i. PREFACE

THIS ENVIRONMENTAL IMPACT STATEMENT CONSISTS OF THE FOLLOWING DOCUMENTS:

Volume 1

- NON-TECHNICAL SUMMARY

Volume 2

- MAIN REPORT

Volume 3

- FIGURES

Volume 4

- APPENDICES

Document Control

Status	Issued For	Signed	Date	Approved
FINAL	*Publication*	*FM*[1]	*December 2013*	*AS*[2]

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ii. ACKNOWLEDGEMENTS

This Environmental Impact Statement (EIS) has been prepared and coordinated by Sligo County Councils National Roads Design Department[3] under the auspices of the National Roads Authority and with the assistance of specialist Environmental sub-consultants as outlined below.

Detailed reports from specialists are available for review in the National Road Design Department of Sligo County Council, Market Yard, Sligo, as are the Constraints Study Report, the Route Selection Report and the Design Report which were prepared during the design process.

EIS Compilation

The National Road Design Department of Sligo County Council is responsible for the following elements of the EIS publication:

- Compilation of the EIS including development of the following chapters:
  - Introduction;
  - Background to the *Proposed Road Development*;
  - Alternatives Considered;
  - Description of the *Proposed Road Development*;
  - Impact Assessment- Introduction;
  - Schedule of Commitments and summary of proposed ameliorative measures;
  - Summary of Cumulative Impacts.

Environmental Impact Assessment

Sligo County Council have commissioned the following specialist sub-consultants to carry out an assessment of environmental effects, significant impacts and proposed mitigation measures based on pre-determined specific baseline information.

Study/Element	Consultant
Socio-Economic.	Optimize Consultants, Barracks House, Croghan, Boyle, Co. Roscommon.
Agriculture and Non Agricultural property.	Philip Farrelly, Unit 5A Fingal Business Park, Balbriggan, Co. Dublin.
Flora, Fauna and Fisheries.	Ecofact Environmental Consultants, Tait Business Centre, Domonic Street, Limerick City.
Landscape and Visual.	MosArt Ltd., The Phoenix Centre, Block 6,

[3] Which is contained within the Directorate of Infrastructural Services.

Study/Element	Consultant
	Broomhall Business Park, Wicklow, County Wicklow.
Hydrology & Hydro- Geology; Soils & Geology.	Minerex Environmental Ltd., Taney Hall, Eglinton Terrace, Dundrum, Dublin 14.
Noise & Vibration; Air Quality and Climate Change.	AWN Consulting, The Tecpro Building, IDA Business and Technology Park, Clonshaugh, Dublin 17.
Archaeology, Architectural and Cultural Heritage.	ADS Ltd., Windsor House, 11 Fairview Strand, Fairview, Dublin 3.

Design

The National Road Design Department of Sligo County Council is responsible for the design of the *Proposed Road Development* with input at various stages from specialist sub consultants including *inter-alia*:

- Aecom;
- Hydro Environmental; and
- AGL Consulting;

