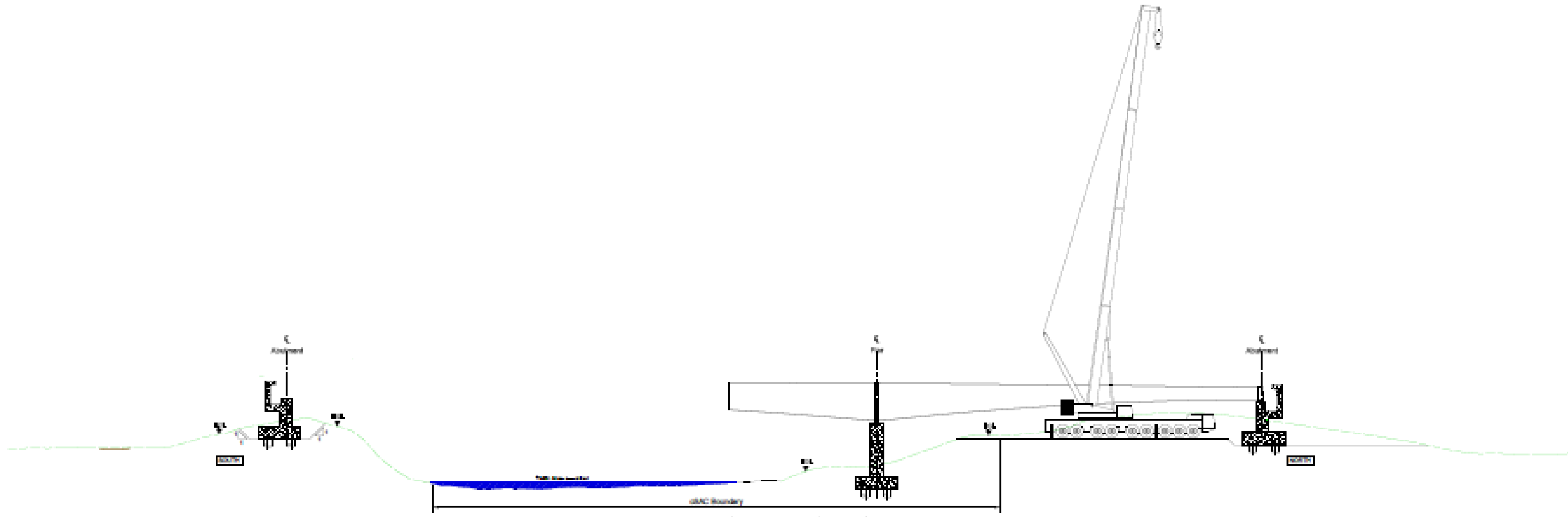
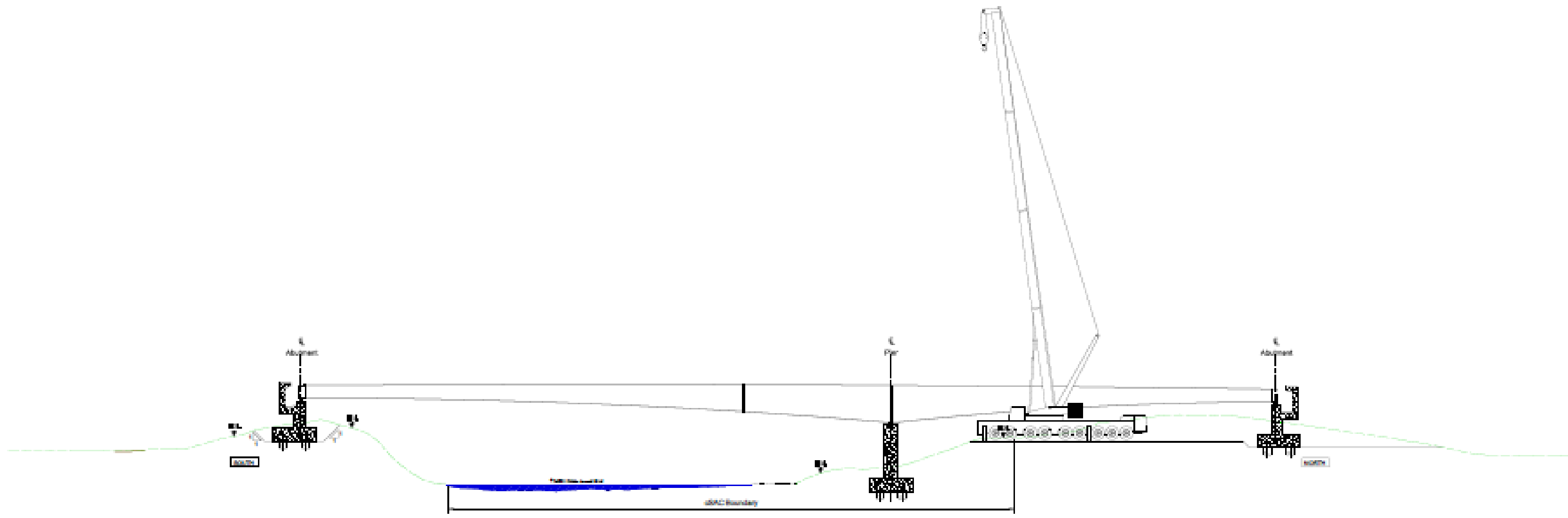


CONSTRUCTION SEQUENCE - STAGE 4
(6 BEAMS IN BRACED PAIRS LANDED BETWEEN PIER AND NORTH ABUTMENT)



CONSTRUCTION SEQUENCE - STAGE 5
(6 BEAMS IN BRACED PAIRS LANDED BETWEEN PIER AND SOUTH ABUTMENT)

NOTES:-

1. All dimensions are in millimetres unless noted otherwise
2. All levels and chainage in metres. All levels refer to Malin Head Datum
3. Construction sequence is indicative and is for initial purposes only. The form of the structure, layout and construction sequencing may be subject to change by the contractor.

Rev	By	Date	Description
0	JTM	30.01.14	First Issue
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Component: Preliminary Corrosion + Sediment Control Plan
Title: River Feale Bridge Construction Sequencing Sheet 2 of 3
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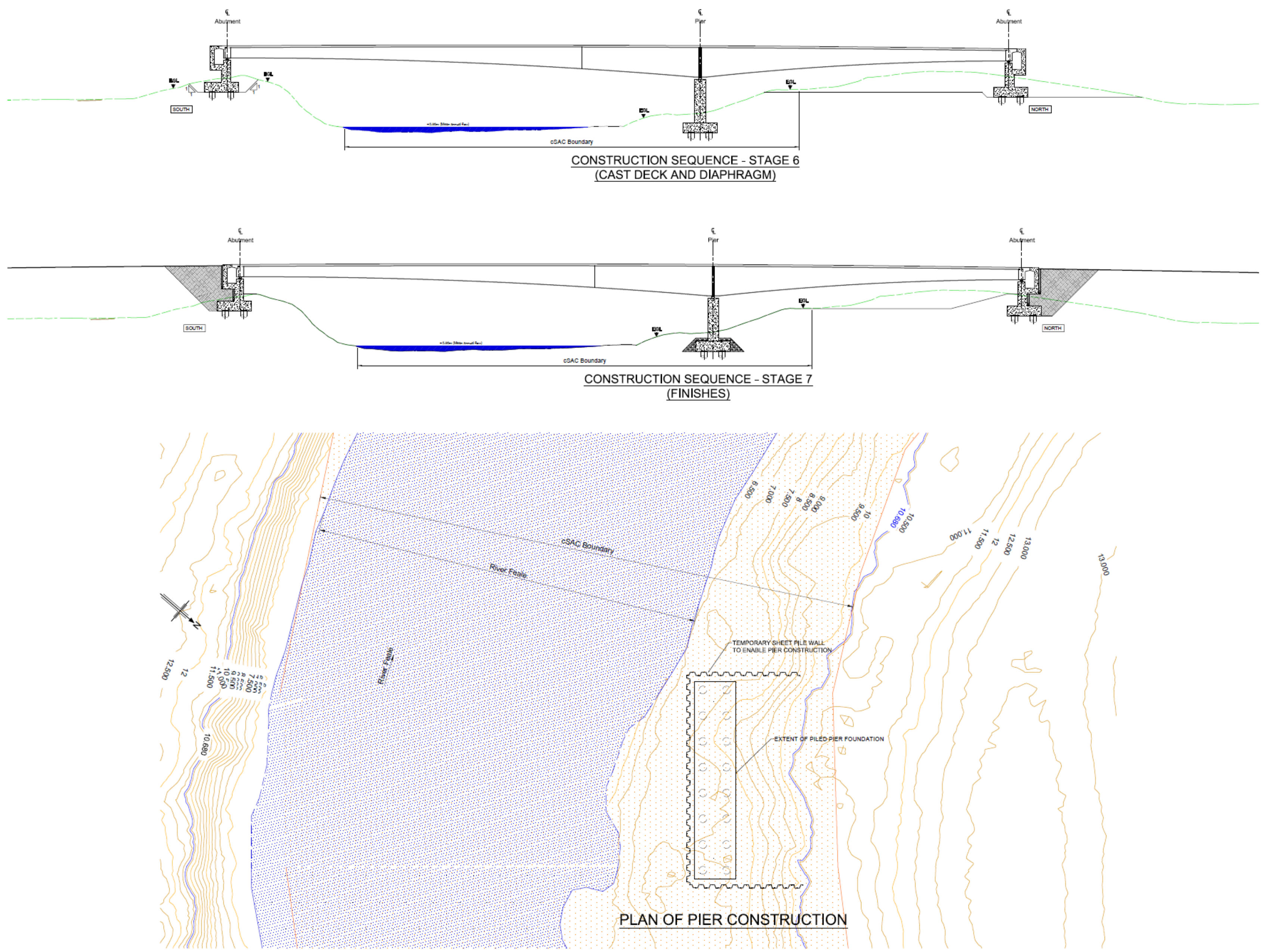

NOTES;-

1. All dimensions are in millimetres unless noted otherwise
2. All levels and chainage in metres. All levels refer to Malin Head Datum
3. Construction sequence is indicative and is for initial purposes only. The form of the structure, layout and construction sequencing may be subject to change by the contractor.

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1	LG	15.12.15	Final

Project:	N69 LISTOWEL BYPASS
Component:	Preliminary Corrosion + Sediment Control Plan
Title:	River Feale Bridge Construction Sequencing Sheet 3 of 3
Designed: JTM	File Name: G:\BABTIE\Infrastructure\Bridges\32105301 N69 Listowel Bypass\5 CAD
Drawn: JTM	Original scales: Not to Scale
Checked: GMH	Date: DEC 2015
Drawing No.	32105301/APP 8.7

Appendix 9.1 Ambient Air Quality Standards

National standards for ambient air pollutants in Ireland have generally ensued from Council Directives enacted in the EU (& previously the EC & EEC). The initial interest in ambient air pollution legislation in the EU dates from the early 1980s and was in response to the most serious pollutant problems at that time. In response to the problem of acid rain, sulphur dioxide and later nitrogen dioxide, were the focus of EU legislation. Linked to the acid rain problem was urban smog associated with fuel burning for space heating purposes. Also apparent at this time were the problems caused by leaded petrol and EU legislation was introduced to deal with this problem in the early 1980s.

In recent years the EU has focused on defining a basis strategy across the EU in relation to ambient air quality. In 1996, a Framework Directive, Council Directive 96/62/EC, on ambient air quality assessment and management was enacted. The aims of the Directive are fourfold. Firstly, the Directive's aim is to establish objectives for ambient air quality designed to avoid harmful effects to health. Secondly, the Directive aims to assess ambient air quality on the basis of common methods and criteria throughout the EU. Additionally, it is aimed to make information on air quality available to the public via alert thresholds and fourthly, it aims to maintain air quality where it is good and improve it in other cases.

As part of these measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, Council Directive 1999/30/EC, was passed into Irish Law as S.I. No 271 of 2002 (Air Quality Standards Regulations 2002), and has set limit values which came into operation on 17th June 2002. The Air Quality Standards Regulations 2002 detail margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance varies from 60% for lead, to 30% for 24-hour limit value for PM10, 40% for the hourly and annual limit value for NO2 and 26% for hourly SO2 limit values. The margin of tolerance commenced from June 2002, and started to reduce from 1 January 2003 and does so every 12 months by equal annual percentages to reach 0% by the attainment date. A second daughter directive, EU Council Directive 2000/69/EC, details limit values for both carbon monoxide and benzene in ambient air. This has also been passed into Irish Law under the Air Quality Standards Regulations 2002.

The most recent EU Council Directive on ambient air quality was published on the 11/06/08. Council Directive 2008/50/EC combines the previous Air Quality Framework Directive and its subsequent daughter directives. This has also been passed into Irish Law under the Air Quality Standards Regulations 2011 (S.I. 180 of 2011). Provisions were also made for the inclusion of new ambient limit values relating to PM2.5. In regards to existing ambient air quality standards, it is not proposed to modify the standards but to strengthen existing provisions to ensure that non-compliances are removed. In addition, new ambient standards for PM2.5 are included in Directive 2008/50/EC. The approach for PM2.5 is to establish a target value of 25 µg/m3, as an annual average (to be attained everywhere by 2010) and a limit value of 25 µg/m3, as an annual average (to be attained everywhere by 2015), coupled with a target to reduce human exposure generally to PM2.5 between 2010 and 2020. This exposure reduction target will range from 0% (for PM2.5 concentrations of less than 8.5 µg/m3 to 20% of the average exposure indicator (AEI) for concentrations of between 18 - 22 µg/m3. Where the AEI is currently greater than 22 µg/m3 all appropriate measures should be employed to reduce this level to 18 µg/m3 by 2020. The AEI is based on measurements taken in urban background locations averaged over a three year period from 2008-2010 and again from 2018-2020. Additionally, an exposure concentration obligation of 20 µg/m3 has been set to be complied with by 2015, again based on the AEI.

Although the EU Air Quality Limit Values are the basis of legislation, other thresholds outlined by the EU Directives are used which are triggers for particular actions. The Alert Threshold is defined in Council Directive 2008/50/EC as "a level beyond which there is a risk to human health from brief exposure and at which immediate steps shall be taken as laid down in Directive 2008/50/EC". These steps include undertaking to ensure that the necessary steps are taken to inform the public (e.g. by means of radio, television and the press).

The Margin of Tolerance is defined in Council Directive 2008/50/EC as a concentration which is higher than the limit value when legislation comes into force. It decreases to meet the limit value by the attainment date. The Upper Assessment Threshold is defined in Council Directive 2008/50/EC as a concentration above which high quality measurement is mandatory. Data from measurement may be supplemented by information from other sources, including air quality modelling.

An annual average limit for both NOx (NO and NO2) is applicable for the protection of vegetation in highly rural areas away from major sources of NOx such as large conurbations, factories and high road vehicle activity such as a dual carriageway or motorway. Annex III of EU Directive 2008/50/EC identifies that monitoring to demonstrate compliance with the NOX limit for the protection of vegetation should be carried out distances greater than:

5 km from the nearest motorway or dual carriageway
5 km from the nearest major industrial installation
20 km from a major urban conurbation

As a guideline, a monitoring station should be indicative of approximately 1000 km2 of surrounding area.

Under the terms of EU Framework Directive on Ambient Air Quality (96/62/EC), geographical areas within member states have been classified in terms of zones. The zones have been defined in order to meet the criteria for air quality monitoring, assessment and management as described in the Framework Directive and Daughter Directives. Zone A is defined as Dublin and its environs, Zone B is defined as Cork City, Zone C is defined as 21 urban areas with a population greater than 15,000 and Zone D is defined as the remainder of the country. The Zones were defined based on among other things, population and existing ambient air quality.

EU Council Directive 96/62/EC on ambient air quality and assessment has been adopted into Irish Legislation (S.I. No. 33 of 1999). The act has designated the Environmental Protection Agency (EPA) as the competent authority responsible for the implementation of the Directive and for assessing ambient air quality in the State. Other commonly referenced ambient air quality standards include the World Health Organisation. The WHO guidelines differ from air quality standards in that they are primarily set to protect public health from the effects of air pollution. Air quality standards, however, are air quality guidelines recommended by governments, for which additional factors, such as socio-economic factors, may be considered.

Air Dispersion Modelling
The inputs to the DMRB model consist of information on road layouts, receptor locations, annual average daily traffic movements, annual average traffic speeds and background concentrations(A1). Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptor using generic meteorological data.

The DMRB underwent an extensive validation exercise(A2) as part of the UK's Review and Assessment Process to designate areas as Air Quality Management Areas (AQMAs).

The validation exercise was carried out at 12 monitoring sites within the UK DEFRAs national air quality monitoring network. The validation exercise was carried out for NOx, NO2 and PM10, and included urban background and kerbside/roadside locations, “open” and “confined” settings and a variety of geographical locations(A2).

In relation to NO2, the model generally over-predicts concentrations, with a greater degree of over-prediction at “open” site locations. The performance of the model with respect to NO2 mirrors that of NOx showing that the over-prediction is due to NOx calculations rather than the NOx:NO2 conversion. Within most urban situations, the model overestimates annual mean NO2 concentrations by between 0 to 40% at confined locations and by 20 to 60% at open locations. The performance is considered comparable with that of sophisticated dispersion models when applied to situations where specific local validation corrections have not been carried out.

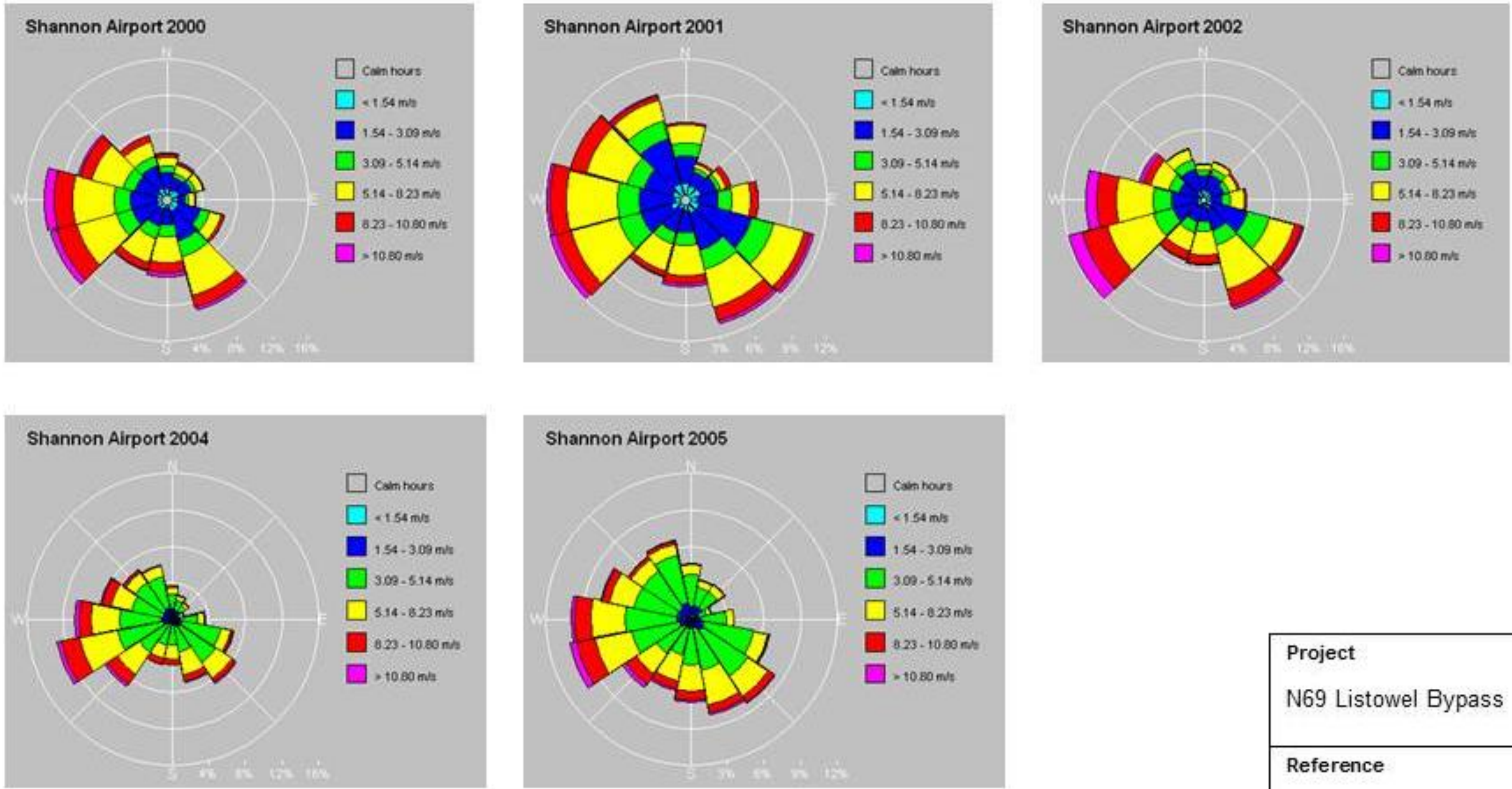
The model also tends to over-predict PM10. Within most urban situations, the model will over-estimate annual mean PM10 concentrations by between 20 to 40%. The performance is comparable to more sophisticated models, which, if not validated locally, can be expected to predict concentrations within the range of ±50%.

Thus, the validation exercise has confirmed that the model is a useful screening tool for the Second Stage Review and Assessment, for which a conservative approach is applicable(A2).

References

(A1) UK DEFRA (2007) Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1 - HA207/07 (Document & Calculation Spreadsheet)

(A2) UK DEFRA (2001) DMRB Model Validation for the Purposes of Review and Assessment



Project

N69 Listowel Bypass

Reference

13/6553AR02

Figure 8.1

Shannon Airport Windrose 2000 – 2002, 2004 and 2005

awnconsulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
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Appendix 9.3 Dust Minimisation Measures

Dust Minimisation Plan

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within two hundred metres of the construction area.

In order to ensure mitigation of the effects of dust nuisance, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions.

Vehicles using site roads shall have their speeds restricted where there is a potential for dust generation. Vehicles delivering material with dust potential to an off-site location shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust.

Vehicles exiting the site shall make use of a wheel wash facility where appropriate, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods. At all times, the procedures put in place will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, satisfactory procedures will be implemented to rectify the problem.

The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

Vehicles using site roads shall have their speeds restricted where there is a potential for dust generation. Vehicles delivering material with dust potential to an off-site location shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust.

Vehicles exiting the site shall make use of a wheel wash facility where appropriate, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

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The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

Appendix 10.1 Receiver Locations

Receiver Location Reference	First Floor Dwelling Height	Second Floor Dwelling Height	Approximate Ground Height (m)	Grid Reference	
				E	N
R001	1.5	4	23	497.553	631.455
R002	1.5	4	24	497.588	631.504
R003	1.5	4	36	497.866	631.411
R004	1.5	4	22	497.731	631.995
R004b	1.5	4	23	497.741	631.993
R005	1.5	4	24	497.789	631.993
R006	1.5	4	21	497.545	631.931
R007	1.5	4	21	497.800	632.072
R008	1.5	4	22	497.877	632.154
R009	1.5	4	19	497.485	632.068
R010	1.5	4	13	497.784	632.346
R011	1.5	4	13	497.740	632.394
R012	1.5	4	13	497.668	632.435
R013	1.5	4	12	497.541	632.607
R014	1.5	4	10	496.813	633.278
R015	1.5	4	10	496.746	633.353
R016	1.5	4	10	496.700	633.321
R017	1.5	4	10	496.986	633.468
R018	1.5	4	10	497.083	633.560
R019	1.5	4	10	497.076	633.581
R020	1.5	4	10	497.040	633.656
R021	1.5	4	10	497.092	633.665
R022	1.5	4	10	497,085	633,690
R023	1.5	4	10	497.081	633.719
R024	1.5	4	10	497.063	633.748
R025	1.5	4	10	496.986	633.817
R026	1.5	4	10	496.993	633.900
R027	1.5	4	10	496.953	633.896
R028	1.5	4	11	497.343	633.902
R029	1.5	4	11	497.353	633.880
R030	1.5	4	11	497.352	633.829
R031	1.5	4	11	497.331	633.772
R032	1.5	4	10	497.294	633.750
R033	1.5	4	10	497.290	633.693
R034	1.5	4	15	497.740	633.986
R035	1.5	4	16	497.790	633.994
R036	1.5	4	17	497.844	634.011
R037	1.5	4	17	497.881	634.066
R038	1.5	4	18	497.924	634.077
R039	1.5	4	17	497.925	634.110
R040	1.5	4	17	497.921	634.132
R041	1.5	4	17	497.919	634.151
R042	1.5	4	18	497.952	634.161
R043	1.5	4	18	497.993	634.171
R044	1.5	4	19	498.081	634.221
R045	1.5	4	20	498.128	634.229
R046	1.5	4	20	498.071	634.172
R047	1.5	4	18	498.024	634.309
R048	1.5	4	18	498.090	634.365
R049	1.5	4	18	497.934	634.391
R050	1.5	4	21	498.187	634.223
R051	1.5	4	22	498.202	634.173
R052	1.5	4	23	498.279	634.161
R053	1.5	4	23	498.305	634.140
R054	1.5	4	22	498.338	634.123
R055	1.5	4	22	498.392	634.141
R056	1.5	4	22	498.423	634.152
R057	1.5	4	22	498.476	634.156
R058	1.5	4	22	498.516	634.154
R059	1.5	4	22	498.550	634.155
R060	1.5	4	23	498.610	634.157
R061	1.5	4	23	498.645	634.154
R062	1.5	4	23	498.661	634.154
R063	1.5	4	23	498.690	634.153
R064	1.5	4	24	498.712	634.154
R065	1.5	4	24	498.723	634.147
R066	1.5	4	25	498.744	634.175
R067	1.5	4	25	498.760	634.175
R068	1.5	4	25	498.784	634.175
R069	1.5	4	24	498.737	634.136
R070	1.5	4	25	498.780	634.137
R071	1.5	4	25	498.808	634.147
R072	1.5	4	25	498.817	634.173
R073	1.5	4	26	498.835	634.149
R074	1.5	4	26	498.858	634.174
R075	1.5	4	26	498.861	634.152
R076	1.5	4	26	498.874	634.174
R077	1.5	4	26	498.873	634.155
R078	1.5	4	26	498.890	634.211
R079	1.5	4	26	498.857	634.216
R080	1.5	4	27	498.945	634.219
R081	1.5	4	27	498.962	634.134
R082	1.5	4	28	499.047	634.166
R083	1.5	4	28	499.055	634.171
R084	1.5	4	28	499.071	634.172
R085	1.5	4	30	499.232	634.177
R086	1.5	4	31	499.266	634.177
R087	1.5	4	32	499.300	634.175
R088	1.5	4	32	499.343	634.173
R089	1.5	4	33	499.382	634.205
R090	1.5	4	33	499.429	634.205

R091	1.5	4	32	499.407	634.173
R092	1.5	4	33	499.468	634.205
R093	1.5	4	34	499.503	634.205
R094	1.5	4	33	499.559	634.165
R095	1.5	4	34	499.566	634.194
R096	1.5	4	34	499.607	634.157
R097	1.5	4	35	499.642	634.197
R098	1.5	4	35	499.645	634.164
R099	1.5	4	35	499.659	634.188
R100	1.5	4	34	499.671	634.141
R100b	1.5	4	35	499.679	634.140
R101	1.5	4	35	499.739	634.142
R102	1.5	4	36	499.757	634.183
R103	1.5	4	37	499.815	634.178
R104	1.5	4	37	499.793	634.131
R105	1.5	4	38	499.844	634.150
R106	1.5	4	37	499.824	634.107

R107	1.5	4	39	499.881	634.083
R108	1.5	4	38	499.878	634.159
R109	1.5	4	40	499.918	634.081
R110	1.5	4	40	499.942	634.121
R111	1.5	4	43	500.020	634.097
R112	1.5	4	41	499.928	634.035
R113	1.5	4	43	499.989	634.017
R113b	1.5	4	44	499.997	634.001
R114	1.5	4	43	500.037	634.059
R115	1.5	4	44	500.026	634.002
R115b	1.5	4	44	500.029	634.011
R116	1.5	4	46	500.101	634.001
R116b	1.5	4	46	500.105	633.998
R117	1.5	4	44	500.049	633.957
R117b	1.5	4	44	500.033	633.958

Appendix 10.2a Predicted Noise Levels (Pre Mitigation)

Receiver Location Reference	Opening Year 2017		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Predicted Noise Level						Predicted Noise Level						
	Do Minimum	Do Something					Do Minimum	Do Something					
	Lden (dB)	Lden (dB)	(a)	(b)	(c)		Lden (dB)	Lden (dB)	(a)	(b)	(c)		
R001_A	66	64	Yes	No	No	No	67	65	Yes	No	No	No	
R001_B	67	66	Yes	No	No	No	68	66	Yes	No	No	No	
R002_A	70	69	Yes	No	No	No	71	70	Yes	No	No	No	
R002_B	72	71	Yes	No	No	No	72	72	Yes	No	No	No	
R003_A	52	51	No	No	Yes	No	53	52	No	No	Yes	No	
R003_B	53	52	No	No	Yes	No	54	53	No	No	Yes	No	
R004e_A	69	63	Yes	No	No	No	70	64	Yes	No	No	No	
R004e_B	71	64	Yes	No	No	No	71	65	Yes	No	No	No	
R004w_A	62	65	Yes	Yes	No	No	63	66	Yes	Yes	No	No	
R004w_B	63	67	Yes	Yes	No	No	65	68	Yes	Yes	No	No	
R005_A	67	60	No	No	No	No	67	61	Yes	No	Yes	No	
R005_B	68	61	Yes	No	No	No	69	62	Yes	No	No	No	
R006_A	58	60	No	Yes	Yes	No	59	61	Yes	Yes	Yes	No	
R006_B	59	61	Yes	Yes	Yes	**Yes**	60	62	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R007_A	66	64	Yes	No	No	No	67	65	Yes	No	No	No	
R007_B	68	66	Yes	No	No	No	68	67	Yes	No	No	No	
R008_A	67	64	Yes	No	No	No	68	65	Yes	No	No	No	
R008_B	69	66	Yes	No	No	No	70	67	Yes	No	No	No	
R009_A	53	55	No	Yes	Yes	No	54	56	No	Yes	Yes	No	
R009_B	54	57	No	Yes	Yes	No	55	58	No	Yes	Yes	No	
R010_A	51	50	No	No	Yes	No	52	51	No	No	Yes	No	
R010_B	52	52	No	No	Yes	No	53	53	No	No	Yes	No	
R011_A	48	51	No	Yes	Yes	No	49	52	No	Yes	Yes	No	
R011_B	50	53	No	Yes	Yes	No	51	54	No	Yes	Yes	No	
R012_A	49	53	No	Yes	Yes	No	50	54	No	Yes	Yes	No	
R012_B	50	54	No	Yes	Yes	No	51	55	No	Yes	Yes	No	
R013_A	48	53	No	Yes	Yes	No	49	54	No	Yes	Yes	No	
R013_B	49	53	No	Yes	Yes	No	50	55	No	Yes	Yes	No	
R014_A	45	58	No	Yes	Yes	No	46	60	No	Yes	Yes	No	
R014_B	46	59	No	Yes	Yes	No	47	61	Yes	Yes	Yes	No	
R015_A	50	57	No	Yes	Yes	No	50	59	No	Yes	Yes	No	
R015_B	51	58	No	Yes	Yes	No	52	60	No	Yes	Yes	No	
R016_A	53	55	No	Yes	Yes	No	54	56	No	Yes	Yes	No	
R016_B	54	56	No	Yes	Yes	No	55	58	No	Yes	Yes	No	
R017_A	53	54	No	No	Yes	No	54	56	No	Yes	Yes	No	
R017_B	54	55	No	No	Yes	No	55	57	No	Yes	Yes	No	
R018_A	54	54	No	No	Yes	No	55	57	No	Yes	Yes	No	
R018_B	56	56	No	No	Yes	No	57	59	No	Yes	Yes	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level Do Minimum	Do Something	NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032 Predicted Noise Level Do Minimum	Do Something	NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Lden (dB)	Lden (dB)	(a)	(b)	(c)		Lden (dB)	Lden (dB)	(a)	(b)	(c)		
R019_A	48	53	No	Yes	Yes	No	49	55	No	Yes	Yes	No	
R019_B	50	54	No	Yes	Yes	No	51	56	No	Yes	Yes	No	
R020_A	44	57	No	Yes	Yes	No	45	58	No	Yes	Yes	No	
R020_B	46	58	No	Yes	Yes	No	47	59	No	Yes	Yes	No	
R021_A	42	53	No	Yes	Yes	No	43	55	No	Yes	Yes	No	
R021_B	44	54	No	Yes	Yes	No	45	56	No	Yes	Yes	No	
R022_A	41	54	No	Yes	Yes	No	42	56	No	Yes	Yes	No	
R022_B	43	55	No	Yes	Yes	No	44	57	No	Yes	Yes	No	
R023_A	42	56	No	Yes	Yes	No	42	57	No	Yes	Yes	No	
R023_B	44	57	No	Yes	Yes	No	45	58	No	Yes	Yes	No	
R024_A	44	58	No	Yes	Yes	No	45	60	No	Yes	Yes	No	
R024_B	46	60	No	Yes	Yes	No	46	61	Yes	Yes	Yes	No	
R025_A	44	59	No	Yes	Yes	No	44	61	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R025_B	45	61	Yes	Yes	Yes	No	46	63	Yes	Yes	Yes	No	
R026_A	43	56	No	Yes	Yes	No	44	58	No	Yes	Yes	No	
R026_B	44	57	No	Yes	Yes	No	45	59	No	Yes	Yes	No	
R027_A	42	52	No	Yes	Yes	No	43	54	No	Yes	Yes	No	
R027_B	44	54	No	Yes	Yes	No	44	56	No	Yes	Yes	No	
R028_A	39	53	No	Yes	Yes	No	40	54	No	Yes	Yes	No	
R028_B	42	54	No	Yes	Yes	No	42	56	No	Yes	Yes	No	
R029_A	40	51	No	Yes	Yes	No	41	52	No	Yes	Yes	No	
R029_B	43	52	No	Yes	Yes	No	44	54	No	Yes	Yes	No	
R030_A	41	51	No	Yes	Yes	No	42	53	No	Yes	Yes	No	
R030_B	43	53	No	Yes	Yes	No	44	54	No	Yes	Yes	No	
R031_A	39	50	No	Yes	Yes	No	40	52	No	Yes	Yes	No	
R031_B	41	51	No	Yes	Yes	No	42	53	No	Yes	Yes	No	
R032_A	38	50	No	Yes	Yes	No	39	52	No	Yes	Yes	No	
R032_B	41	51	No	Yes	Yes	No	42	53	No	Yes	Yes	No	
R033_A	39	48	No	Yes	Yes	No	40	50	No	Yes	Yes	No	
R033_B	41	49	No	Yes	Yes	No	42	51	No	Yes	Yes	No	
R034_A	42	53	No	Yes	Yes	No	43	54	No	Yes	Yes	No	
R034_B	44	54	No	Yes	Yes	No	45	55	No	Yes	Yes	No	
R035_A	43	52	No	Yes	Yes	No	45	54	No	Yes	Yes	No	
R035_B	44	53	No	Yes	Yes	No	46	55	No	Yes	Yes	No	
R036_A	42	53	No	Yes	Yes	No	44	55	No	Yes	Yes	No	
R036_B	44	54	No	Yes	Yes	No	45	55	No	Yes	Yes	No	
R037_A	43	55	No	Yes	Yes	No	44	56	No	Yes	Yes	No	
R037_B	44	56	No	Yes	Yes	No	46	57	No	Yes	Yes	No	
R038_A	43	54	No	Yes	Yes	No	44	55	No	Yes	Yes	No	
R038_B	45	55	No	Yes	Yes	No	46	56	No	Yes	Yes	No	
R039_A	41	55	No	Yes	Yes	No	42	57	No	Yes	Yes	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Do Minimum Lden (dB)	Do Something Lden (dB)	(a)	(b)	(c)		Do Minimum Lden (dB)	Do Something Lden (dB)	(a)	(b)	(c)		
R039_B	44	56	No	Yes	Yes	No	45	58	No	Yes	Yes	No	
R040_A	42	57	No	Yes	Yes	No	43	59	No	Yes	Yes	No	
R040_B	44	58	No	Yes	Yes	No	45	60	No	Yes	Yes	No	
R041_A	44	61	Yes	Yes	Yes	No	45	62	Yes	Yes	Yes	No	
R041_B	45	62	Yes	Yes	Yes	**Yes**	47	63	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R042_A	46	61	Yes	Yes	Yes	No	47	62	Yes	Yes	Yes	No	
R042_B	47	62	Yes	Yes	Yes	**Yes**	49	63	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R043_A	47	60	No	Yes	Yes	No	49	61	Yes	Yes	Yes	No	
R043_B	49	61	Yes	Yes	Yes	**Yes**	50	62	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R044_A	52	59	No	Yes	Yes	No	54	61	Yes	Yes	Yes	No	
R044_B	54	60	No	Yes	Yes	No	55	62	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R045_A	60	64	Yes	Yes	Yes	**Yes**	62	65	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R045_B	62	65	Yes	Yes	Yes	No	63	66	Yes	Yes	Yes	No	
R046_A	48	54	No	Yes	Yes	No	50	56	No	Yes	Yes	No	
R046_B	50	56	No	Yes	Yes	No	51	57	No	Yes	Yes	No	
R047_A	60	62	Yes	Yes	Yes	**Yes**	61	63	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R047_B	61	63	Yes	Yes	Yes	No	62	65	Yes	Yes	Yes	No	
R048_A	55	57	No	Yes	Yes	No	57	58	No	Yes	Yes	No	
R048_B	57	58	No	Yes	Yes	No	58	60	No	Yes	Yes	No	
R049_A	57	58	No	Yes	Yes	No	58	59	No	Yes	Yes	No	
R049_B	60	61	Yes	No	No	No	62	62	Yes	No	No	No	
R050_A	59	63	Yes	Yes	Yes	**Yes**	61	64	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R050_B	62	66	Yes	Yes	Yes	No	64	68	Yes	Yes	Yes	No	
R051_A	61	63	Yes	Yes	Yes	No	62	65	Yes	Yes	Yes	No	
R051_B	63	66	Yes	Yes	Yes	**Yes**	64	67	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R052_A	58	61	Yes	Yes	Yes	**Yes**	60	63	Yes	Yes	Yes	**Yes**	Mitigation requirement confirmed
R052_B	62	66	Yes	Yes	Yes	No	64	67	Yes	Yes	Yes	No	
R053_A	52	54	No	Yes	Yes	No	54	55	No	Yes	Yes	No	
R053_B	55	57	No	Yes	Yes	No	57	58	No	Yes	Yes	No	
R054_A	51	52	No	Yes	Yes	No	52	54	No	Yes	Yes	No	
R054_B	55	56	No	No	Yes	No	56	57	No	No	Yes	No	
R055_A	58	59	No	No	Yes	No	59	60	No	No	Yes	No	
R055_B	61	62	Yes	No	Yes	No	62	63	Yes	No	Yes	No	
R056_A	59	60	No	No	Yes	No	60	61	Yes	No	Yes	No	
R056_B	63	64	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R057_A	60	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R057_B	65	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R058_A	59	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R058_B	64	65	Yes	No	Yes	No	66	66	Yes	No	Yes	No	
R059_A	60	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R059_B	65	65	Yes	No	Yes	No	67	67	Yes	No	Yes	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level Do Minimum	Opening Year 2017 Predicted Noise Level Do Something	NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032 Predicted Noise Level Do Minimum	Design Year 2032 Predicted Noise Level Do Something	NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Lden (dB)	Lden (dB)	(a)	(b)	(c)		Lden (dB)	Lden (dB)	(a)	(b)	(c)		
R060_A	60	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R060_B	65	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R061_A	55	56	No	No	Yes	No	57	57	No	No	Yes	No	
R061_B	60	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R062_A	58	59	No	No	Yes	No	60	60	No	No	Yes	No	
R062_B	63	64	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R063_A	58	59	No	No	Yes	No	60	60	No	No	Yes	No	
R063_B	63	63	Yes	No	Yes	No	64	64	Yes	No	Yes	No	
R064_A	57	58	No	No	Yes	No	59	59	No	No	Yes	No	
R064_B	61	62	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R065_A	55	55	No	No	Yes	No	57	57	No	No	Yes	No	
R065_B	58	58	No	No	Yes	No	59	59	No	No	Yes	No	
R066_A	65	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R066_B	66	67	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R067_A	65	65	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R067_B	66	66	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R068_A	64	65	Yes	No	Yes	No	66	66	Yes	No	Yes	No	
R068_B	66	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R069_A	51	51	No	No	Yes	No	52	52	No	No	Yes	No	
R069_B	53	53	No	No	Yes	No	54	54	No	No	Yes	No	
R070_A	55	56	No	No	Yes	No	57	57	No	No	Yes	No	
R070_B	57	57	No	No	Yes	No	58	59	No	No	Yes	No	
R071_A	56	56	No	No	Yes	No	57	57	No	No	Yes	No	
R071_B	59	60	No	No	Yes	No	60	61	Yes	No	Yes	No	
R072_A	65	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R072_B	66	67	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R073_A	56	56	No	No	Yes	No	57	58	No	No	Yes	No	
R073_B	59	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R074_A	64	65	Yes	No	Yes	No	66	66	Yes	No	Yes	No	
R074_B	66	66	Yes	No	Yes	No	67	68	Yes	No	Yes	No	
R075_A	54	55	No	Yes	Yes	No	56	56	No	No	Yes	No	
R075_B	58	58	No	No	Yes	No	60	59	No	No	Yes	No	
R076_A	64	65	Yes	No	Yes	No	66	66	Yes	No	Yes	No	
R076_B	66	66	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R077_A	56	58	No	Yes	Yes	No	58	59	No	No	Yes	No	
R077_B	62	64	Yes	Yes	Yes	**Yes**	64	65	Yes	Yes	Yes	**Yes**	
R078_A	62	61	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R078_B	63	63	Yes	No	Yes	No	64	64	Yes	No	Yes	No	
R079_A	55	55	No	No	Yes	No	57	57	No	No	Yes	No	
R079_B	57	57	No	No	Yes	No	58	58	No	No	Yes	No	
R080_A	62	62	Yes	No	Yes	No	64	64	Yes	No	Yes	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Do Minimum	Do Something					Do Minimum	Do Something					
	Lden (dB)	Lden (dB)	(a)	(b)	(c)		Lden (dB)	Lden (dB)	(a)	(b)	(c)		
R080_B	64	63	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R081_A	67	65	Yes	No	No	No	68	66	Yes	No	No	No	
R081_B	68	66	Yes	No	No	No	69	67	Yes	No	No	No	
R082_A	56	57	No	No	Yes	No	58	58	No	No	Yes	No	
R082_B	61	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R083_A	58	58	No	No	Yes	No	59	60	No	No	Yes	No	
R083_B	64	64	Yes	No	Yes	No	65	66	Yes	No	Yes	No	
R084_A	59	59	No	No	Yes	No	60	61	Yes	No	Yes	No	
R084_B	65	65	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R085_A	60	60	No	No	Yes	No	62	62	Yes	No	Yes	No	
R085_B	67	67	Yes	No	Yes	No	69	69	Yes	No	Yes	No	
R086_A	60	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R086_B	68	68	Yes	No	Yes	No	70	69	Yes	No	Yes	No	
R087_A	64	64	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R087_B	67	67	Yes	No	Yes	No	69	69	Yes	No	Yes	No	
R088_A	59	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R088_B	66	66	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R089_A	58	58	No	No	Yes	No	59	59	No	No	Yes	No	
R089_B	63	63	Yes	No	Yes	No	64	65	Yes	No	Yes	No	
R090_A	58	58	No	No	Yes	No	59	59	No	No	Yes	No	
R090_B	63	63	Yes	No	Yes	No	64	64	Yes	No	Yes	No	
R091_A	58	58	No	No	Yes	No	60	60	No	No	Yes	No	
R091_B	65	66	Yes	No	Yes	No	67	67	Yes	No	Yes	No	
R092_A	59	59	No	No	Yes	No	60	60	No	No	Yes	No	
R092_B	63	63	Yes	No	Yes	No	64	64	Yes	No	Yes	No	
R093_A	58	59	No	No	Yes	No	60	60	No	No	Yes	No	
R093_B	62	62	Yes	No	Yes	No	63	64	Yes	No	Yes	No	
R094_A	60	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R094_B	63	63	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R095_A	61	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R095_B	66	66	Yes	No	Yes	No	68	68	Yes	No	Yes	No	
R096_A	60	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R096_B	62	62	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R097_A	59	59	No	No	Yes	No	60	60	No	No	Yes	No	
R097_B	62	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R098_A	58	58	No	No	Yes	No	59	59	No	No	Yes	No	
R098_B	64	63	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R099_A	60	60	No	No	Yes	No	62	62	Yes	No	Yes	No	
R099_B	63	63	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R100_A	53	53	No	No	Yes	No	54	54	No	No	Yes	No	
R100_B	56	56	No	No	Yes	No	57	57	No	No	Yes	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level Do Minimum Lden (dB)	Do Something Lden (dB)	NRA Condition for Noise Mitigation Satisfied? (a)	(b)	(c)	Mitigation Required?	Design Year 2032 Predicted Noise Level Do Minimum Lden (dB)	Do Something Lden (dB)	NRA Condition for Noise Mitigation Satisfied? (a)	(b)	(c)	Mitigation Required?	Comments
R100b_A	55	55	No	No	Yes	No	56	56	No	No	Yes	No	
R100b_B	57	57	No	No	Yes	No	58	59	No	No	Yes	No	
R101_A	57	57	No	No	Yes	No	59	59	No	No	Yes	No	
R101_B	60	61	Yes	No	Yes	No	62	62	Yes	No	Yes	No	
R102_A	58	58	No	No	Yes	No	59	59	No	No	Yes	No	
R102_B	60	60	No	No	Yes	No	61	61	Yes	No	Yes	No	
R103_A	53	53	No	No	Yes	No	55	55	No	No	Yes	No	
R103_B	56	57	No	No	Yes	No	58	58	No	No	Yes	No	
R104_A	57	57	No	No	Yes	No	59	59	No	No	Yes	No	
R104_B	61	61	Yes	No	Yes	No	62	63	Yes	No	Yes	No	
R105_A	61	62	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R105_B	64	64	Yes	No	Yes	No	65	65	Yes	No	Yes	No	
R106_A	54	54	No	No	Yes	No	55	55	No	No	Yes	No	
R106_B	55	56	No	No	Yes	No	57	57	No	No	Yes	No	
R107_A	51	52	No	No	Yes	No	53	53	No	No	Yes	No	
R107_B	53	53	No	No	Yes	No	55	55	No	No	Yes	No	
R108_A	57	57	No	No	Yes	No	58	59	No	No	Yes	No	
R108_B	58	59	No	No	Yes	No	60	60	No	No	Yes	No	
R109_A	57	57	No	No	Yes	No	58	58	No	No	Yes	No	
R109_B	60	60	No	No	Yes	No	61	62	Yes	No	Yes	No	
R110_A	62	62	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R110_B	63	63	Yes	No	Yes	No	64	64	Yes	No	Yes	No	
R111_A	56	57	No	Yes	Yes	No	57	58	No	No	Yes	No	
R111_B	57	58	No	No	Yes	No	58	59	No	No	Yes	No	
R112_A	49	49	No	No	Yes	No	50	50	No	No	Yes	No	
R112_B	50	51	No	No	Yes	No	52	52	No	No	Yes	No	
R113_A	50	50	No	No	Yes	No	51	52	No	No	Yes	No	
R113_B	52	52	No	No	Yes	No	53	54	No	No	Yes	No	
R113b_A	64	65	Yes	No	No	No	65	65	Yes	No	No	No	
R113b_B	66	66	Yes	No	No	No	67	67	Yes	No	No	No	
R114_A	60	62	Yes	Yes	Yes	No	62	63	Yes	Yes	Yes	No	
R114_B	62	63	Yes	No	Yes	No	63	64	Yes	No	Yes	No	
R115_A	64	65	Yes	No	No	No	65	66	Yes	No	No	No	
R115_B	66	66	Yes	No	No	No	67	67	Yes	No	No	No	
R115b_A	58	58	No	No	Yes	No	59	60	No	No	Yes	No	
R115b_B	62	62	Yes	No	Yes	No	63	63	Yes	No	Yes	No	
R116_A	62	64	Yes	Yes	No	No	63	65	Yes	Yes	No	No	
R116_B	67	67	Yes	No	No	No	68	68	Yes	No	No	No	
R116b_A	68	69	Yes	No	No	No	69	70	Yes	No	No	No	
R116b_B	70	69	Yes	No	No	No	71	70	Yes	No	No	No	
R117_A	64	65	Yes	No	No	No	65	66	Yes	No	No	No	