iii. LIST OF ABBREVIATIONS

AA	*Appropriate Assessment*
AADT	*Average Annual Daily Traffic*
AAP	*Area of Archaeological Potential*
AEP	*Annual Exceedance Probability*
AGI	*American Geological Institute*
ASL	*Above Sea Level*
ATC	*Automatic Traffic Counts*
BAP	*Biodiversity Action Plan*
BD	*Bridge Document*
BH	*Bore Hole*
BKL	*Bricklieve Limestone Formation Lower*
BKU	*Bricklieve Limestone Formation Upper*
BOD	*Biochemical Oxygen Demand*
BS	*British Standards*
BSBI	*Botanical Survey of the British Isles*
BTO	*British Trust of Ornithology*
c.	*circa or approximate distance*
CAFE	*Cleaner Air for Europe*
CBA	*Cost Benefit Analysis*
CBR	*California Bearing Ratio*
CDB	*Congested District Boards*
CDP	*County Development Plan*
CGSJ	*Compact Grade Separated Junction*
Ch.	*Chainage*
CHC	*Cultural Heritage Constraint*
CHG's	*Greenhouse Gases*
CLASP	*Community of Lough Arrow Social Project*
CO	*Carbon Monoxide*
CO2	*Carbon Dioxide*
COD	*Chemical Oxygen Demand*
CPO	*Compulsory Purchase Order*
CRTN	*Calculation of Road Traffic Noise*
cSAC	*Candidate Special Area of Conservation*
CSO	*Central Statistics Office*
Cu	*Shear Strength*
DEHLG	*Department of Environment, Health and Local Government*
DX	*Watercourse Crossing for Hydrological Impact Assessment*
EAR	*Environmental Assessment Report*
EC	*European Community*
ED	*Electoral Division*
EEC	*European Economic Community*
EIA	*Environmental Impact Assessment*
EIS	*Environmental Impact Statement*
EM	*Electromagnetic Flow Meter*
EMD	*Exploration and Mining Division*
EOP	*Environmental Operating Plan*
EPA	*Environmental Protection Agency*
EPH	*Extractable Petroleum Hydrocarbons*
ESB	*Electrical Supply Board*
EU	*European Union*
FOSD	*Full Overtaking Sight Distance*
FE	*Standard Factorial Error*
GSI	*Geological Survey of Ireland*
GWB	*Groundwater Body*
GWDTE	*Groundwater Dependent Terrestrial Ecosystem*
HAWRAT	*Highways Agency Water Risk Assessment Tool*
HECRAS	*Hydrologic Engineering Centres River Analysis System*
HGV	*Heavy Goods Vehicle*
HRI	*Heritage Rating Index*
HSE	*Health Service Executive*
ICD	*Inscribed Circle Diameter*
IEEM	*Institute of Ecology and Environmental Management*
IFI	*Inland Fisheries Ireland*
ING	*Irish National Grid*
IPCC	*Intergovernmental Panel on Climate Change*
IPPC	*Integrated Pollution Prevention Control*
IS EN	*Irish Standard European Norm*
ITM	*Irish Transverse Mercator*
IUCN	*International Union for Conservation of Nature*
LG	*Lisgorman Shale*
LMA	*Lands Made Available*
MAC	*Maximum Acceptable Concentration*
MCC	*Manual Traffic Counts*
MCV	*Moisture Condition Value*
MIU	*Major Inter Urban*

List of Abbreviations (continued)

NDP	*National Development Plan*	QBAR	*An FSR term denoting the Mean Annual Flood flow rate for a river.*
NF	*Narrow Fin drain*	RC	*Rotary Core*
NHA	*Natural Heritage Area*	RMP	*Record of Monuments and Places*
NIAH	*National Inventory of Architectural Heritage*	ROW	*Right of Way*
NIS	*Natura Impact Statement*	RPS	*Record of Protected Structures*
NMI	*National Museum of Ireland*	RSA	*Road Safety Authority*
NO	*Nitrogen Monoxide*	RSP	*Route Selection Process*
NO2	*Nitrogen Dioxide*	RSPB	*Royal Society for the Protection of Birds*
NOX	*Nitrogen Oxide*	RSR	*Route Selection Report*
NPV	*Net Present Value of Benefits*	RU	*Fish Rearing Unit*
NPWS	*National Parks and Wildlife Services*	SAAR	*Seasonal Mean Annual Average Rainfall*
NRA	*National Roads Authority*	SAC	*Special Area of Conservation*
NRA DMRB	*National Roads Authority Design Manual for Roads and Bridges*	SCC	*Sligo County Council*
NRA PAG	*NRA Project Appraisal Guidelines*	SEI	*Sustainable Energy Ireland*
NRA PMG	*National Roads Authority Project Management Guidelines*	SI	*Statutory Instrument*
NRNS	*National Roads Needs Study*	SL	*Sligo*
NSS	*National Spatial Strategy*	SPA	*Special Protection Area*
NTS	*Non Technical Summary*	SPT	*Standard Penetration Test*
NWRFB	*North Western Regional Fisheries Board*	SUDS	*Sustainable Urban Drainage Systems*
O3	*Ozone*	TD	*Technical Document*
OPW	*Office of Public Works*	TP	*Trial Pit*
OS	*Ordnance Survey*	TSP	*Total Suspended Particles*
OSI	*Ordnance Survey Ireland*	UK DEFRA	*UK Department for Environment, Food and Rural Affairs*
PCMNR	*Department of Communications Marine and Natural Resources*	UKDETR	*United Kingdom Department of Environment, Transport and Regions*
PH	*Probe Hole*	UNFCC	*United Nations Framework Convention on Climate Change*
PIR	*Potential Impact Rating*	USEPA	*United States Environmental Protection Agency*
PM	*Particulate Matter*	VOC's	*Volatile Organic Compounds*
PM10	*Particular Matter (fine airborne particles) less than 10 micrometers in diameter*	WFD	*Water Framework Directive*
PM2.5	*Particular Matter (fine airborne particles) less than 2.5 micrometers in diameter*	WHO	*World Health Organization*
PR	*Preferred Route*	WRAP	*Winter Rainfall Acceptance Potential*
PRD	*Proposed Road Development*	WRBD	*Western River Basin District*
PW	*Public Works*		
PVB	*Present Value of Scheme Benefits*		

iv. GLOSSARY OF TERMS

Below is a partial glossary of terms used in this report. The definitions herein are not to be taken as comprehensive, but solely as an aid for the non-technical reader.

Term	Glossary
Accommodation works	Ancillary works carried out by the road authority to mitigate the effects of the construction of a development (such as access roads)
At Grade Junction	Road junction where at least one road meets another at same level
Attenuation pond	Pond used for the collection and slow release of run-off
Borrow Pits	Excavation, within or outside the limits of the works, for producing materials necessary for its construction. Borrow Pits used for the purposes of the *Proposed Road Development* will be reinstated to original lines and levels
Chainage (Ch)	Distance in metres from start of the *Proposed Road Development*
Constructed Wetland Attenuation Facility	Attenuation Pond which will be provided as a vegetative treatment system, i.e. a pond which will incorporate ecological landscape planting
Culvert	Structure or drain for the bringing of a stream or river under a structure such as the road development proposed herein
Cutting (cut)	Section of earthworks where the indicative road level is below the original/existing ground level
Design	A design prepared for the purposes of Phase 3 and 4 of the NRA PMG
Detailed Design	A design prepared for the purposes of Phase 5 and 6 of the NRA PMG
Do Minimum	This scenario assumes construction of the *Proposed Road Development* does not take place and considers minimal maintenance and improvement to the affected section of road
Do Nothing Scenario	This scenario assumes construction of the *Proposed Road Development* does not take place
Do Something Scenario	This scenario assumes construction of the *Proposed Road Development* does take place
Enclosure	Any monument consisting of an enclosing feature such as a bank or a ditch, usually earthen, such as barrows or ringforts
Fauna	A collective term for the animals of a region
Flora	A collective term for the plants of a region
Geometrics	Details of the various vertical and horizontal curves and straights used to make up the *Proposed Road Development*
Glacial Till	A mixture of clay, silt, sand, gravel and boulders ranging in size and shape deposited by a glacier
Groundwater	Water stored in the soil and rock both above and below the water table
Habitat	The dwelling place of a species or community, providing a particular set of environmental conditions
L_{den}	The day-evening-night composite noise indicator adopted by the EU for the purposes of assessing overall annoyance
Mitigation measures	Measures to ease or soothe the effects of something. Mitigation measures suggest ways to avoid or lessen the negative effects of a project on the environment.
National Parks and Wildlife Service (NPWS)	This organisation has responsibility for the protection and conservation of our natural heritage