Receiver Location Reference	Opening Year 2017 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Design Year 2032 Predicted Noise Level		NRA Condition for Noise Mitigation Satisfied?			Mitigation Required?	Comments
	Do Minimum Lden (dB)	Do Something Lden (dB)	(a)	(b)	(c)		Do Minimum Lden (dB)	Do Something Lden (dB)	(a)	(b)	(c)		
R001_A	66	64	Yes	No	No	No	67	65	Yes	No	No	No	
R001_B	67	66	Yes	No	No	No	68	66	Yes	No	No	No	
R002_A	70	69	Yes	No	No	No	71	70	Yes	No	No	No	
R002_B	72	71	Yes	No	No	No	72	72	Yes	No	No	No	
R003_A	52	51	No	No	Yes	No	53	52	No	No	Yes	No	

Location S01 Noise levels at this location were dominated by distant traffic from the N69. Other sources noted were birdsong and occasional local traffic movements. Noise levels were in the range 42dB to 49dB L_{Aeq} and 44 to 47dB L_{A10}. The derived L_{den} at this location is 48dB.

Location S02 Noise levels at this location were dominated by road traffic on the N69. Noise levels were in the range 72dB to 73dB L_{Aeq} and 77 to 78dB L_{A10}. The derived L_{den} at this location is 76dB.

Location S03 Noise levels at this location were dominated by traffic movements on the R557. Other sources noted were birdsong and occasional dog barking. Noise levels were in the range 54dB to 68dB L_{Aeq} and 53 to 55dB L_{A10}. Please note that the elevated L_{Aeq} level during the second survey period was due to a local car movement to the farm yard and dog barking. The derived L_{den} at this location is 55dB.

This was also the location of an unattended 24-hour measurement. The measured L_{den} at this location was 61dB. The difference between the derived L_{den} and the actual L_{den} was most likely due to several noisy periods during the unattended noise monitoring. This could have been due to farm activity or dog barking. It is considered that the derived L_{den} value is more representative of the existing ambient traffic noise level.

Location S04 Noise levels at this location were dominated by traffic movements along the N69. Noise levels were in the range of 67 to 68dB L_{Aeq} and 71 to 73dB L_{A10}. The derived L_{den} at this location is 71dB.

Location S05 Noise levels at this location were dominated by distant traffic movements along the N69 and occasional birdsong and local traffic movements. Noise levels were in the range 51dB to 53dB L_{Aeq} and 52 to 53dB L_{A10}. The derived L_{den} at this location is 55dB.

Location S06 Noise levels at this location were dominated by distant road traffic and occasional birdsong. Noise levels were in the range 46dB to 48dB L_{Aeq} and 47 to 50dB L_{A10}. The derived L_{den} at this location is 50dB.

Location S07 Noise levels at this location were dominated by road traffic along Greenville Road. Noise levels were in the range of 60dB to 65dB L_{Aeq} and 58 to 64dB L_{A10}. The derived L_{den} at this location is 62dB.

Location S08 Noise levels at this location were dominated by distant road traffic. Other sources noted were infrequent local traffic and birdsong. Noise levels were in the range of 43dB to 45dB L_{Aeq} and 45 to 47dB L_{A10}. The derived L_{den} at this location is 49dB.

This was also the location of an unattended 24-hour measurement. The measured L_{den} at this location was 51dB. This shows good agreement with the derived L_{den} level.

Location S09 Noise levels at this location were dominated by road traffic along Greenville Road. Noise levels were in the range of 59dB to 62dB L_{Aeq} and 63 to 65dB L_{A10}. The derived L_{den} at this location is 64dB.

Location S10 Noise levels at this location were dominated by distant road traffic. Birdsong was also noted. Noise levels were in the range of 43dB to 46dB L_{Aeq} and 45 to 47dB L_{A10}. The derived L_{den} at this location is 49dB.

Location S11 Noise levels at this location were dominated by distant road traffic. Birdsong was also noted. Noise levels were in the range of 44dB to 46dB L_{Aeq} and 46 to 48dB L_{A10}. The derived L_{den} at this location is 49dB.

Location S12 Noise levels at this location were dominated by road traffic along the R553. Birdsong was also noted. Noise levels were of the order of 59dB L_{Aeq} and in the range of 63 to 64dB L_{A10}. The derived L_{den} at this location is 63dB.

Location S13 Noise levels at this location were dominated by road traffic along the John B. Keane Road. Grass cutting, birdsong and children playing were also noted. Noise levels were in the range of 56 to 61dB L_{Aeq} and in the range of 49 to 64dB L_{A10}. The derived L_{den} at this location is 59dB.

Location S14 Noise levels at this location were dominated by road traffic along the John B. Keane Road. Noise levels were in the range of 67 to 71dB L_{Aeq} and in the range of 72 to 74dB L_{A10}. The derived L_{den} at this location is 72dB.

Location S15 Noise levels at this location were dominated by road traffic on the John B. Keane Road. Other sources noted were birdsong and distant activity from commercial premises. Noise levels were in the range of 59dB to 60dB L_{Aeq} and 62 to 63dB L_{A10}. The derived L_{den} at this location is 62dB.

This was also the location of an unattended 24-hour measurement. The measured L_{den} at this location was 66dB. This generally shows good agreement with the derived L_{den} level, however, the slightly elevated measured L_{den} level is most likely as a result of the fact that the unattended noise monitor was at a first floor level while the attended survey was a ground floor level.

Location S16 Noise levels at this location were dominated by road traffic along the John B. Keane Road. Birdsong and pedestrian activity were also noted. Noise levels were in of the order of 66dB L_{Aeq} and 70dB L_{A10}. The derived L_{den} at this location is 69dB.

Location S17 Noise levels at this location were dominated by road traffic along the John B. Keane Road. Grass cutting and birdsong were also noted. Noise levels were in the range of 49 to 51dB L_{Aeq} and in the range of 53 to 54dB L_{A10}. The derived L_{den} at this location is 55dB.

Location S18 Noise levels at this location were dominated by road traffic along the John B. Keane Road. Birdsong and children playing were also noted. Noise levels were in the range of 59 to 60dB L_{Aeq} and in the range of 62 to 64dB L_{A10}. The derived L_{den} at this location is 63dB.

Appendix 10.6 Unattended Noise Monitoring Results

Hour Monitoring Results at Survey Location S03

Time Period	Measured Noise Levels (dB re.2x10-5Pa)		
	LAeq	LA10	LA90
17:00 – 18:00	58	56	49
18:00 – 19:00	52	55	48
19:00 – 20:00	53	55	48
20:00 – 21:00	52	55	48
21:00 – 22:00	51	54	45
22:00 – 23:00	49	52	37
23:00 – 00:00	46	51	30
00:00 – 01:00	42	46	29
01:00 – 02:00	39	42	32
02:00 – 03:00	43	42	35
03:00 – 04:00	42	44	37
04:00 – 05:00	46	49	41
05:00 – 06:00	53	55	48
06:00 – 07:00	53	56	48
07:00 – 08:00	53	56	48
08:00 – 09:00	54	56	50
09:00 – 10:00	66	56	49
10:00 – 11:00	61	56	47
11:00 – 12:00	67	57	47
12:00 – 13:00	57	55	47
13:00 – 14:00	53	56	48
14:00 – 15:00	69	56	47
15:00 – 16:00	61	57	48
16:00 – 17:00	62	56	48
Measured value of Lden		61	
Derived value of Lden		55	

24-Hour Monitoring Results at Survey Location S08

Time Period	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
17:00 – 18:00	58	56	49
18:00 – 19:00	52	55	48
19:00 – 20:00	53	55	48
20:00 – 21:00	52	55	48
21:00 – 22:00	51	54	45
22:00 – 23:00	49	52	37
23:00 – 00:00	46	51	30
00:00 – 01:00	42	46	29
01:00 – 02:00	39	42	32
02:00 – 03:00	43	42	35
03:00 – 04:00	42	44	37
04:00 – 05:00	46	49	41
05:00 – 06:00	53	55	48
06:00 – 07:00	53	56	48
07:00 – 08:00	53	56	48
08:00 – 09:00	54	56	50
09:00 – 10:00	66	56	49
10:00 – 11:00	61	56	47
11:00 – 12:00	67	57	47
12:00 – 13:00	57	55	47
13:00 – 14:00	53	56	48
14:00 – 15:00	69	56	47
15:00 – 16:00	61	57	48
16:00 – 17:00	62	56	48
Measured value of L_{den}		61	
Derived value of L_{den}		55	

24-Hour Monitoring Results at Survey Location S15

Time Period	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:30 – 17:30	45	47	38
17:30 – 18:30	42	44	38
18:30 – 19:30	45	47	39
19:30 – 20:30	48	49	39
20:30 – 21:30	47	49	40
21:30 – 22:30	45	48	37
22:30 – 23:30	42	42	33
23:30 – 00:30	35	38	31
00:30 – 01:30	33	37	27
01:30 – 02:30	34	36	28
02:30 – 03:30	40	40	34
03:30 – 04:30	41	43	34
04:30 – 05:30	48	52	40
05:30 – 06:30	47	49	41
06:30 – 07:30	46	48	42
07:30 – 08:30	45	46	39
08:30 – 09:30	46	48	38
09:30 – 10:30	48	50	38
10:30 – 11:30	46	49	35
11:30 – 12:30	44	45	36
12:30 – 13:30	46	49	38
13:30 – 14:30	46	49	40
14:30 – 15:30	50	50	39
15:30 – 16:30	47	48	40
Measured value of L_{den}		51	
Derived value of L_{den}		49	

Appendix 11.1
PHOTOMONTAGES

for

Project No. 5991
N69 LISTOWEL BYPASS

for

Client: Kerry National Road Design Office (KNRDO)

Date: 10 May 2017

Brady Shipman Martin
Canal House
Canal Road
Dublin 6

Tel: +353 (0)1 208 1900
Email: mail@bradyshipmanmartin.com

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

CONTENTS AMENDMENT RECORD

This report has been issued and amended as follows:

REVISION	DESCRIPTION	DATE	PREPARED BY	CHECKED BY
00	View Location Map and 5 no. of Photomontages	27 November 2015	RN	JK
01	Additional Photomontage	15 December 2015	RN	JK
02	Additional 3 no. of Photomontages	03 May 2017	BP	DBos
03	Revision to view location map and 3 no. of Photomontages	05 May 2017	BP	DBos
04	Revision to 1 Photomontage	10 May 2017	BP	DBos

PHOTOMONTAGE TABLE OF CONTENT

Day:	27	15	03	05	10
Month:	11	12	05	05	05
Year:	15	15	17	17	17
FIGURE NUMBER	**REVISION**				
Figure 1	00	01	02	03	03
View 1a	00	00	00	00	00
View 1b	00	00	00	00	00
View 1c	00	00	00	00	00
View 2a	00	00	00	00	00
View 2b	00	00	00	00	00
View 2c	00	00	00	00	00
View 3a	00	00	00	00	00
View 3b	00	00	00	00	01
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View 4c	00	00	00	00	00
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View 8a			00	00	00
View 8b			00	01	01
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View 9b			00	01	01

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

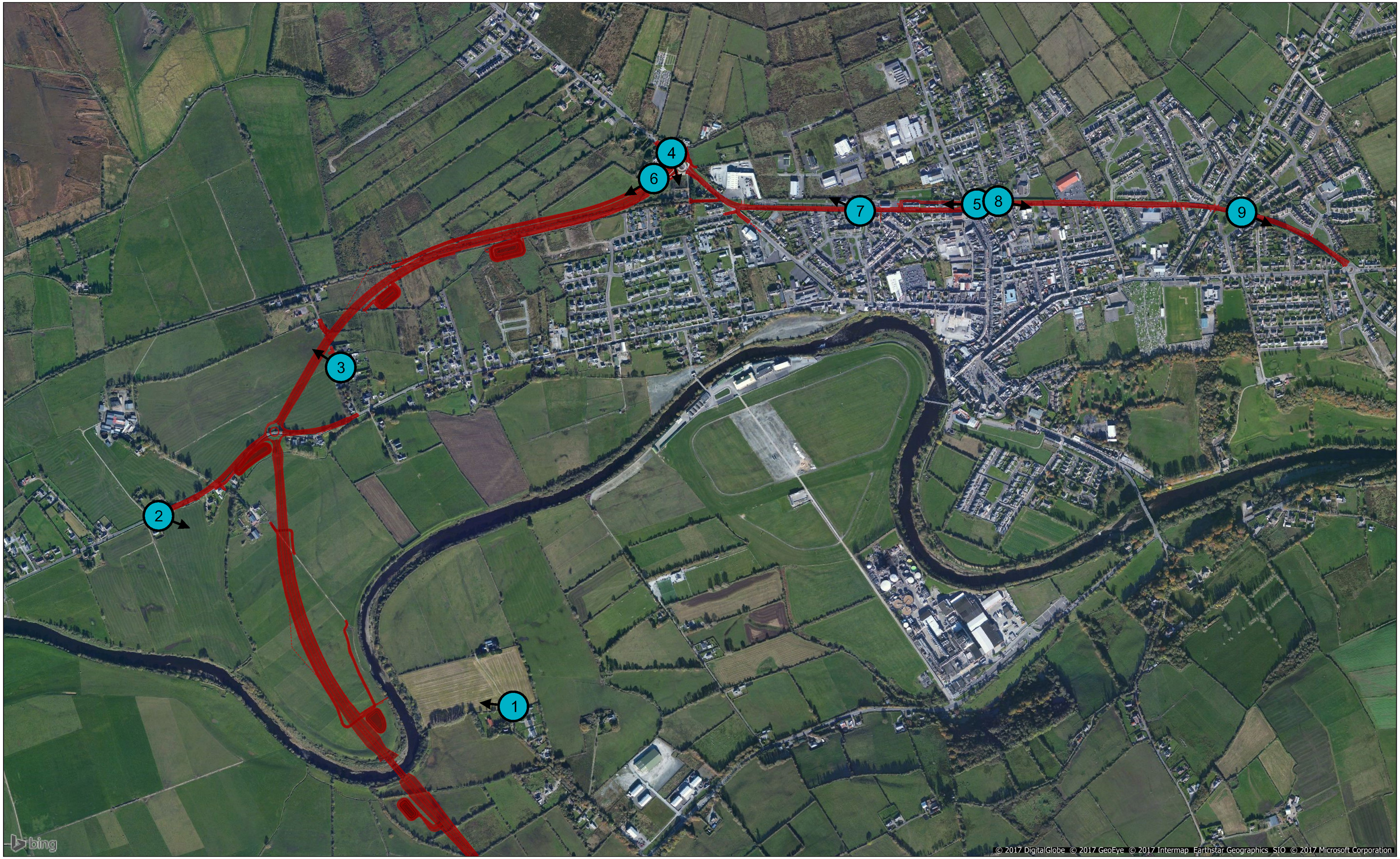

Figure: Figure 1

Rev: 03

View Location Map

BSM Brady Shipman Martin. Est. 1968 Built. Environment.

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm ANGLE OF VISION / LENS FOCAL LENGTH 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 1a **Rev: 00**

Existing view east of River Feale bridge crossing

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 1b **Rev: 00**

Proposed view east of River Feale bridge crossing (pre establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 1c **Rev: 00**

Proposed view east of River Feale bridge crossing (post establishment)

Brady Shipman Martin. Built. Environment. Est. 1968

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 2a **Rev: 00**

Existing view from Greenville Road

Brady Shipman Martin. Built. Environment. Est. 1968

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 2b **Rev: 00**

Proposed view from Greenville Road looking southeast (pre establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 2c **Rev: 00**

Proposed view from Greenville Road looking southeast (post establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 3a **Rev: 00**

Existing view from Bog Road

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 3b **Rev: 01**

Proposed view from Bog Road looking north (pre establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 3c **Rev: 00**

Proposed view from Bog Road looking north (post establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 4a **Rev: 00**

Existing view from Ballybunnion Road (R555) looking south

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 4b **Rev: 00**

Proposed view from Ballybunnion Road (R555) looking south (pre establishment)

Brady Shipman Martin.
Built.
Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 4c **Rev: 00**

Proposed view from Ballybunnion Road (R555) looking south (post establishment)

Brady Shipman Martin. Built. Environment. BSM Est. 1968

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 5a **Rev: 00**

Existing view from John B. Keane Road looking west

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 5b **Rev: 00**

Proposed view from John B. Keane Road looking west (pre establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 5c **Rev: 00**

Proposed view from John B. Keane Road looking west (post establishment)

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Figure: View 6 **Rev: 00**

View along the proposed Sive amenity walkway

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 7a **Rev: 00**

Existing view from John B Keane Road (at Lartigue Station) looking west

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm ANGLE OF VISION / LENS FOCAL LENGTH 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 7b **Rev: 01**

Proposed view from John B Keane Road (at Lartigue Station) looking west

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 8a **Rev: 00**

Exisiting view from John B Road (east of R552 Road Junction) looking east

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 8b **Rev: 01**

Proposed view from John B Road (east of R552 Road Junction) looking east

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm | < 65.5° / 28mm | < 54.4° / 35mm | < 39.6° / 50mm | < 28.8° / 70mm | ANGLE OF VISION / LENS FOCAL LENGTH | 70mm / 28.8° > | 50mm / 39.6° > | 35mm / 54.4° > | 28mm / 65.5° > | 24mm / 73.7° >

Figure: View 9a **Rev: 00**

Exisiting view from John B Road (east of Ballygologue Junction) looking east

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Project Number:	5991	Document Number:	Appendix 11.1	Revision:	04
Project Name:	N69 LISTOWEL BYPASS	Document Title:	PHOTOMONTAGES	Date:	10 May 2017

< 73.7° / 24mm	< 65.5° / 28mm	< 54.4° / 35mm	< 39.6° / 50mm	< 28.8° / 70mm	ANGLE OF VISION / LENS FOCAL LENGTH	70mm / 28.8° >	50mm / 39.6° >	35mm / 54.4° >	28mm / 65.5° >	24mm / 73.7° >

Figure: View 9b **Rev: 01**

Proposed view from John B Road (east of Ballygologue Junction) looking east

BSM Est. 1968 Brady Shipman Martin. Built. Environment.

Appendix 12.1 Archaeology and Cultural Heritage Gazetteer

Site No.	AR01
Site Name	Townland boundary Coolnaleen Upper / Billeragh
Designation	None
Townland	Coolnaleen Upper / Billeragh
Site Type	Townland boundary
Grid Reference	497557, 631519
Description	Townland boundary between Coolnaleen Upper and Billeragh - shown on 1st edition OS map [1]. The boundary now exists solely as a road. [2].
Adjacent Archaeological Sites	None
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	No impact
Mitigation Measures	None

Site No.	AR02
Site Name	Ringfort Coolnaleen Lower
Designation	Recorded Monument (KE010-075)
Townland	Coolnaleen Lower
Site Type	Ringfort
Grid Reference	49755, 631823
Description	Situated SE of the previous site (AR04), in a large pastoral field, this univallate rath is in a poor state of preservation. It consists of a circular area enclosed by an earthen bank 3.4-6m wide, 1m high externally and 0.6m-1.2m above the interior. Numerous cattle breaks and gaps exist in the bank. Extending from the SSE sector is a low straight bank running E, possibly the remains of an old field bank [1]. No evidence of ringfort is visible at this location. [2]
Adjacent Archaeological Sites	AR03
Sources	[1] Toal, C. 1995. Archaeological survey of North Kerry. Site 396 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	30m
Type of Impact	None
Mitigation Measures	None

Site No.	AR03
Site Name	Fulacht Fia, Coolnaleen Lower
Designation	Recorded Monument (KE010-074001)
Townland	Coolnaleen Lower
Site Type	Fulacht Fia
Grid Reference	497428, 631965
Description	This site is situated one field SSW of another fulacht fiadh. According to the landowner while a drain was being dug through the rath, the trough of a fulacht Fiadh was discovered along with some burnt stones and charcoal. No surface trace of this can be seen today. Originally it lay within the centre of the fort. [1] Field under crop at time of walkover survey. [2]
Adjacent Archaeological Sites	AR04
Sources	[1] Toal, C. 1995. Archaeological Survey of North Kerry, page 55 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR04
Site Name	Ringfort 2, Coolnaleen Lower
Designation	Recorded Monument (KE010-074)
Townland	Coolnaleen Lower
Site Type	Ringfort
Grid Reference	497428, 631965
Description	RMP paper records record this as an enclosure, rather than a ring fort. GIS data records as ring fort. This univallate rath has been very much levelled, and all that remains today is a crescent shaped raised area . 7m high. Slight traces of a bank are to be noted to the E and SW, where it is 11m wide and .5m high, albeit barely perceptible. During drainage work through the centre of this rath, burnt stones and charcoal were uncovered, plus the possible timber trough of a fulacht fiadh. [1] Site under crop at time of survey. [2]
Adjacent Archaeological Sites	AR03
Sources	[1] Toal, C. 1995. North Kerry Archaeological Survey. Site 395 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR05
Site Name	Buildings (site of)
Designation	None
Townland	Coolnaleen Lower
Site Type	Building
Grid Reference	497815, 632028
Description	Three buildings shown on 1st edition map by roadside, flanked to rear by a small orchard. [1] Well labelled to rear on 1st edition 25" Ordnance Survey map. [2] Modern rebuild on plot dating to the 20th century (corrugated iron sheds) [3]
Adjacent Archaeological Sites	AR06
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Approximate Distance from Proposed development	1m
Type of Impact	None
Mitigation Measures	None

Site No.	AR06
Site Name	Cottage (site of) Coolnaleen Lower
Designation	None
Townland	Coolnaleen Lower
Site Type	Building
Grid Reference	497810, 632074
Description	Site of building shown on 1st edition 6" OS map. [1] Site has subsequently been redeveloped. [2]
Adjacent Archaeological Sites	AR05
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	5m
Type of Impact	None
Mitigation Measures	None

Site No.	AR07
Site Name	Building (site of) 2, Coolnaleen Lower
Designation	None
Townland	Coolnaleen Lower
Site Type	Building
Grid Reference	497858, 632098
Description	Site of building shown on 1st edition 6" OS map. [1] Site has subsequently been redeveloped. [2]
Adjacent Archaeological Sites	AR5; AR6

Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR08
Site Name	Townland boundary Coolnaleen Lower / Garryantanvally
Designation	None
Townland	Coolnaleen Lower / Garryantanvally
Site Type	Townland boundary
Grid Reference	497501, 632211
Description	Townland boundary between Coolnaleen Lower and Garryantanvally. Follows a water course.
Adjacent Archaeological Sites	AR07
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR09
Site Name	Farmstead (site of), Coolnaleen Lower
Designation	None
Townland	Coolnaleen Lower
Site Type	Buildings
Grid Reference	497494, 632083
Description	Site of farmstead identified from the first edition 6" Ordnance Survey map. [1] Now replaced by modern farm structures. [2]
Adjacent Archaeological Sites	AR03; AR04; AR10; AR11
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	39m
Type of Impact	None
Mitigation Measures	None

Site No.	AR10
Site Name	Holy Well, Coolnaleen Lower
Designation	Recorded Monument (KE010-079)
Townland	Coolnaleen Lower
Site Type	Holy well
Grid Reference	496857, 633432
Description	This well consists of a crescent-shaped depression within which is the well. According to the landowner, this well is associated with St Brigid. The top of the well is mortared and below this is drystone walling. [1] At the time of the walkover survey the area was very overgrown however the well appeared to be a concrete structure with a hole for a connecting pipe, capped with what appeared to be a large stone. No additional evidence that the well is used for the veneration of St Brigid (whose feast day is the 1st February) has been identified. [2]
Adjacent Archaeological Sites	AR11
Sources	[1] Toal, C. 1995. Archaeological survey of North Kerry. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Geophysical survey Test excavation Resolution excavation as required

Site No.	AR11
Site Name	Burnt spread, Coolnaleen Lower
Designation	Recorded Monument (KE010-077)
Townland	Coolnaleen Lower
Site Type	Burnt Spread
Grid Reference	497472, 632199
Description	According to the land owner, burnt stones and charcoal were discovered during ploughing. It was situated about 11m NW of a possible holy well. A scattering of burnt stones can still be seen today. [1] Burn stone identified in an adjacent stream during the walkover survey. [2]
Adjacent Archaeological Sites	AR10
Sources	[1] Toal, C. 1995. Archaeological survey of North Kerry. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Geophysical survey Test excavation Resolution excavation as required

Site No.	AR12
Site Name	Flood Defence Embankment (site of)
Designation	None
Townland	Garryantanvally
Site Type	Flood Defence Embankment
Grid Reference	497110, 6326701
Description	Embankment shown on the 1st edition 6" OS map running from the River Feale to the west, to link to area called Broom Island adjacent to the River Feale. Part destroyed by realignment of river in late 19th century. Not depicted on the 25" map. [2] No longer visible [3].
Adjacent Archaeological Sites	AR12; AR13
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR13
Site Name	River Feale Area of Archaeological Potential
Designation	None
Townland	Scartleigh; Gortcurreen
Site Type	Area of Archaeological Potential
Grid Reference	496857, 633432
Description	Former course of River Feale, mapped from 1st edition OS map. [1] Altered by time of 25" OS map. [2]
Adjacent Archaeological Sites	AR14; AR15; AR16; AR17; AR18
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Palaeoenvironmental assessment Metal detector survey Test excavation Resolution excavation as required

Site No.	AR14
Site Name	Townland boundary Scartleigh/Garryantanvally
Designation	None
Townland	Scartleigh; Garryantanvally
Site Type	Townland boundary
Grid Reference	496960, 632600
Description	Townland boundary between Scartleigh and Garryantanvally. [1] Follows realigned riverbank. [2]
Adjacent Archaeological Sites	AR12; AR13

Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841. [2] Walkover survey July 2013.
Approximate Distance from Proposed development	23m
Type of Impact	None
Mitigation Measures	None

Site No.	AR15
Site Name	Ford & footstick (site of)
Designation	None
Townland	Scartleigh / Garryantanvally
Site Type	Ford & footstick (site of)
Grid Reference	496729, 633318
Description	Site of ford and footstick identified on 1st edition 25" Ordnance Survey map, crossing former course of the River Feale [1].
Adjacent Archaeological Sites	AR14, AR16, AR17
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913
Approximate Distance from Proposed development	20m
Type of Impact	None
Mitigation Measures	None

Site No.	AR16
Site Name	Townland boundary Drumloughra / Gortcurreen
Designation	None
Townland	Drumloughra, Gortcurreen
Site Type	Townland boundary
Grid Reference	496712, 633328
Description	Townland boundary between Drumloughra and Gortcurreen townlands. [1] No evidence of boundary observed during walkover survey. [2]
Adjacent Archaeological Sites	AR14; AR15; AR17

Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	None
Mitigation Measures	None

Site No.	AR17
Site Name	Townland boundary Gortcurreen/Garryantanvally
Designation	None
Townland	Gortcurreen / Garryantanvally
Site Type	Townland boundary
Grid Reference	496795, 633401
Description	Townland boundary between Gortcurreen and Garryantanvally. [1] Represented by a line of trees and a low bank. [2]
Adjacent Archaeological Sites	AR13
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Topographic survey Photographic survey Test Excavation Resolution Excavation as required

Site No.	AR18
Site Name	Buildings (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Buildings
Grid Reference	496941,633475

Description	Small dispersed complex of buildings depicted on 1st edition 6" Ordnance Survey map. [1] Buildings present on site today of modern origin. [2]
Adjacent Archaeological Sites	AR13; AR17; AR17
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	3m
Type of Impact	None
Mitigation Measures	None

Site No.	AR19
Site Name	Kilcreen Cottage gate lodge (site of)
Designation	None
Townland	Kilcreen
Site Type	Building
Grid Reference	497154,633528
Description	Gate lodge for Kilcreen cottage labelled on 1st edition 6" Ordnance Survey map. [1] Now demolished. [2] [2] Walkover survey July 2013.
Adjacent Archaeological Sites	AR20
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841
Approximate Distance from Proposed development	46m
Type of Impact	None
Mitigation Measures	None

Site No.	AR20
Site Name	Townland boundary Kilcreen / Gortcurreen
Designation	None
Townland	Townland boundary Kilcreen / Gortcurreen
Site Type	Townland boundary
Grid Reference	497224, 633553
Description	Townland boundary between Kilcreen and Gortcurreen. [1] Employed as a mill lead associated with former tuck and corn mill. Possibly adapted from natural watercourse, straightened to east of mill. [2]
Adjacent Archaeological Sites	AR17; AR19; AR21; AR22
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913
Approximate Distance from Proposed development	10m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR21
Site Name	Buildings 2 (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	497038, 633535
Description	Two rectangular buildings depicted on 1st edition 6" Ordnance Survey map laid out parallel to the road.[1] Demolished by time of the 1st edition 25" map and replaced with woodland planting around field perimeter. [2] Field under pasture - no evidence of any buildings during site walkover. [3]
Adjacent Archaeological Sites	AR18; AR22; AR20
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013.
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Geophysical Survey Test Excavation Resolution Excavation as required

Site No.	AR22
Site Name	Buildings 3 (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	497121, 633574
Description	Site of buildings shown on 1st edition 6" Ordnance Survey map. [1] Now demolished and modern development on site. [2]
Adjacent Archaeological Sites	AR19; AR20; AR21
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	5m
Type of Impact	No impact
Mitigation Measures	None proposed.