Term	Glossary
Nitrogen Dioxide	Pollutant emitted from combustion sources. Most significant source is road transport
Particulate Matter	Particulate matter (dust) generally less than 10 micrometres in diameter. Various sources including road traffic, construction works, wind-blown dusts and biological particles
Piezometer	An instrument to measure the level of the water table
Ringfort	Early Christian defended secular settlement consisting of a bank and external ditch defining a circular area that contained the dwelling structures of the occupants
Riparian	The strip of land adjacent to a natural watercourse such as a river or stream. Often supports vegetation that provides the best fish habitat values when growing large enough to overhang the bank
Salmonid Waters	Waters (generally of high quality) suitable for the maintenance of viable self-sustaining populations of wild salmon and trout

v. ADDITIONAL INFORMATION

Additional Information not included in this EIS but which may be made available to interested parties includes *inter-alia*:

- Constraints Study Report, Sligo County Council, 2000;
- Route Selection Report, Sligo County Council, 2002;
- Addendum to Route Selection Report, Sligo County Council, 2013;
- EIS Screening Report, Sligo County Council, 2012;
- Informal Scoping Report, Sligo County Council, 2012;
- References to the Main Report of the EIS.

vi. CHAPTER LAYOUT

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Part 1 – Background Information/General Description

This section of the EIS describes the characteristics of the *Proposed Road Development*, information on the need, related policy, planning matters and information on alternatives considered.

All proposed works indicated in this Environmental Impact Statement and shown on drawings are part of a design developed in accordance with Phase 3 of the *'NRA Project Management Guidelines, 2010'* which has evolved iteratively through the initial stages of the EIA process.

The design and the environmental mitigation measures may be further refined during the detailed design stage, including the incorporation of mitigation measures contained in such Approval as may be granted by An Bord Pleanála.

The detailed design will seek to develop the design in a manner such that there is no material change in terms of significant adverse effect on the environment. Opportunities may be identified to further reduce the significance of adverse effect/impact and, in some cases, to improve the residual effect/impact.

1 Introduction

1.1 General

Sligo County Council (SCC), under the auspices of the National Roads Authority (NRA), are developing a project to upgrade c. 14.71km of the N4 National Primary Route between the townlands of *Collooney/Toberbride* and *Cloghoge Lower* in the south-east of County Sligo.

An overview of the location of the *Proposed Road Development* is given in Figure 1.0, Volume 3.

The assessment of impacts, the prediction of environmental effects and the proposed mitigation measures are based on the design[4] of the proposal as detailed in the Environmental Impact Statement (EIS). The design and the environmental mitigation measures may be refined and developed during the detailed design[5] stage before construction. This may result in some changes to the design which will not however result in any significant additional adverse environmental impacts of the *Proposed Road Development*. Opportunities may be identified that may reduce the impact. Stringent contract requirements and close supervision will ensure that the detailed design, including environmental mitigation measures will be of the required quality and that through the construction process this detailed design will be translated into the final product.

This Environmental Impact Statement (EIS) is a compilation of work carried out by Sligo County Council's National Road Design Department together with impact assessments from specialist consultants. A separate Non-Technical summary of the Environmental Impact Statement is also available in accordance with statutory requirements.

1.2 Structure of the Environmental Impact Statement

An EIS should contain information on the likely significant environmental effects (both positive and negative) of a *Proposed Road Development* and the measures proposed to mitigate those effects so as to allow a fully informed decision to be made by An Bord Pleanála.