Site No.	AR23
Site Name	Building 2 (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	496955, 633614
Description	Two buildings shown in arranged in L-plan on 1st edition 6" Ordnance Survey map. Now demolished. [1] Area is a large agricultural field under crop at time of survey.[2]
Adjacent Archaeological Sites	AR21; AR24; AR25
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	16m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR24
Site Name	Building (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	496864, 633670
Description	Building shown on 1st edition 6" Ordnance Survey map. [1] Demolished by time of the 1st edition 25" map. [2] Now demolished. Area is a large agricultural field under crop at time of survey. [3]
Adjacent Archaeological Sites	AR23
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Approximate Distance from Proposed development	39m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR25
Site Name	Building 3 (Site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	497046, 633701
Description	Building shown on 1st edition 6" Ordnance Survey map. [1] Demolished by time of the 1st edition 25" map and replaced with bank of woodland planting around field edge [2]. No evidence of building at time of survey - area very overgrown. [3]
Adjacent Archaeological Sites	AR22; AR23; AR26
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Approximate Distance from Proposed development	18m
Type of Impact	No impact

Mitigation Measures	None proposed

Site No.	AR26
Site Name	Building 4 (site of), Gortcurreen
Designation	None
Townland	Gortcurreen
Site Type	Building
Grid Reference	467016, 633873
Description	Site of building shown on 1st edition 25" Ordnance Survey map. [1] Now demolished. Area is an agricultural field - no evidence of a building.[2]
Adjacent Archaeological Sites	AR27
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013.
Approximate Distance from Proposed development	47m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR27
Site Name	Limerick & Kerry Railway (site of)
Designation	None
Townland	Gortcurreen; Islandganniv North; Curraghatoosane; Listowel
Site Type	Railway
Grid Reference	498200, 634200
Description	Limerick and Kerry Railway first shown on 1st edition 25" Ordnance Survey map. Now disused. After Limerick city had been connected to the Irish railway system in 1848, the onward link to Tralee was forged in three stages in the period 1858-80. Firstly, in 1858 the Limerick and Foynes Railway commenced operations via Ballingrane. This was followed some three years later by the Rathkeale and Newcastle Junction Railway from Newcastle to a junction with the Foynes line at Ballingrane; this opened on 1st January 1867. In 1865 the Limerick and Kerry Railway was proposed and in the late 1870's the 43 mile line from Newcastle to Tralee was built. It was opened on 20th December 1880 with intermediate stations at Barnagh, Devon Road, Abbeyfeale, Kilmorna, Listowel, Lixnaw, Abbeydorney and Ardfert. In 1902 the R.& N.J.R. and the L. & K.R. were absorbed into the Great Southern and Western Railway (G.S. & W.R.) At its peak four passenger trains and one goods train operated daily to and from Limerick; however the early impetus failed to be maintained and after WW2 the future of the line looked bleak. In 1963 the passenger service was withdrawn although occasional passenger specials continued to use the line. [2] Now part of Listowel Heritage Trail
Adjacent Archaeological Sites	AR26; AR28; AR29; AR32; AR34; AR36;
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] http://www.disused-stations.org.uk/l/listowell/index.shtml
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Topographic Survey

Site No.	AR28
Site Name	Building (site of), Curraghtoosane
Designation	None
Townland	Curraghtoosane
Site Type	Building
Grid Reference	497335, 634040
Description	Site of building shown on 1st edition 6" Ordnance Survey map. [1] Demolished by time of the 1st edition 25" map.[2]
Adjacent Archaeological Sites	AR27
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913
Approximate Distance from Proposed development	0m
Type of Impact	Direct
Mitigation Measures	Test Excavation Resolution Excavation as required

Site No.	AR29
Site Name	Well (site of)

Designation	None
Townland	Curraghatoosane
Site Type	Well
Grid Reference	498007634249
Description	Site of well labelled on the 1st edition 25" Ordnance Survey map. [1] No evidence of well at time of survey - July 2013 [2]
Adjacent Archaeological Sites	AR27; AR32
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Approximate Distance from Proposed development	0m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR30
Site Name	Building (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Building
Grid Reference	498010, 634373
Description	Site of building depicted on the 1st edition 6" Ordnance Survey map. [1] Demolished by time of 25" map.[2] Site appears to have been redeveloped in the 1980s with residential development. [3]
Adjacent Archaeological Sites	AR31; AR33
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Approximate Distance from Proposed development	3m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR31
Site Name	John Paul II Graveyard
Designation	None
Townland	Curraghatoosane
Site Type	Graveyard
Grid Reference	498025, 634588
Description	Site of graveyard. Still in active use [1]
Adjacent Archaeological Sites	AR30; AR33
Sources	[1] Kerry County Council, 2011, N69 Listowel Bypass Road Improvement Scheme, Stage 2 Route Selection, Cultural Heritage Report
Approximate Distance from Proposed development	17m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR32
Site Name	Buildings (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Buildings
Grid Reference	498080, 634256
Description	Site of buildings depicted on 1st edition 6" Ordnance survey map. Now demolished.
Adjacent Archaeological Sites	AR29; AR33
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841
Approximate Distance from Proposed development	19m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR33
Site Name	Building 3 (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Buildings
Grid Reference	498089, 634306
Description	Site of buildings depicted on 1st edition 6" Ordnance survey map. Area re-developed with single storey structures appearing to date to mid-late 20th century [2].
Adjacent Archaeological Sites	AR32; AR35
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841 [2] Walkover survey July 2013
Approximate Distance from Proposed development	0m
Type of Impact	Direct impact
Mitigation Measures	Test Excavation Resolution Excavation as required

Site No.	AR34
Site Name	Buildings 4 (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Buildings
Grid Reference	498100, 634160
Description	Site of buildings shown on 1st edition 6" OS map. Long narrow range to west of track. [1] Partially demolished by time of 25" map. [2] Now replaced by modern structures. [3]
Adjacent Archaeological Sites	AR27
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Approximate Distance from Proposed development	33m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR35
Site Name	Pump (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Pump
Grid Reference	498157, 634278
Description	Site of pump identified on the 1st edition 25" Ordnance Survey map. Area redeveloped in 20th century - no evidence of a pump. [2]
Adjacent Archaeological Sites	AR32; AR33
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Approximate Distance from Proposed development	28m
Type of Impact	No impact
Mitigation Measures	None proposed

Site No.	AR36
Site Name	Level crossing cottage (site of), Curraghatoosane
Designation	None
Townland	Curraghatoosane
Site Type	Building
Grid Reference	498232, 634183
Description	Site of cottage identified on the 1st edition 25" Ordnance Survey map next to level crossing for the Limerick and Kerry Railway, likely to have been constructed as residence for the Level Crossing keeper. Level crossing in situ, but no evidence of original structure. New building there called 'Railway Cottage'. [2]
Adjacent Archaeological Sites	AR27;
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Approximate Distance from Proposed development	0m
Type of Impact	Direct impact

Mitigation Measures	Test Excavation Resolution Excavation as required

Site No.	AR37
Site Name	Townland boundary Curraghatoosane/Listowel
Designation	None
Townland	Curraghatoosane / Listowel
Site Type	Townland boundary
Grid Reference	498656, 634189
Description	Townland boundary between Curraghatoosane and Listowel. Now represented by a single road, but no longer respected by 20th century residential development. [2]
Adjacent Archaeological Sites	AR27; AR30; AR31; AR32
Sources	[1] 1st edition 6" Ordnance Survey map 1829-1841 [2] Walkover survey July 2013
Approximate Distance from Proposed development	0m
Type of Impact	No impact
Mitigation Measures	None proposed

Appendix 12.2 Architectural Heritage Gazetteer

Reference Number	AH1 - Cottage, Billeragh
Photo reference number	Site inspection 360 - 362
Address	Billeragh
Location / Coordinates	497585631505
Site type	Cottage
Description	Roadside cottage of early 20th century date. Constructed of coursed rubble with brick lintels to windows and doors. Half hipped slate roof with central brick stack. Principal elevation faces onto road and contains two window openings (modern fittings) and a doorway to the left. Extended to rear. [1]
Approximate date	Early 20th century
Sources	[1] Walkover survey July 2013
Importance / Legal Status	Local / None
Distance from route (m)	0
Type of Impact	Indirect Impact
Nature of Impact	Impact on setting. Noise and visual intrusion
Quality of Impact	Negative
Magnitude of Construction Impact	Medium negative
Significance of Construction Impact	Slight negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Imperceptible negative
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Medium negative
Significance of Construction Impact with Mitigation	Slight negative
Magnitude of Operation Impact with Mitigation	Low negative
Significance of Operation Impact with Mitigation	Imperceptible negative
Extent of Impact	Impact on setting

Reference Number	AH2 – Farmstead Coolnaleen
Photo reference number	Site Inspection 084 - 085
Address	Coolnaleen Lower
Location / Coordinates	497522431933
Site type	Outbuildings
Description	Farm complex replacing complex shown on the 1st edition 6" and 25" Ordnance Survey maps. [1], [2] Current farmhouse dates from 1949. To rear (south) is a cast iron water pump and small outbuilding likely to be of early 20th century date. [3]
Approximate date	Early 20th century
Sources	[1] 1st edition 6" Ordnance Survey map 1840-1841 [2] 1st edition 25" Ordnance Survey map 1888-1913 [3] Walkover survey July 2013
Importance / Legal Status	Record Only / None
Distance from route (m)	48
Type of Impact	Indirect Impact
Nature of Impact	Temporary intrusion from construction activities. Impact on setting from construction and operation of the scheme
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Imperceptible negative
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	Low negative
Significance of Operation Impact with Mitigation	Imperceptible negative
Extent of Impact	Impact on setting

Reference Number	AH3 – Former Labourer's Cottage, Coolanleen Lower
Photo reference number	Site Inspection 094
Address	Coolnaleen Lower
Location / Coordinates	497734631994
Site type	Cottage
Description	Former labourer's cottage. Single storey with central stack, rendered externally, modern window fittings, with lower extension to north. [1]
Approximate date	19th century
Sources	[1] Walkover survey July 2013
Importance / Legal Status	Record only / None
Distance from route (m)	2
Type of Impact	Indirect Impact
Nature of Impact	Temporary intrusion from construction activities. Impact on setting from construction and operation of the scheme
Quality of Impact	Negative
Magnitude of	Medium negative

Construction Impact	
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Imperceptible negative
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Medium negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	Low negative
Significance of Operation Impact with Mitigation	Imperceptible negative
Extent of Impact	Impact on setting

Reference Number	AH4 – Kilcreen Cottage Demesne
Photo reference number	Site inspection 266 – 278
Address	Kilcreen
Location / Coordinates	497344633428
Site type	Demesne
Description	Former demesne established for Kilcreen Cottage and depicted on the 1st edition 6" Ordnance Survey map of 1829-1841. [1] Main house now demolished and replaced with a single storey cottage of mud construction. Principal aspect of the house looked to the south, towards the river. A range of substantial outbuildings survives to the rear of the cottage comprising one and two storey buildings including a stable and tackroom, constructed of rubble with slate roofs. Cobbled yard and water pump also survive. Demesne now all turned over the pasture farmland. Formerly included a gatelodge (Asset AR17) and tree-lined driveway. Only fragments of this designed landscape now survive including thick stone wall with substantial piers, and specimen trees along the driveway. [2]
Approximate date	Early 19th century
Sources	[1] 1st edition 6" Ordnance Survey map, 1829-1841 [2] S. Honeywell, Site inspection
Importance / Legal Status	Record Only / None
Distance from route (m)	13
Type of Impact	Neutral Impact
Nature of Impact	No impact
Quality of Impact	Neutral
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	No impact

Reference Number	AH5 - Former Labourer's Cottage, Scartleigh
Photo reference number	Site inspection 244
Address	Scartleigh
Location / Coordinates	496691633330
Site type	Cottage
Description	Cottage on site of a building shown on the 1st edition 25" Ordnance Survey map of 1888-1913. [1] Compact single-storey two-bay building with attic, central stack, catslide roof to rear. Extensively renovated, rendered externally with modern window frames. [2]
Approximate date	Early 20th century
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Importance / Legal Status	Record Only / None
Distance from route (m)	2
Type of Impact	Indirect Impact
Nature of Impact	Temporary intrusion from construction activities. Impact on setting from construction and operation of the scheme
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Imperceptible negative
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative

Magnitude of Operation Impact with Mitigation	Low negative
Significance of Operation Impact with Mitigation	Imperceptible negative
Extent of Impact	Impact on setting

Reference Number	AH6 – Greenville Demesne
Photo reference number	Site inspection 223, 226-241
Address	Gortcurreen
Location / Coordinates	9929601266940
Site type	Demesne
Description	In 1840, Greenville was a large house of many angles, forming a broken square with the stable yard. There were plantations of trees and a tree-lined avenue to the edge of Listowel. Today the back regions of the earlier house remain; a stone dairy and cottage are joined to the 'new' house, built 70 years ago after the original had been burnt. The new house is of one storey with a bow on one side. There are two chimneys on the hipped roof with a further 2nd chimney on the old wing. The woods are now gone, but new plantings are being made along the avenue. History: George Sandes married Elizabeth, daughter of Fitzmaurice O'Connor about 1778 and was known as 'of Greenville'. He was high sheriff of Kerry and was a friend of Daniel O'Connell. His seat is named in 1814 and on his death in 1829 he was succeeded by his son, William, Gough Sandes. Another son, Arthur, became a general in Ecuador, dying there before he was 40 years old. The Sandes family continued to reside at Greenville during the early 19th century. About the time of the First World War part of the house was burned down and the Sandes family moved into the Square in Listowel. In the early 1920s the Healy family bought Greenville, built and repaired the house and still remain and farm here. [1] Greenville Demesne dates from at least the late 18th century when it is recorded as the residence of George Sandes, High Sherriff of Kerry. Subsequently passed to his descendants, including George Sandes, a local land agent and landlord who was notorious for his cruelty in the late 19th century. [2] Main house burnt down in the early 20th century. Single storey building, much modernised now survives of stone with brick lintels and a slate roof. Series of stone boundary walls survive around the house, however all farm buildings are of modern construction. Demesne now turned over the agriculture and comprises flat pasture fields, defined by a low earth bank to the road to the south. Trees have been replanted along the driveway. Little surviving evidence of historic design. [3]
Approximate date	Late 18th century
Sources	[1] M Bence Jones, 1990. A Guide to Irish Country Houses [2] B MacMahon, 2003. 'George Sandes. Land agent, magistrate and terror of North Kerry' in Journal of Kerry Archaeology and History Society, Series 2, Vol 3, p5-56 [3] Walkover survey July 2013
Importance / Legal Status	Record Only / None
Distance from route (m)	0
Type of Impact	Direct Impact
Nature of Impact	Construction of scheme across edge of demesne. Removal of modern gateway.
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Imperceptible negative
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	Low negative
Significance of Operation Impact with Mitigation	Imperceptible negative
Extent of Impact	Construction of scheme across south edge of former demesne.

Reference Number	AH7 – Smithy, Greenville
Photo reference number	Site inspection 279-280
Address	Greenville
Location / Coordinates	497080633585
Site type	Smithy
Description	Smithy shown on 1st edition 25" map. [1] One storey building with catslide roof to rear. Construction in coursed limestone with modern slate roof, obscured by vegetation at time of inspection. Three openings to principal elevation comprising two doorways with single window to the left. Well in front of building. Roadside location to rear of modern house. [2]
Approximate date	19th century
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Importance / Legal Status	Local / None
Distance from route (m)	27
Type of Impact	Neutral Impact
Nature of Impact	No impact
Quality of Impact	Neutral
Magnitude of	No impact

Construction Impact	
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	No impact

Reference Number	AH8 - Cottage 1, Curraghatoosane
Photo reference number	Site inspection 153-157
Address	Curraghatoosane
Location / Coordinates	497939634396
Site type	Cottage
Description	Single storey cottage, now ruinous, of probable early 20th century date. Finely worked stone gateway and archway to stream present along roadside, includes knotwork decoration over arch to stream. Date of this feature is unknown. [1]
Approximate date	Early 20th century
Sources	[1] Walkover survey July 2013
Importance / Legal Status	Local / None
Distance from route (m)	14
Type of Impact	Temporary intrusion from construction works
Nature of Impact	Indirect
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	Temporary impact on setting

Reference Number	AH9 - Cottage 2, Curraghatoosane
Photo reference number	Site inspection 152
Address	Curraghatoosane
Location / Coordinates	497971634362
Site type	Cottage
Description	Ruinous cottage shown on 1st edition 25" Ordnance Survey map of 1888-1913. One storey with attic, constructed of rubble and rendered, with brick stack. Corrugated metal roof, now largely missing. Much overgrown. [1]
Approximate date	19th century
Sources	[1] 1st edition 25" Ordnance Survey map 1888-1913 [2] Walkover survey July 2013
Importance / Legal Status	Local / None
Distance from route (m)	2
Type of Impact	Indirect Impact
Nature of Impact	Temporary intrusion from construction works
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	Temporary impact on setting

Reference Number	AH10 – Lartigue Monorailway
Photo reference number	N/A
Address	Listowel
Location / Coordinates	498210634200
Site type	Railway
Description	Monorail opened in 1888 running from Listowel to Ballybunion. This was the only commercial passenger line constructed using the monorail design of the French engineer Charles Lartigue comprising a single elevated rail supported

	on an A-frame truss, with specially constructed locomotives and rolling stock. The line operated until the 1920s, however declining passenger and freight levels, combined with unreliability and damage during the Civil War contributed to the closure of the line in 1924. Footings from the original monorail yard are now exposed to the north of the former Listowel Railway Station, and part of the line has been reconstructed and now operates as a tourist attraction. [1], [2].
Approximate date	1888
Sources	[1] Walkover survey July 2013 [2] Newham, A. T. 1989. The Listowel and Ballybunion Railway
Importance / Legal Status	Local / None
Distance from route (m)	0
Type of Impact	Neutral Impact
Nature of Impact	No impact
Quality of Impact	Neutral
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	No impact

Reference Number	AH11 – Teampaillin Ban
Photo reference number	Site inspection 140 - 148
Address	Listowel
Location / Coordinates	9963701268633
Site type	Memorial
Description	Famine graveyard, 1845 - 1850, with various cut-stone grave markers and mausolea. Freestanding cut-stone Celtic Cross-style memorial, erected 1932, to east. Detached single-bay single-storey chapel, dated 1997 [1] Famine graveyard, 1845-1850, with various cut-stone grave markers and mausolea. Freestanding cut-stone Celtic Cross style memorial, erected 1932, to east. Detached single-bay single-storey chapel, dated 1997, having pitched artificial slate roof, painted rendered walls and timber panelled door with sidelights. Pathways to site, flanked by shrubs and carved slate Stations of the Cross. Marble statue of the Blessed Virgin Mary in front of the chapel entrance. [2] 2700 souls estimated to have been buried here during the famine. Subsequently used as a burial ground for the workhouse for the following 80 years. Formed by a rectangular grassed enclosure with a mature tree at its centre. The graveyard is enclosed by tall hedges to the north, south and west, whilst a small modern chapel is located to the west. Accessed by a path from the west with a free-standing cross at the entrance. [3]
Approximate date	Mid-19th century
Sources	[1] Record of Protected Structures description [2] NIAH reference 21400287 [3] Walkover survey July 2013
Importance / Legal Status	Regional / Protected Structure
Distance from route (m)	9
Type of Impact	Indirect Impact
Nature of Impact	Temporary intrusion on setting from construction activities Impact on setting
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Slight negative
Magnitude of Operation Impact	Low negative
Significance of Operation Impact	Slight negative
Mitigation Measures	Landscaping
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Slight negative
Magnitude of Operation Impact with Mitigation	Neutral
Significance of Operation Impact with Mitigation	No Impact
Extent of Impact	Impact on setting

Reference Number	AH12 – Monorailway Bridge
Photo reference number	Site inspection 167-168
Address	Curraghatoosane
Location / Coordinates	498157634245
Site type	Bridge
Description	Bridge constructed in late 19th century to carry a local road over the Listowel and Ballybunion Monorailway. Single span structure of random coursed ashlar construction. Deck supported on steel girders with open steel parapets of geometric design. Slightly battered wing walls. Now sited in

	verge to side of road, with steel palisade fence below. Reputed to be one of the first structures to use reinforced concrete in County Kerry. [1], [2]
Approximate date	Late 19th century
Sources	[1] Walkover survey July 2013 [2] A T Newham, 1989. The Listowel and Ballybunion Railway.
Importance / Legal Status	Local / None
Distance from route (m)	0
Type of Impact	Indirect Impact
Nature of Impact	Impact on setting
Quality of Impact	Negative
Magnitude of Construction Impact	Low negative
Significance of Construction Impact	Imperceptible negative
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	Protection from accidental damage during construction phase
Magnitude of Construction Impact with Mitigation	Low negative
Significance of Construction Impact with Mitigation	Imperceptible negative
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	Temporary impact on setting

Reference Number	AH13 – Goods Shed
Photo reference number	Site inspection 125
Address	Listowel
Location / Coordinates	498684634178
Site type	Railway shed
Description	Detached two-bay double-height gable-fronted stone-built former railway goods shed, c. 1900, originally with round-headed opening to left having cut-stone voussoirs and three-bay double-height side elevations having segmental-headed window openings with red brick surrounds; renovated, c. 1980, with openings remodelled and some blocked-up to accommodate use as outbuilding. Freestanding iron crane, c. 1900, to site. Renovated and remodelled to accommodate historic and cultural use. [1] Detached gable-fronted two-bay double-height gable-fronted former railway goods shed, built c. 1900, originally with round-headed opening to left having cut-stone voussoirs. Three-bay double-height side elevations having segmental-headed window openings with red brick surrounds. Renovated with openings remodelled and some blocked-up to accommodate use as outbuilding. Pitched slate roof with red brick chimneystack to east gable. Coursed rubble stone walls with raised hammered limestone ashlar quoins and corbels at half-height along south wall. Segmental red brick arches to side openings with limestone reveals and cement sills, openings now blocked up. Round-headed opening to engine house with ashlar voussoirs and reveals, red brick surround to bulls eye and having arched windows to north wall. Freestanding iron crane, built c. 1900, to site. [2] As described. Now in use by Lartigue Monorailway. Forms a group with the former train station (AH13) located to the east. [3]
Approximate date	c.1900
Sources	[1] Listowel Development Plan Appendix A [2] NIAH reference 21400288 [3] Walkover survey July 2013
Importance / Legal Status	Regional / Protected Structure
Distance from route (m)	5
Type of Impact	Neutral Impact
Nature of Impact	No impact
Quality of Impact	Neutral
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	No impact

Reference Number	AH14 – 5 & 6 John B. Keane Grove
Photo reference number	Site inspection 126
Address	Listowel
Location / Coordinates	498829634176
Site type	Railway station
Description	Detached seven-bay single-and two-storey limestone ashlar former Victorian railway station, built 1880, comprising four-bay single-storey main block with two-bay two-storey gabled

	projecting bay to west, single-bay two-storey recessed end bay to west and single-bay single – storey gabled projecting end bay to east; closed, 1963; was ruinous and mostly collapsed with remains of section of stone-built platform, c. 1880, along north elevation. Restored to use as 2 semi-detached dwellings.[1] Detached seven-bay single- and two-storey Victorian former railway station, built 1880, comprising four-bay single-storey main block with two-bay two-storey gabled projecting bay to west, single-bay two-storey recessed end bay to west and single-bay single-storey gabled projecting end bay to east. Closed in 1963, now ruinous and mostly collapsed. Limestone ashlar chimneystacks, one with a yellow clay pot, chimneystacks are brick below former roof level. Hammered limestone ashlar walls with raised bevel-edged quoins. Limestone ashlar sills, lintels and reveals to square-headed openings. Two round-headed windows at first floor with ashlar voussoirs. Windows now blocked up. Remains of section of stone-built platform, built c. 1880, along north elevation. Coursed rubble wall to platform with castellated coping. [2] As described. Located directly to the north of the busy John B Keane Road. Forms a group with the former Goods Shed located to the west (Asset AH13). [3]
Approximate date	1880
Sources	[1] Listowel Development Plan Appendix A [2] NIAH reference 21400289 [3] Walkover survey July 2013
Importance / Legal Status	Regional / Protected Structure
Distance from route (m)	8
Type of Impact	Neutral Impact
Nature of Impact	No impact
Quality of Impact	Neutral
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact

Reference Number	AH15 – Listowel
Photo reference number	Site inspection 366 – 390
Address	Listowel
Location / Coordinates	99200133866
Site type	Town
Description	Historic core of Listowel, now designated as nine separate conservation areas. Historic townscape reflects development of the settlement from the medieval period, as evidenced by the presence of Listowel Castle, but is predominantly of later 18th and 19th century date. Buildings of two and three storeys comprising a mixture of cottages and townhouses, notable for their brightly painted exteriors and particularly the distinctive decorative plasterwork which characterises the town. Public structures in contrast predominantly of stone. [1]
Approximate date	Multiperiod
Sources	[1] Walkover survey July 2013
Importance / Legal Status	Regional / Architectural Conservation Area
Distance from route (m)	52
Type of Impact	Indirect impact
Nature of Impact	Enhancement of amenity Reduction in noise and visual intrusion
Quality of Impact	Positive
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	Low positive
Significance of Operation Impact	Slight positive
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	Reduction in traffic levels from town centre.

Reference Number	AH16 – Culvert
Photo reference number	SEC30 bridge outfall 1
Address	Below R553, Curraghatoosane
Location / Coordinates	498000,634370
Site type	Culvert
Description	Stone-built culvert carrying a small watercourse under the R553. West face formed by a segmental stone arch over a stone-lined channel. The east face of culvert now formed by concrete lintel and was heavily overgrown during survey. The route of the R553 is shown on the first edition 6" Ordnance Survey map of 1847, and it is possible that the construction of the culvert dates from the 19th century. [1]
Approximate date	Modern
Sources	[1] Watercourse survey June 2013
Importance / Legal Status	Local
Distance from route (m)	5
Type of Impact	No impact
Nature of Impact	No impact
Quality of Impact	No impact
Magnitude of Construction Impact	No impact
Significance of Construction Impact	No impact
Magnitude of Operation Impact	No impact
Significance of Operation Impact	No impact
Mitigation Measures	None proposed
Magnitude of Construction Impact with Mitigation	No impact
Significance of Construction Impact with Mitigation	No impact
Magnitude of Operation Impact with Mitigation	No impact
Significance of Operation Impact with Mitigation	No impact
Extent of Impact	No impact.

N69 Listowel Bypass,

County Kerry

Archaeological Geophysical Survey

Detection Licence No. 14R0084

Survey undertaken on behalf of

Kerry County Council/NRA

H. Gimson BA (Hons) MSc MIAI

Dr. J. Bonsall MIAI

EAG 251

06 August 2014

EARTHSOUND archaeological geophysics

PROSPECT HOUSE, DRUMAGH, CLAREMORRIS, COUNTY MAYO, IRELAND

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Summary of Results

Between the 9th June and 12th July 2014, a geophysical survey commissioned by Kerry County Council/NRA NRDO was conducted along the proposed N69 Listowel Bypass, County Kerry, in areas of archaeological potential which would be affected by the road scheme. A fluxgate gradiometer survey was undertaken at a sampling resolution of 1 x 0.25 m accompanied by a resistivity survey at a sampling resolution of 0.5 x 0.25m.

The survey was conducted upon a bedrock geology consisting of Visean undifferentiated Limestone. The survey area comprised of grass pasture fields, newly cut silage fields and occasional areas of bog grass.

The geophysical survey has identified anomalies of possible archaeological origin within the specified survey areas. Significant findings of the geophysical assessment include ditches, possible ditches or gullies, pits and stone or compacted earth features.

The anomalies have been accurately located and their provenance has been described in tabular and map form. Further work in the form of test trench excavations has been recommended where required.

Statement of Indemnity

A geophysical survey is a scientific procedure that produces observations of results which are influenced by specific variables. The results and subsequent interpretation of the geophysical survey presented here should not be treated as an absolute representation of the underlying archaeological features, but as a hypothesis that must be proved or disproved. ***Direct investigations are recommended to confirm the findings of this report.*** *Verification can only be provided via intrusive means, such as test trench excavations.*

1 Introduction

1.1 Brief Description of the Proposed Development

Earthsound Archaeological Geophysics were commissioned by Kerry County Council/NRA to execute a geophysical survey over the route of the proposed Listowel Bypass. The bypass is intended to commence on the existing N69 road, crossing the River Feale in order to connect with John B. Keane Bridge. The survey was undertaken in two individual blocks encompassing a total area of 2.69 hectares with the intention of investigating three sites of archaeological potential.

1.2 Aims of the Survey

Kerry County Council/NRA required an archaeological geophysical survey of the proposed route of the N69 Listowel Bypass.

The aims of the Stage (i) i Geophysical Survey Services were to:

- identify any geophysical anomalies of possible archaeological origin within the specified survey areas.
- accurately locate these anomalies and present the findings in map form.
- describe the anomalies and discuss their likely provenance in a written report.
- recommend any further work (including other forms of geophysical survey if appropriate) likely to contribute to the mitigation of the impacts of the road scheme on these features.
- incorporate all of the above in a report to Kerry County Council/NRA.

The geophysical survey was requested to determine the identity and location of anomalies of possible archaeological origin. The survey will form part of the environmental Impact assessment in advance of the proposed scheme. A magnetometer and resistivity survey was conducted over the area of interest.

1.3 Description of the Survey Area

The two survey areas are both located within the townland of Coolnaleen Lower, Listowel. These comprised of four pasture fields, some of which had been subdivided and containing occasional areas of bog grass.

The survey areas are located upon a bedrock geology of undifferentiated Visean Limestone. Limestone is a weakly magnetic geology. Archaeological features that have been burnt or heated attain a thermoremanant magnetisation, which appear as a strong magnetic anomaly against the magnetically quiet limestone geology. However, cut archaeological features such as ditches and pits, will contrast poorly with the background soils – the fills may be weakly- or non-magnetic compared to the geological background.

The climatic conditions were a mixture of dry sunny days and days of heavy showers. The weather is unlikely to have had an impact on the results obtained.

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1.4 Statutory Protections

There are three recorded monuments located adjacent to the survey areas; a ringfort (KE-010-075); a burnt spread (KE-010-077); and a holy well (KE-010-079). No other archaeological remains are known to be contained within the survey area.

The National Monuments Acts (1930-2004) prohibit the unauthorised use of detecting devices on archaeological sites as well as unauthorised searches for archaeological objects using such devices. All elements of the survey were carried out in accordance with a written method statement and an application for a detection licence from the DoAHG to carry out the work. The Detection Licence was issued to Heather Gimson, Number 14R0084.

1.5 Archaeological Background

The proposed development is near a number of archaeological monuments, the closest being as mentioned above a ringfort (KE-010-075), a burnt spread (KE-010-077) and a holy well (KE-010-079).

ID	Location (Townland)	Description	Calculated Area (ha)
GS-01	Coolnaleen Lower	KE-010-077: According to the landowner, burnt stones and charcoal were discovered during ploughing. It was situated about 11m NW of a possible holy well. A scattering of burnt stones can still e seen today. KE-010-079: This well consists of a crescent –shaped depression within which is the well. The top of the well is mortared and below is drystone walling	2.16
GS-02	Coolnaleen Lower	KE-010-075: Internal diameter 28m NS, 27m EW In a large pasture field, this univallate rath is in a poor state of preservation. It consists of a circular area enclosed by an earthen bank 3.4m-6m wide, 1m high externally and 0.6m-1.2m above the interior. Numerous cattle breaks and gaps exist in the bank. Extending from the SSE sector is a low straight bank running E, possibly the remains of an old field bank.	0.52

Table 1.5 Archaeological background

2 Methodology

The fieldwork was carried out between the 9th July and 12th July 2014 by J. Bonsall and D. Regan of Earthsound Archaeological Geophysics.

A magnetic gradiometer survey was carried out using four Geoscan Research FM256 fluxgate gradiometers. Two pairs of sensors were each mounted on a CF6 carry frame.

An electromagnetic survey was carried out in order to collect apparent resistivity data using a GF Instruments CMD Mini-Explorer.

The survey areas covered a total of 2.68 hectares, this was surveyed using magnetic gradiometers and the electromagnetic instrument. The presence of poor and disturbed ground precluded survey in the northern portion of GS01, while the resistivity survey could not be used in a small area of the southern field due to the presence of nearby electric fences and a limited survey area. A rectangular grid was laid out using a Trimble Pro-XRS Differential Global Positioning System (see Technical Appendix 2), and divided into 40 × 40 m sub-grids.

2.1 Magnetic Gradiometer Survey

The survey was undertaken along lines parallel to the sub-grid edges, walking approximately west to east or south to north (depending on the shape of the site and the orientation of the proposed road take), starting in the southwest or northwest corner of each grid. Subsequent lines were surveyed in alternate directions ('zigzag').

Data were recorded using an FM256 at a spatial resolution of 1 m intervals between traverses and 0.25 m intervals along those lines. The instruments were positioned facing north, parallel to the Earth's magnetic field, to allow increased geo-magnetic resolution.

The instrument was set to a recording sensitivity of 0.1 nT. Prior to the beginning of the survey and after the completion of every two sub-grids, the electronic and mechanical set-up of the instrument were examined and calibrated as necessary over a common reference point. The magnetic drift from zero was not logged.

Data were collected automatically using an internal sample trigger while the operator walked at a constant pace along the traverse. The data were stored in an internal data logger and downloaded to a field computer using the Geoscan Research Geoplot v.3.00a software.

2.1.1 Data Processing

2.1.1.1 Preliminary Data Treatment

The data were pre-processed in Geoplot 3.00.

Spurious high-intensity anomalies, commonly statistical outliers, are referred to as geophysical 'spikes'. In magnetic data, an 'iron spike' is a response to a buried ferrous object, often in the topsoil. Iron spikes are generally not removed in geophysical data; although often modern in origin, they can be indicative of archaeological material.

The raw data contained some poorly matched sub-grids, caused by the internal drift of the fluxgate gradiometer and the gradual misalignment of the fluxgate sensors between calibration episodes. To compensate for this, a zero mean traverse (ZMT) function was employed. The use of ZMT alters data to adjust the mean of each traverse to zero by increasing or decreasing data as necessary. This alters the statistical properties of the data to give a uniformly bipolar background, centred around zero. Post-ZMT plots were compared with raw data to analyse the potential removal of geophysical anomalies along the line of a traverse.

2.1.1.2 Further Processing

No further processing functions were applied due to the high quality of the data collection.

A low pass Gaussian filter was applied, reducing the variability of the data while improving the visibility of weak archaeological features. This also had a smoothing effect on the data.

A sine wave interpolation function was applied to provide a smooth, aesthetically pleasing image for presentation. For a given point x, the contribution of adjacent readings to the interpolated point is given by the function sinc $(x) = \sin \pi x / \pi x$ (Scollar 1990). This function is used as a sliding window along each transect, resulting in an interpolated image, expanding the resolution of the data from 1 m x 0.25 m to 0.5 m x 0.25 m. This function was chosen as giving a clearer interpolated image than linear interpolation (which assumes a direct linear change between each point) or bicubic interpolation (taking the surrounding sixteen values into account).

2.1.2 Graphical Display

Processed data are shown in Greyscale format in Figures 3 & 7. The greyscale plot presents data as pixels on a linear grey shaded scale, increasing or decreasing dependent on the values of the maximum and minimum clip. The geophysical data have been clipped at –1.5 nT (white) and +1.5 nT (black). Data values beyond the clip limits are shown as 'pure' black or white. The main advantage of this display option is that the data can be viewed as a base map.

Interpretation plots are presented in Figures 4 & 8.

2.2 Resistivity Survey

An electromagnetic instrument collected resistivity data. The horizontal dipole orientation ('Low', or Vertical Coplanar Coil configuration) was chosen for a depth range that is applicable to archaeological remains. Resistivity data are displayed in ohm/m to a resolution of 0.1 ohm/m.

The survey collected conductivity and magnetic susceptibility data at a sample interval of 0.5 m between traverses and 0.2 seconds along the traverse. The data were collected in continuous mode by a time based sample trigger connected via blue-tooth to the instrument. The instrument was held approximately 5cm above the ground.

The survey was undertaken along lines parallel to the sub-grid edges, walking approximately south to north, starting in the southwest corner of each grid. Subsequent lines were surveyed in alternate directions ('zigzag').

The data were stored in an automatic data logger and downloaded to a field computer.

2.2.1 Data Display

2.2.1.1 Preliminary Data Treatment

The data were downloaded via standard software (GF Instruments' CMD Data Transfer). Both data outputs were gridded in Surfer to a spatial resolution of 0.5m x 0.25m and imported into Geoplot.

The electromagnetic instrument drifts over time but is calibrated at the start of each traverse, therefore drift is limited between traverses rather than across the entire grid of data. To compensate for the drift along the traverse, a zero mean traverse (ZMT) function was employed. The use of ZMT alters data to adjust the mean of each traverse to zero by increasing or decreasing data as necessary. This alters the statistical properties of the data to give a uniformly bipolar background, centred around zero. Post-ZMT plots were compared with raw data to analyse the potential removal of geophysical anomalies along the line of a traverse.

2.2.1.2 Further Processing

No further processing functions were applied due to the high quality of the data collection.

A sine wave interpolation function was applied to provide a smooth, aesthetically pleasing image for presentation. For a given point x, the contribution of adjacent readings to the interpolated point is given by the function sinc $(x) = \sin \pi x / \pi x$ (Scollar 1990). This function is used as a sliding window along each transect, resulting in an interpolated image, expanding the resolution of the data from 0.5m x 0.25m to 0.25m x 0.125m. This function was chosen as giving a clearer interpolated image than linear interpolation (which assumes a direct linear change between each point) or bicubic interpolation (taking the surrounding sixteen values into account).

2.2.2 Graphical Display

The processed data are displayed in greyscale plot format in Figures 5 & 9. The data were clipped at 3 Ohms (black) and 10 Ohms (white).

An interpretation plot of the data is presented in Figures 6 & 10.

2.3 Reporting, Mapping & Archiving

The geophysical survey and report follow the recommendations outlined in the English Heritage Guidelines (David et al. 2008) and IFA Paper No. 6 (Gaffney et al. 2002) as a minimum standard. The conditions of the Detection Licence issued by the Licensing Section of the Department of the Arts, Heritage and the Gaeltacht require a copy of this report.

Geophysical data, figures and text are archived following the recommendations of the Archaeology Data Service (Schmidt 2001).

Field boundaries were mapped and drawn based upon data gathered by the DGPS.

Technical information on the equipment used, data processing and methodology are given in Appendix 1. Appendix 2 details the survey geo-referencing information and Appendix 3 describes the composition and location of the archive.

3 Results & Discussion

The interpretation figures should not be looked at in isolation but in conjunction with the relevant discussion section and with the information contained in the Appendices. Features are highlighted in the interpretation diagrams and are described and interpreted within the text.