Section 50(2) of the Roads Act, 1993, as substituted by European Communities (Environmental Impact Assessment) (Amendment) Regulations 1999 (S.I. No. 93 of 1999), reg. 14(b) states the following information shall be included in the EIS:

(a) *a description of the Proposed Road Development comprising information on the site, design and size of the Proposed Road Development;*

(b) *a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;*

(c) *the data required to identify and assess the main effects which the Proposed Road Development is likely to have on the environment;*

(d) *an outline of the main alternatives studied by the road authority concerned and an indication of the main reasons for its choice, taking into account the environmental effects;*

(e) *a summary in non-technical language of the above information.*

Section 50(3) of the Roads Act, 1993, as substituted by European Communities (Environmental Impact Assessment) (Amendment) Regulations 1999 (S.I. No. 93 of 1999), reg. 14(b) also states the following:

An environmental impact statement shall, in addition to and by way of explanation or amplification of the specified information referred to in subsection (2), contain further information on the following matters:

(a) (i) a description of the physical characteristics of the whole Proposed Road Development and the land-use requirements during the construction and operational phases;

[4] *Design* means a design to satisfy the requirements of Phase 3 of the NRA Project Management Guidelines.

[5] *Detailed design* means a design prepared during Phase 5 and 6 of the NRA Project Management Guidelines.

(ii) an estimate, by type and quantity, of expected residues and emissions (including water, air and soil pollution, noise, vibration, light, heat and radiation) resulting from the operation of the Proposed Road Development

(b) a description of the aspects of the environment likely to be significantly affected by the proposed road development, including in particular

- *human beings, fauna and flora,*
- *soil, water, air, climatic factors and the landscape,*
- material assets, including the architectural and archaeological heritage, and the cultural heritage,
- *the inter-relationship between the above factors;*

(c) a description of the likely significant effects (including direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the Proposed Road Development on the environment resulting from—

- *the existence of the Proposed Road Development,*
- *the use of natural resources,*
- *the emission of pollutants, the creation of nuisances and the elimination of waste,*

and a description of the forecasting methods used to assess the effects on the environment;

(d) an indication of any difficulties (technical deficiencies or lack of know-how) encountered by the road authority concerned in compiling the required information;

(e) a summary in non-technical language of the above information;

to the extent that such information is relevant to a given stage of the consent procedure and to the specific characteristics of the Proposed Road Development or type of Proposed Road Development concerned, and of the environmental features likely to be affected, and the road authority preparing the environmental impact statement may reasonably be required to compile such information having regard, inter alia, to current knowledge and methods of assessment.

This EIS presents the findings of the EIA process to date which has been undertaken on the potential impacts associated with the *Proposed Road Development* during construction and operation. In order to do this effectively, the EIS has been prepared in discrete chapters in order to present the full picture for each area, which is likely to be affected by the *Proposed Road Development*. The environmental subject areas have been determined through consultations and from the statutory criteria as defined above. Furthermore the interaction of impacts of the *Proposed Road Development* is set out herein. The content has been informed by an Informal Scoping Report prepared for the *Proposed Road Development.*

A Non Technical Summary (NTS) has also been produced to summarise the main details of the project in non-technical terms and is available as a separate A4 report.

The report is divided into sections i.e. Human Environment, Natural Environment and Material Assets. There is a potential for interactions between two or more environmental topics in each of these sections. These potential interactions have been taken into account and where possible complimentary mitigation measures have been proposed. Table 1-1 summarises the structure of the EIS.

Table 1-1: Structure of the Environmental Impact Statement

Volume	Part	Description
Volume 1: Non-Technical Summary	Non-Technical Summary	A Non-Technical Summary of the key issues of the project
Volume 2: Main Report	Chapter 1.0	Introduction. This section introduces the project and sets out the need for the *Proposed Road Development* and its key objectives.
	Chapter 2.0	Background to the *Proposed Road Development*. Describes the background information to the *Proposed Road Development*.
	Chapter 3.0	Consideration of Alternatives. Describes the alternative routes studied and the reasons for selection of the preferred route. Also described here are alternatives considered