3.1 Geophysical Anomalies

Anomalies presented in standard text were identified in the magnetometer data; anomalies presented in *italics* have been detected within the resistivity surveys undertaken within the relevant field

Suvey Area	Townland	Site Description	ITM (E,N)	Form of Anomaly	Possible Source(s) of Anomaly	Recommendation
GS-01	Coolnaleen Lower	Low level pasture field sub-divided by electric fences. The northern fields contained poor and disturbed ground which were unsuitable for surveying.	497564, 632154	1. Area of magnetic interference	1. Probably modern dumping, but possibly associated with burnt soils either archaeological or modern	1. Assess as necessary
				2. Area of magnetic interference	2. Probably modern dumping, but possibly associated with burnt soils either archaeological or modern	2. Assess as necessary
				3. Possible Ditch or Gully	3. Possible ditch – archaeological or agricultural	3. Test Trench Excavation
				4. Possible Ditch or Gully	4. Possible ditch or gully – archaeological or geological	4. Test Trench Excavation
				5. Possible Ditch or Gully	5. Possible ditch or gully – archaeological or agricultural	5. Test Trench Excavation
				6. Possible Ditch or Gully	6. Possible ditch or gully – archaeological or agricultural	6. Test Trench Excavation
				7. Area of magnetic interference	7. Probably modern dumping, associated with adjacent buildings	7. Assess as necessary
				8. Ditch	8. Possible ditch – archaeological or agricultural	8. Test Trench Excavation
				9. Ditch	9. Possible ditch – archaeological or agricultural	9. Test Trench Excavation
				10. Possible Ditch or Gully	10. Possible ditch or gully – archaeological or geological	10. Test Trench Excavation
				11. Possible Ditch or Gully	11. Possible ditch or gully – archaeological or geological	11. Test Trench Excavation
				12. Area of magnetic interference	12. Possible burning – possibly archaeological	12. Test Trench Excavation
				13. Area of magnetic interference	13. Geological bore hole	13. No Action Necessary
				14. Possible Ditch or Gully	14. Possible ditch or gully – archaeological or agricultural	14. Test Trench Excavation
				15. Possible Ditch or Gully	15. Possible ditch or gully – archaeological or agricultural	15. Test Trench Excavation

Suvey Area	Townland	Site Description	ITM (E,N)	Form of Anomaly	Possible Source(s) of Anomaly	Recommendation
				16. Possible Ditch or Gully	16. Possible ditch or gully – archaeological or agricultural	16. Test Trench Excavation
				17. *Thirteen isolated areas of disturbed ground*	17. *Possible Pits – archaeological or agricultural*	17. *Test Trench Excavation*
				18. *Linear compacted earth or stone feature*	18. *Possible Wall – archaeological or agricultural*	18. *Test Trench Excavation*
				19. *Ditch*	19. *Possible ditch – archaeological or agricultural*	19. *Test Trench Excavation*
				20. *Four areas of disturbed ground*	20. *Possible archaeological or agricultural*	20. *Test Trench Excavation*
				21. *Ditch*	21. *Possible ditch – archaeological or agricultural*	21. *Test Trench Excavation*
				22. *Ditch*	22. *Possible archaeological or geological*	22. *Test Trench Excavation*
				23. *Linear compacted earth or stone feature*	23. *Possible Wall – archaeological or agricultural*	23. *Test Trench Excavation*
				24. *Right-angled compacted earth or stone feature*	24. *Possible Wall or Boundary – archaeological or agricultural*	24. *Test Trench Excavation*
				25. *Right-angled compacted earth or stone feature*	25. *Possible Wall or Boundary – archaeological or agricultural*	25. *Test Trench Excavation*
				26. *Ditch*	26. *Possible archaeological or geological*	26. *Test Trench Excavation*
				27. *Ditch*	27. *Possible archaeological or geological*	27. *Test Trench Excavation*
				28. *Ditch*	28. *Possible archaeological or geological*	28. *Test Trench Excavation*
				29. *Right-angled compacted earth or stone feature*	29. *Possible Wall or Boundary – archaeological or agricultural*	29. *Test Trench Excavation*
				30. *Linear compacted earth or stone feature*	30. *Possible Wall – archaeological or agricultural*	30. *Test Trench Excavation*
GS-02	Coolnaleen Lower	Low level pasture field sub-divided by a electric fence.	497657, 631876	31. Possible Ditch or Gully 32. Possible Ditch or Gully 33. Parallel Linear Trends 34. Possible Ditch or Gully 35. Curvilinear Possible Ditch or Gully 36. Ditch	31. Possible Archaeological or Agricultural 32. Possible Archaeological or Agricultural 33. Cultivation Furrows – possibly burnt 34. Possible Archaeological or Agricultural 35. Possible Archaeological or Geological 36. Possible Archaeological or Agricultural	31. Test Trench Excavation 32. Test Trench Excavation 33. Access As Necessary 34. Test Trench Excavation 35. Test Trench Excavation 36. Test Trench Excavation

Suvey Area	Townland	Site Description	ITM (E,N)	Form of Anomaly	Possible Source(s) of Anomaly	Recommendation
				37. Six isolated areas of disturbed ground *38. Right-angled compacted earth or stone feature* *39. Right-angled compacted earth or stone feature* *40. Ditch* *41. Curving trend of compacted earth or stone*	*37. Possible Pits – archaeological or agricultural* *38. Possible Wall or Boundary – archaeological or agricultural* *39. Possible Wall or Boundary – archaeological or agricultural* *40. Possible archaeological, agricultural or geological* *41. Possible Stone or bank material - archaeological or geological*	*37. Test Trench Excavation* *38. Test Trench Excavation* *39. Test Trench Excavation* *40. Test Trench Excavation* *41. Test Trench Excavation*

4 Conclusion

4.1 Summary of Results

The survey has identified geophysical anomalies of possible archaeological origin within the specified survey areas. These have been accurately located and their provenance has been described in tabular and map form. Further work in the form of test trench excavations has been recommended where required. Significant findings of the geophysical assessment include comprised of ditches, possible ditches or gullies, pits and stone or compacted earth features. No anomalies with a direct relationship to any of the surrounding recorded monuments have been detected.

Survey Area	Anomaly No.	Description of Significant Anomaly	Detection Technique
GS01	4	Arcing possible ditch or gully	Magnetic Gradiometer
GS01	11	Arcing possible ditch or gully	Magnetic Gradiometer
GS01	12	Possible burnt remains	Magnetic Gradiometer
GS01	17	Possible pits	Resistivity
GS01	22	Sub-circular ditch	Resistivity
GS02	36	Arcing possible ditch or gully	Magnetic Gradiometer
GS02	37	Possible pits	Resistivity
GS02	41	Possible pits	Resistivity

Table 4.1 Significant anomalies.

4.2 Recommendations

- Test trenching should occur at locations recommended in Section 3.1, above. Many of these will be to determine the presence/absence of geology/archaeology interpreted from weakly magnetic trends.

4.3 Dissemination

The results of this survey were submitted to Kerry County Council / NRA. Earthsound will ensure that copies will be forwarded to the Department of the Arts, Heritage and the Gaeltacht and the National Museum of Ireland in compliance with the Licence agreement.

5 Acknowledgements

Fieldwork: Dr. James Bonsall MIAI
Darren Regan BSc (Hons) MA

Report: Heather Gimson BA (Hons) MSc MIAI
James Bonsall

Graphics: Heather Gimson

6 Bibliography

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Websites Consulted

http://gsigis1.dcmnronline.ie/imf/imf.jsp?site=GSI_Simple Accessed 16/07/2014

7 Figures

Technical Appendix

Appendix 1: Methodology

Magnetic Gradiometer Survey

A detailed survey requires a sample trigger to automatically take readings at predetermined points. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning or magnetic susceptibility.

Resistivity Survey

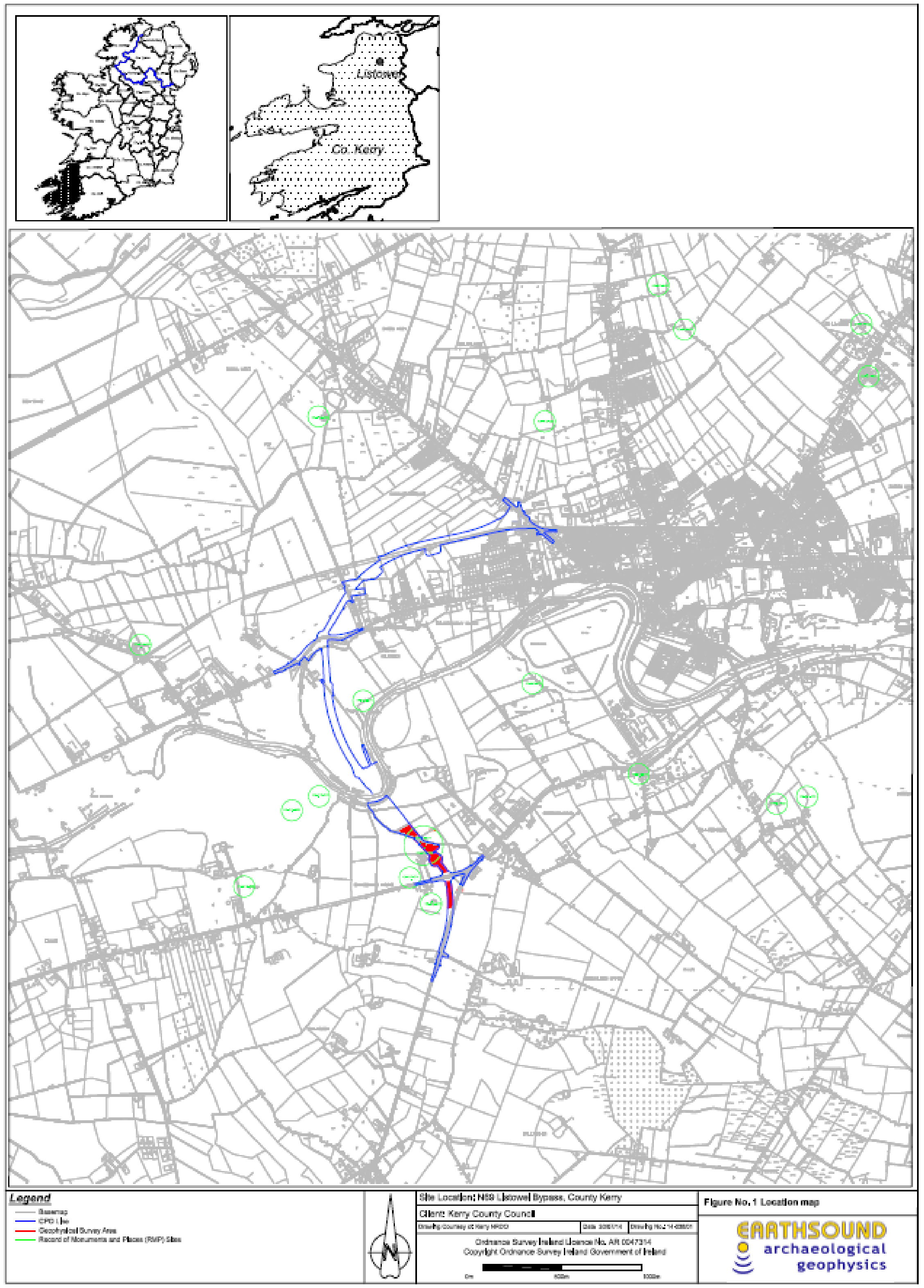
The instrument comprises of a transmitter and receiver coil. The instruments transmit an alternating current which induces a primary and subsequently a secondary electromagnetic field. The electromagnetic fields interact with the underlying soils and the subsequent responses are measured.

Appendix 2: Survey Grid Re-location

1. Each survey grid was laid out using a *Trimble* Pro-XRS Differential Global Positioning System (DGPS), to an accuracy of ±50cm.
2. There was a good correlation between the geophysical survey data and the digital map base and it is estimated that the average 'best fit' error is lower than ±0.25m. It is important to note that local grid north (27/08/03) varies slightly from *Ordnance Survey* north, with an annual decrease of 0.9°3'.

Appendix 3: Geophysical Archive

At present, two copies of the archive are held by *Earthsound Archaeological Geophysics*, at separate locations to ensure preservation against accidental damage or theft. The Client, *Kerry County Council/Kerry NRDO*, holds one further copy of the archive. Additional paper copies intended for ultimate deposition with the *Department of the Arts, Heritage and the Gaeltacht* are in the guardianship, and are the responsibility of, *Earthsound Archaeological Geophysics.*


Listowel
Co. Kerry
Legend
Basemap
CPO Line
Geophysical Survey Area
Record of Monuments and Places (RMP) Sites
Site Location: N69 Listowel Bypass, County Kerry
Client: Kerry County Council
Ordnance Survey Ireland Licence No. AR 0047314
Copyright Ordnance Survey Ireland Government of Ireland
Figure No. 1 Location map
EARTHSOUND
archaeological
geophysics

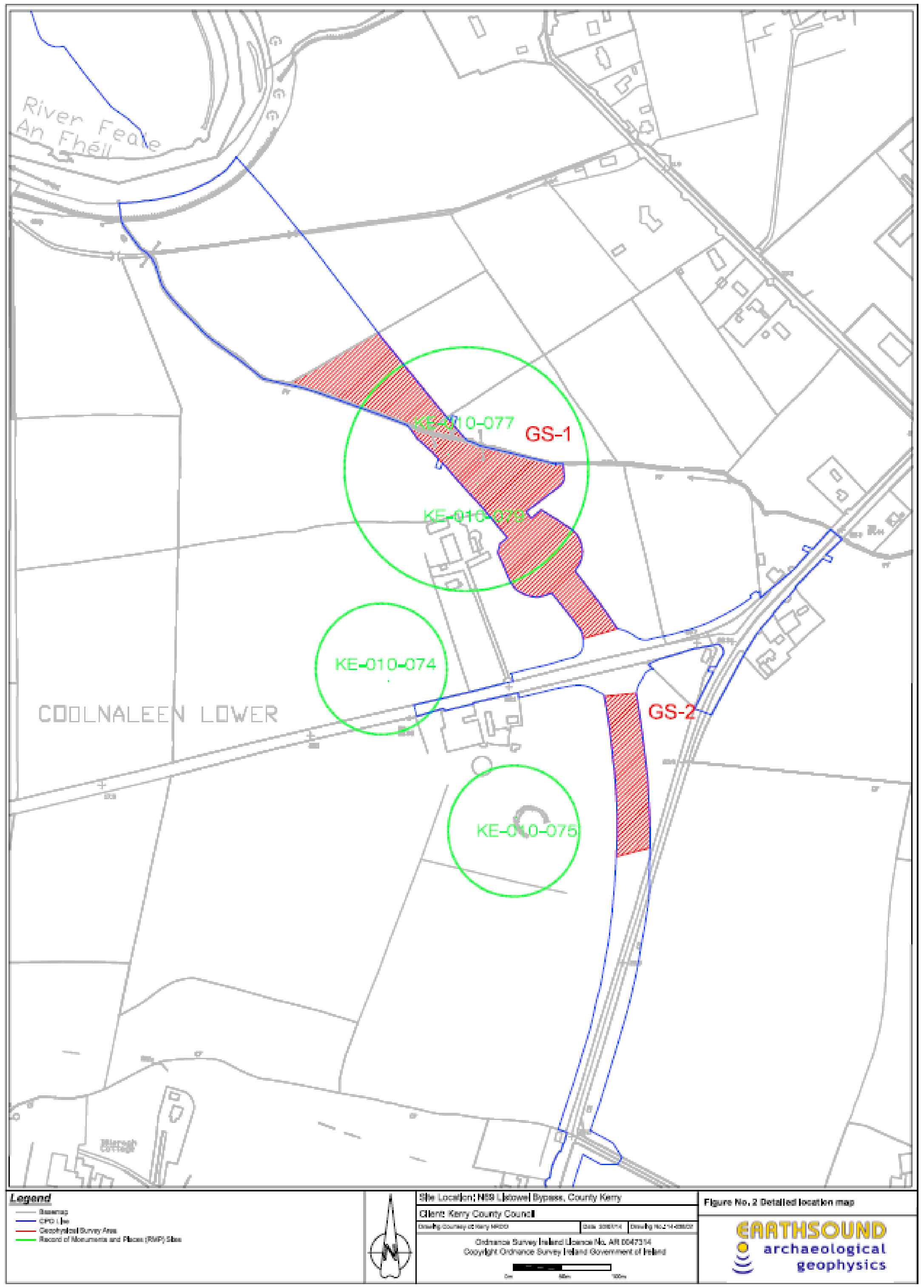

River Feale
An Fhéil
KE-010-077
GS-1
KE-010-074
COOLNALEEN LOWER
GS-2
KE-010-075
Legend
Basemap
CPO Line
Geophysical Survey Area
Record of Monuments and Places (RMP) Sites
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Figure No. 2 Detailed location map
EARTHSOUND
archaeological
geophysics

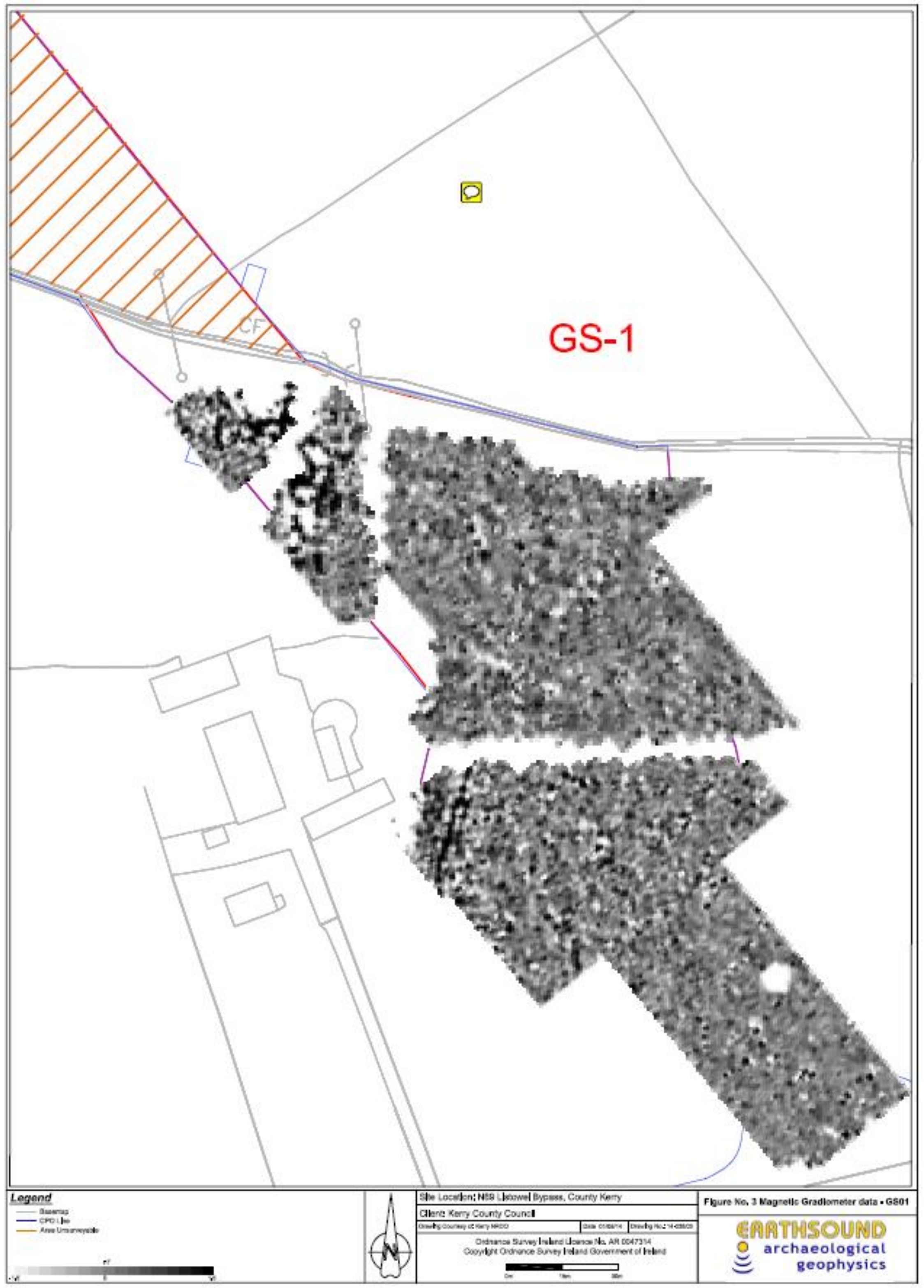
GS-1
Legend
Basemap
CPO Line
Area Unsurveyable
Site Location: N69 Listowel Bypass, County Kerry
Client: Kerry County Council
Ordnance Survey Ireland Licence No. AR 0047314
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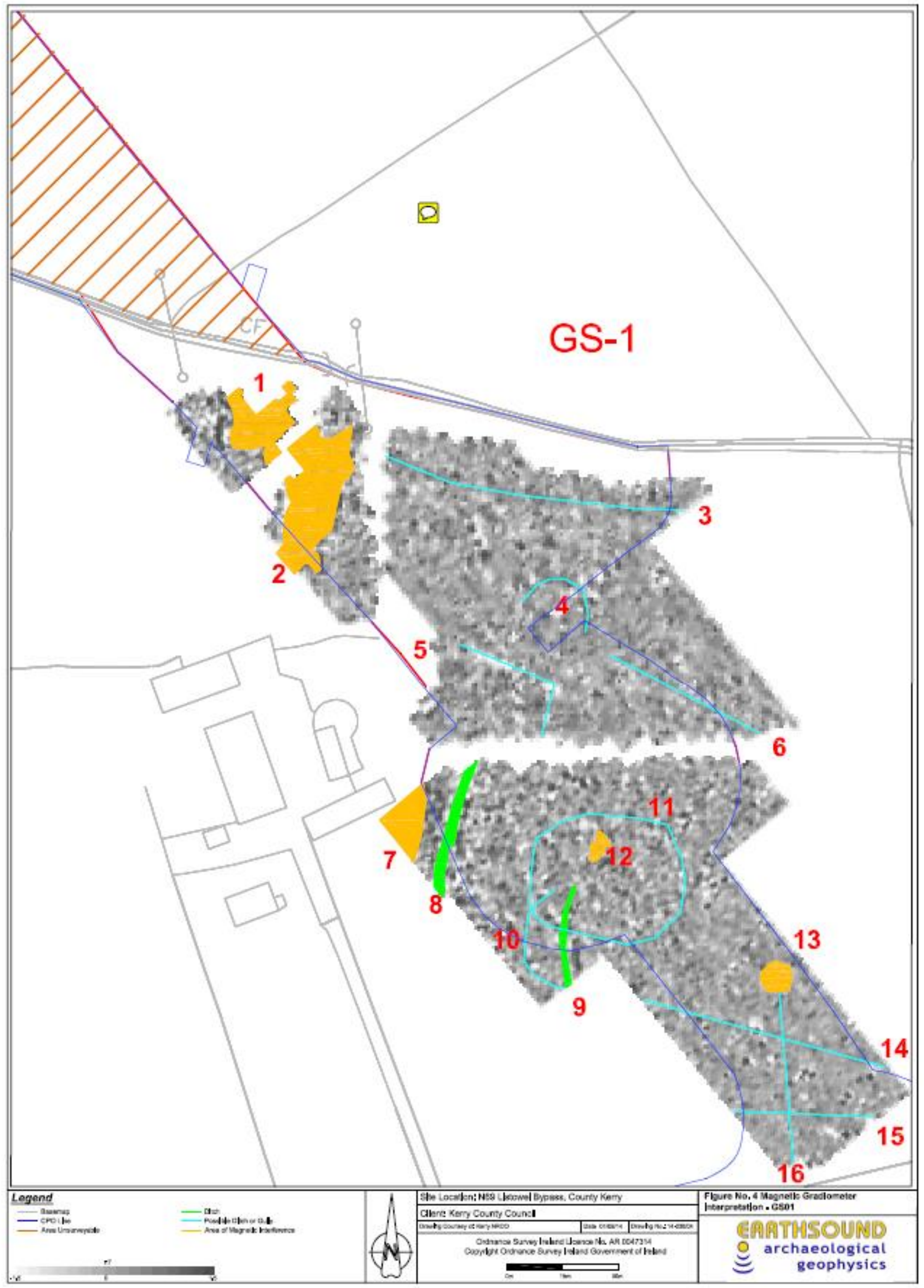
Figure No. 3 Magnetic Gradiometer data - GS01
EARTHSOUND
archaeological
geophysics


GS-1
1
2
3
4
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6
7
8
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10
11
12
13
14
15
16
Legend
Basemap
CPO Line
Area Unsurveyable
Ditch
Possible Ditch or Gully
Area of Magnetic Interference
Site Location: N69 Listowel Bypass, County Kerry
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Figure No. 4 Magnetic Gradiometer Interpretation - GS01
EARTHSOUND
archaeological
geophysics

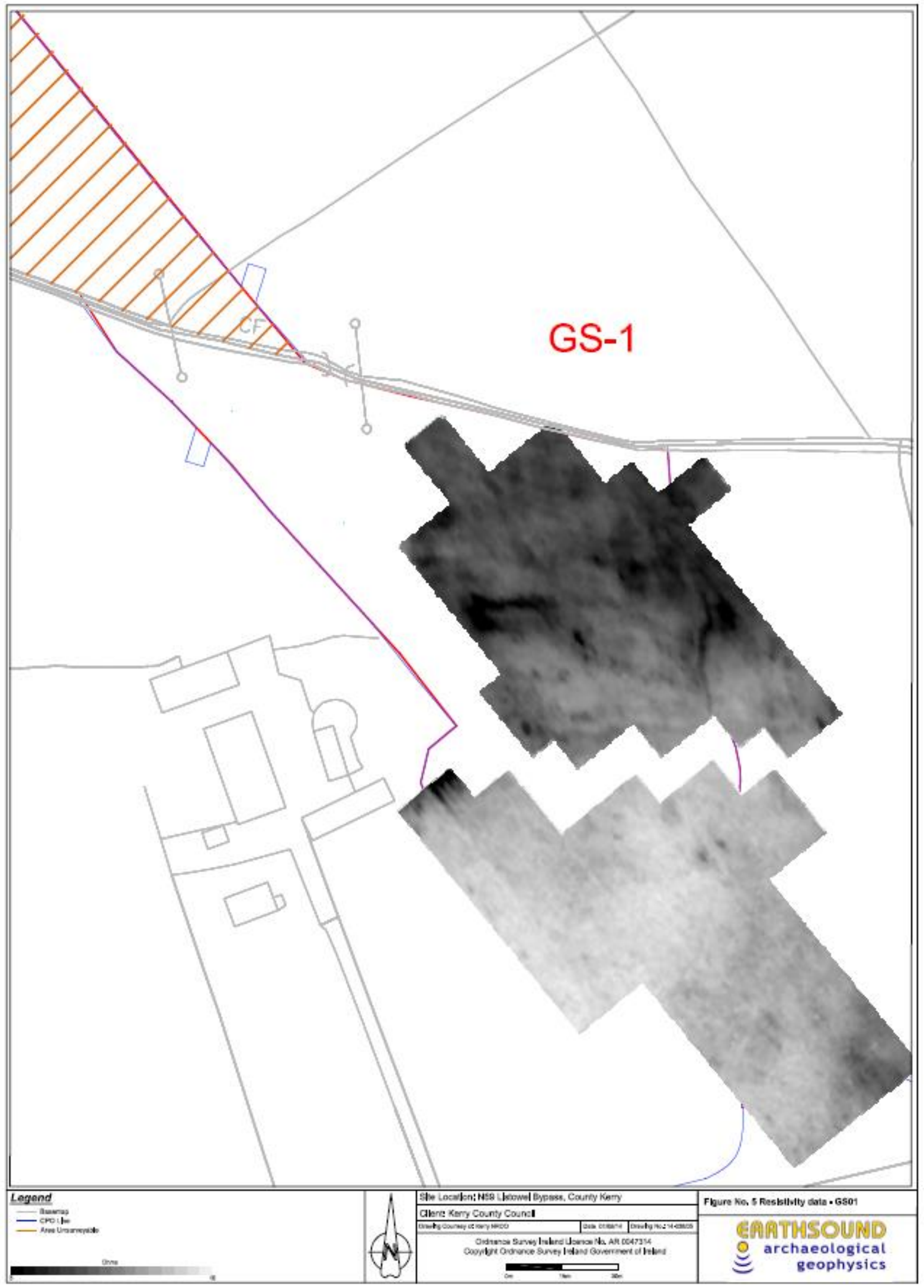
GS-1
CF
Legend
Basemap
CPO Line
Area Unsurveyable
Ohms
Site Location: N69 Listowel Bypass, County Kerry
Client: Kerry County Council
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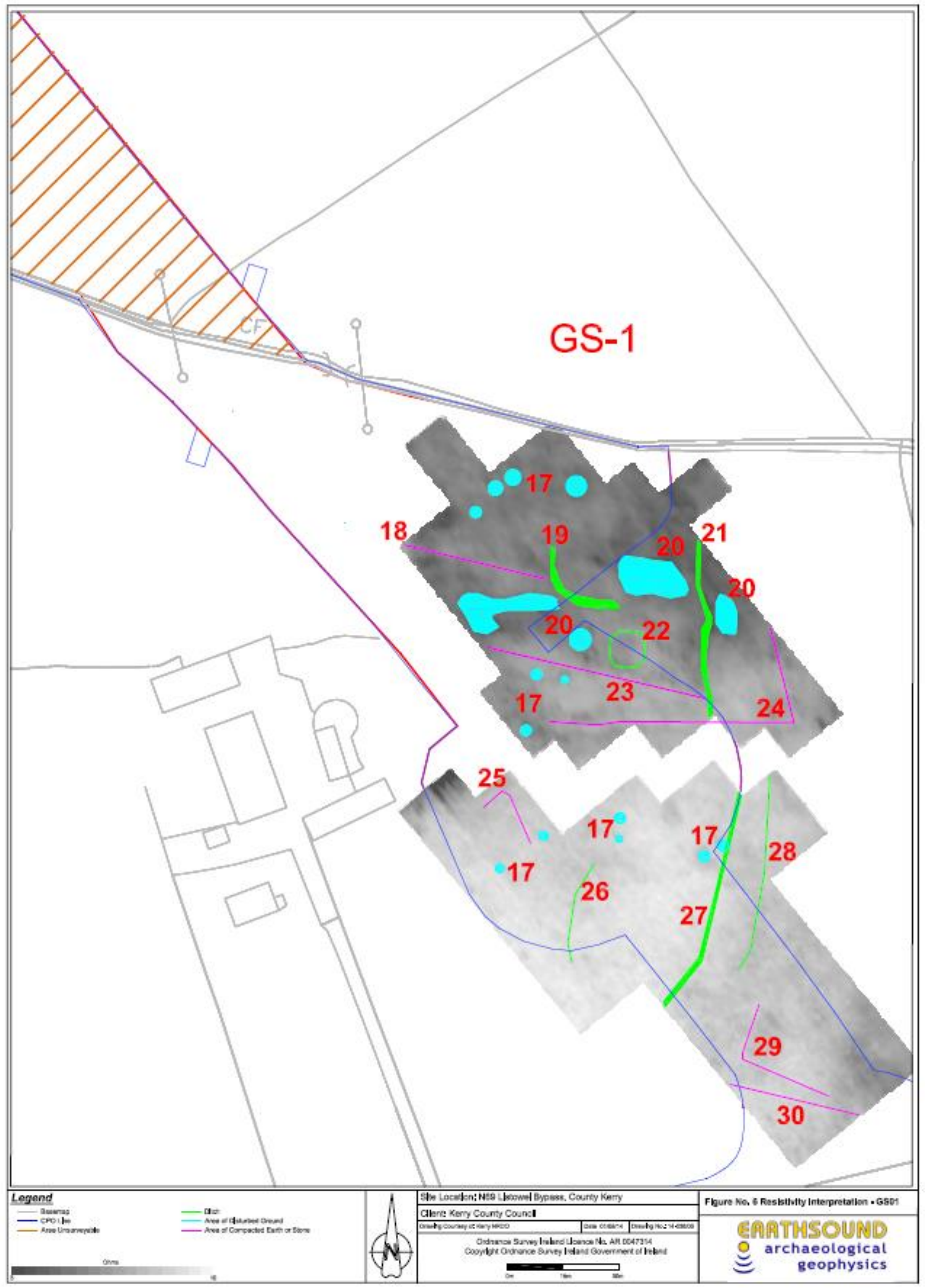
Figure No. 5 Resistivity data - GS01
EARTHSOUND
archaeological
geophysics


GS-1
CF
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25
17
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28
26
27
29
30
Legend
Basemap
CPO Line
Area Unsurveyable
Ditch
Area of Disturbed Ground
Area of Compacted Earth or Stone
Ohms
Site Location: N69 Listowel Bypass, County Kerry
Client: Kerry County Council
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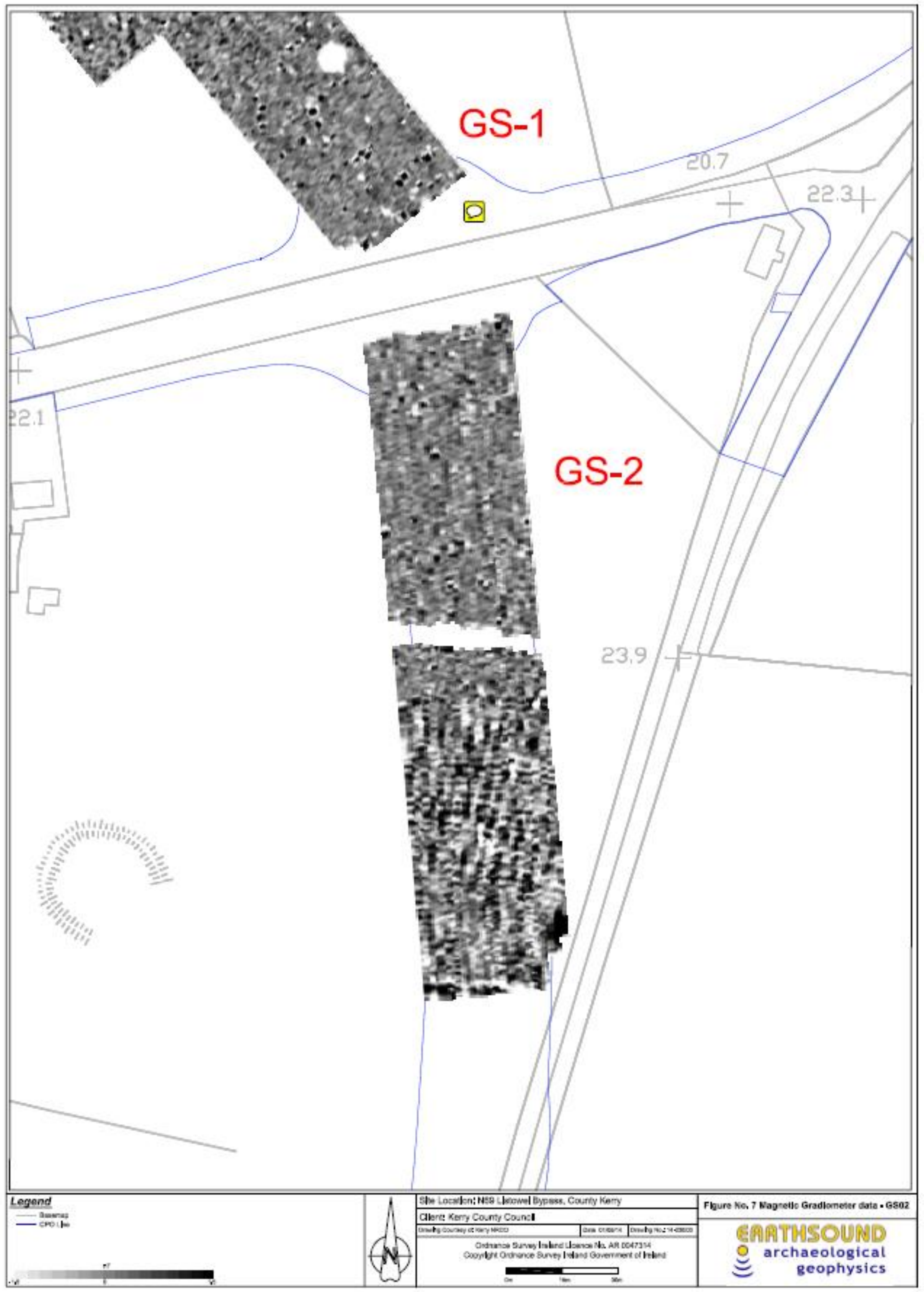
Figure No. 6 Resistivity Interpretation - GS01
EARTHSOUND
archaeological
geophysics


GS-1
20.7
22.3
22.1
GS-2
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Legend
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CPO Line
Site Location: N69 Listowel Bypass, County Kerry
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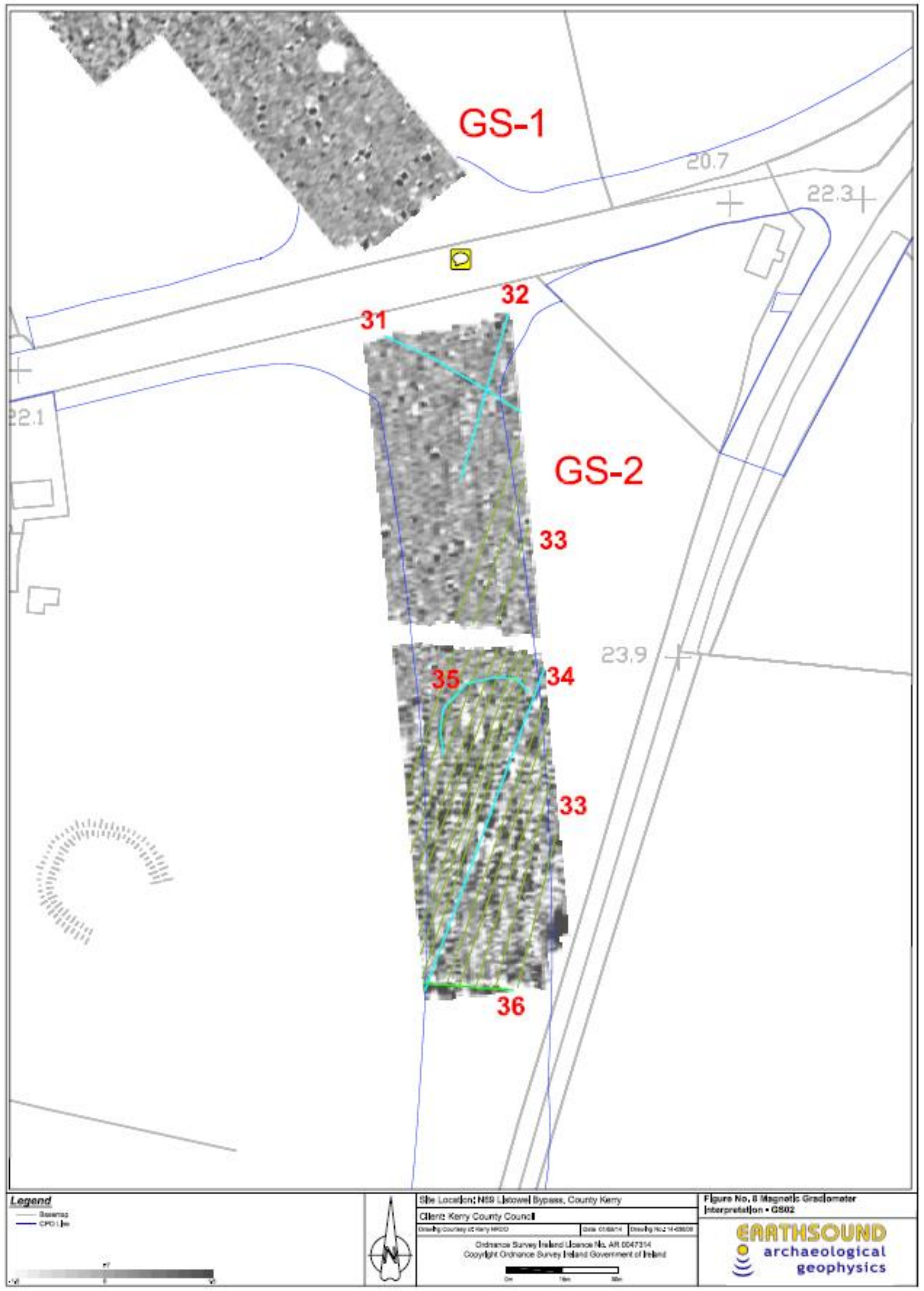
Figure No. 7 Magnetic Gradiometer data - GS02
EARTHSOUND
archaeological
geophysics


GS-1
20.7
22.3
22.1
31
32
GS-2
33
23.9
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Legend
Basemap
CPO Line
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Figure No. 8 Magnetic Gradiometer Interpretation - GS02
EARTHSOUND
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GS-1
GS-2
20.7
22.3
22.1
23.9
Legend
Basemap
CPO Line
Ohms
Site Location: N69 Listowel Bypass, County Kerry
Client: Kerry County Council
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Figure No. 9 Resistivity Data - GS02
EARTHSOUND
archaeological
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GS-1
GS-2
20.7
22.3
22.1
23.9
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Legend
Basemap
CPO Line
Ditch
Area of Disturbed Ground
Area of Compacted Earth or Stone
Ohms
Site Location: N69 Listowel Bypass, County Kerry
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Figure No. 10 Resistivity Interpretation - GS02
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