Volume	Part	Description
		during the design and project appraisal process.
	Chapter 4.0	Description of the *Proposed Road Development*. Describes the *Proposed Road Development* in terms of road type, existing and projected traffic projections, safety benefits, engineering features, environmental design considerations, land take requirements, construction and operational requirements.
	Chapter 5.0	Introduction to Impact Assessment. The scope and methodology for EIS is set out. Information on interactions between various EIA disciplines is also outlined.
	Chapters 6.0-15.0	Assessment Chapters. The assessment chapters consider the environmental effects of the *Proposed Road Development* for each subject area and evaluate the potential effects that may occur as a result of the proposal. Within each environmental subject area, a methodology for the assessment is presented. A description of the baseline environmental conditions is then provided followed by an assessment of the effects of construction and operation. Mitigation measures are also discussed where appropriate. A summary of the results of the assessment, highlighting potentially significant effects both positive and negative are presented.
	Chapter 16.0	Schedule of commitments. Provides a summary of the proposed ameliorative measures.
	Chapter 17	Summary of Cumulative Impacts
Volume 3: Figures	Figures	The figures referred to in this EIS are contained in Volume 3.
Volume 4: Appendices	Appendices	Information in support of that contained in this EIS is contained within Volume 4.

1.3 Purpose of and Legislative Requirement for an EIA

Environmental Impact Assessment (EIA) is defined as *the process of examining the environmental effects of the development – from consideration of the environmental aspects at design stage, through to the preparation of an Environmental Impact Statement, evaluation of the EIS by a competent authority and the subsequent decision as to whether the development should be permitted to proceed, also encompassing public response to that decision.*[6]

The Environmental Impact Statement (EIS) is defined as *a statement of the effects, if any, which the proposed development, if carried out, would have on the environment*. Certain public and private projects that are likely to have significant effects on the environment are subject to EIA requirements derived from EIA Directive 85/337/EC (as amended) which has been the subject of codification by Directive 2011/92/EU.

Insofar as roads are concerned, the EIA Directive is transposed into law in Ireland through the Roads Act, 1993 (No. 14 of 1993). The current requirements for EIA are set out in Part IV of the Roads Act, 1993 and Part V of the Roads Regulations, 1994 (S.I. No. 119 of 1994). In particular, sections 50 and 51 of the Act, as amended, deal with EIA. These sections have been subject to significant amendment through *inter-alia*:

- The Roads Act, 2007, (34/2007);
- The European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999);
- The European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011);
- The Planning and Development (Strategic Infrastructure) Act, 2006 (27/2006);
- The European Communities (Environmental Impact Assessment) Amendment Regulations, 1998 (S.I. No. 351 of 1998);
- The European Communities (Public Participation) Regulations, 2010 (S.I. No. 352 of 2010);

[6] *Guidelines on the information to be contained in Environmental Impact Statements,* EPA (2002).

An EIS is prepared as part of the application for development consent. It provides environmental information that is assessed by the competent authority - An Bord Pleanála - to determine whether or not to grant consent.

In relation to road developments it is stated under Section 50 (1) (a) (iv) of the Roads Act 1993, as amended by the Roads Act 2007 (34/2007), that, *a road authority or the Authority shall prepare a statement of the likely effects on the environment ('environmental impact statement') of any proposed road development it proposes consisting of—*

> *(iv) any prescribed type of Proposed Road Development consisting of the construction of a proposed public road or the improvement of an existing public road.*

1.3.1 EIA Screening

1.3.1.1 Irish Legislation

As already outlined, in relation to roads projects, the requirements of these EU Directives have been transposed into Irish legislation by, *inter-alia*, Sections 50 and 51 of the Roads Act (1993) and subsequent amendments to this Act.

This results in the categorisation of all roads projects into one of two categories:

- Those that exceed the thresholds laid down and where, therefore, there is a mandatory requirement to prepare an EIS; and
- Those projects that are sub-threshold and must be assessed on a *case-by-case* basis to determine whether or not they are likely to have significant effects on the environment.

As the proposal constitutes, *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*[7], there is mandatory requirement to undertake an EIA.

1.3.1.2 EIA Screening Report.

As the project had in late 2011/early 2012 been proposed to be a *Standard Single Carriageway* the threshold as discussed above had not been reached, the project was assessed (at that time) on a *case-by-case* basis via an EIA Screening Report prepared by Sligo County Council. Although information and decisions made on this basis are not now relevant in determining the requirement to undertake an EIA as the thresholds discussed in section 1.3.1.1 are reached, the results of the process are nevertheless useful in terms of understanding the interaction between the *Proposed Road Development* and the existing environment.

In this regard it is notable that the EIA Screening report concluded that *'there was a likelihood of significant effects on the environment'.* Therefore, formal direction was requested from An Bord Pleanála to undertake an EIA for the development. A Direction[8] to carry out an EIS was subsequently received from An Bord Pleanála having regard to:

(a) the nature and scale of the proposed road development,
(b) the potential for significant environmental effects in relation to landscape and visual amenity,
(c) the route of the proposed development through an area vulnerable in terms of geology and hydrogeology,
(d) the environmental sensitivity of the route due to its proximity to the Unshin River candidate Special Area of Conservation and the Lough Arrow candidate Special Area of Conservation/Special Protection Area and the Lough Arrow proposed National Heritage Area,
(e) the criteria set out in the "Environmental Impact Assessment Guidance for Consent Authorities regarding Sub-Threshold Development" issued by the Department of the Environment, Heritage and Local Government in August, 2003, and the "Environmental Impact Assessment of National Road

[7] Article 8 of the Roads Regulations, 1994 (Road development prescribed for the purposes of S. 50(1)(a) of the Roads Act, 1993.

[8] An Bord Pleanála decision, 21.HD0025.

Schemes – A Practical Guide" and the "Guidelines for Assessment of Ecological Impacts of National Road Schemes", issued by the National Roads Authority in 2008 and 2009 respectively,

(f) the submissions made to the Board, and

(g) the report and recommendation of the person appointed by the Board to make a report and recommendation on the matter.

1.3.2 EIA Informal Scoping

An informal EIA Scoping report[9] has been prepared for the *Proposed Road Development* to avail of the opportunity for consultation prior to the publication of the EIS. The report describes the project and identifies any potential significant environmental impacts which may arise.

Additionally, ongoing Scoping has been applied proactively throughout the EIA process through the design team and the various specialist sub-consultants.

1.4 Background to the *Proposed Road Development*

The N4 National Primary Route is part of the East/West road corridor (Operational Plan for Transport, 1994-1999) linking Irelands largest transportation node (Dublin) with the largest transportation node in the North-West (Sligo). It measures c. 34.8km in County Sligo of which c. 11.6km between Sligo Town and Collooney is Type 1 Dual Carriageway with c. 8.8km south of Castlebaldwin having already been realigned to Standard Single Carriageway standard.

The *Proposed Road Development* is the remaining portion of the N4 in Co. Sligo requiring improvement and measures approximately 14.71km in length passing through the townlands of *Collooney, Toberbride, Mullaghnabreena, Ardcurley, Cloonamahan, Doorly, Knocknagroagh, Drumfin, Cloonlurg, Carrowkeel, Carrownagark, Kingsbrook, Aghalenane, Ardloy, Springfield, Tawnagh, Cloonymeenaghan, Sheerevagh, Cloongad, Drumderry, Castlebaldwin, Cloghoge Upper and Cloghoge Lower.* The road type will be Type 2 Dual Carriageway tied into the existing network to the south via a section of Standard Single Carriageway.

1.5 The Need for the Realignment

1.5.1 The NRA, National Road Needs Study

The original basis for the current proposal was highlighted in a report produced by the NRA, entitled *The National Road Needs Study* (NRNS) in 1998. This study assessed the adequacy and performance of the national road network on the basis of the ability of existing roads to deliver a quality level of service consistent with the efficient movement of traffic. The study represented a comprehensive assessment of the network against the average inter-urban speed of at least 80kph, which is categorised within the report as a Level of Service (LOS) D objective. The LOS is a technical concept which attempts to describe the travel experience in terms of operating speed, the ability to overtake traffic in safety, traffic congestion, overall safety and driver and passenger comfort. The Authority's objective for road planning purposes was to achieve a minimum LOS of D, equivalent to the aforementioned 80kph inter-urban journey speed on the network.

The N4 realignment (Collooney to Ballinafad) was identified at that time as having 'Phase 2' needs. This meant that the existing road was considered to be no longer able to provide a level of service D, equivalent to an inter-urban travel speed of 80kph. By realigning the road, the level of service would be improved; therefore it was scheduled at that time for improvement during the years 2005-2009 under the NRNS.

[9] *N4 Cloonamahan to Castlebaldwin Realignment, EIA Informal Scoping*, Sligo County Council (May 2012).

Plate 1-1: Existing N4 at Carrownagark Td. (picture following a traffic incident in 2012)

1.5.2 Existing Network

The existing road network in the area is multi-functional and is required to cater for conflicting demands, including accommodating long distance through traffic and locally generated trips.

The existing route is sub-standard with overall pavement widths varying from c. 6.5m to 7.5m and average verge widths of 1.0m. There is restricted overtaking along approximately 70% of its length while it also passes through the village of Castlebaldwin which has a speed limit of 50kph. This is with the exception of a 2.6km section between *Collooney/Toberbride* and *Doorly* which was improved geometrically in the 1980's.

There are a significant number of junctions (29) with local roads along the existing route and including the village of Castlebaldwin there are approximately 78 houses and 130 agricultural entrances onto the existing route. Of these accesses, a high percentage occur (17%) on the aforementioned improved section.

From a safety point of view, field accesses are especially problematic as they encourage slow moving and frequently heavy agricultural traffic onto the high-speed national primary network. The increasing volumes of inter-urban traffic on this strategic east-west route corridor will lead to a greater risk of road accidents and a significant loss of amenity to the local residential population. The rural sections of the existing route are deficient in traffic capacity due to the proliferation of vehicular entrances and inadequacies in cross section and alignment.

The stretch of road proposed to be replaced herein constitutes one of the few sections of the N4 between Dublin and Sligo which is not of a standard commensurate with the NRA DMRB; furthermore, with the exception of its northern limits, this particular section has not received any significant improvements (with the exception of localised minor improvements) since its designation from a Trunk Road to a National Primary Route in 1977 and has very restricted opportunities for safe overtaking.

1.5.3 Traffic

Traffic count surveys show traffic volumes on the existing N4 in 2008[10] of 9,300 AADT at Drumfin Td. and 7,500 AADT at *Castlebaldwin Td.* rising to 11,600 and 9,200 AADT respectively in a design year of 2032 in a Do-Minimum Medium Growth Scenario. It is also predicted that c. 8-10% of traffic on the existing route consists of HGV's.

The risk of accidents will increase as vehicles seeking to access the N4 from side roads will find fewer opportunities to do so and may through frustration take unnecessary risks. The increase in traffic will give rise to an increase in noise nuisance and community severance.

1.5.4 Economy

The existing road is operating within capacity during the Peak Periods under current traffic flows however travel speeds are impacted by the alignment and gradient of the road together with the high number of on

[10] Which was confirmed to represent current day usage via a 2012 check.

road accesses. The N4/M4 is a key national corridor and delays to traffic have a negative impact upon the economy. It is an objective of the *Proposed Road Development* to reduce journey times and improve journey time reliability, both of which will generate positive economic benefits to businesses and consumers.

The Economic justification for the *Proposed Road Development* as set out in the Business Case undertaken by Aecom is based on a Benefit to Cost Ratio in the range of 1.45 to 1.79 (Based on Total Scheme Budget and a Medium Growth Scenario). This figure demonstrates the Present Value of Benefits to be greater than the Present Value of Costs, therefore the proposal is deemed to be economically justifiable.

1.5.5 Safety

There have been 72[11] traffic reported accidents to the Garda Síochána between the period 1996 to 2011 on that c. 14.36km section of existing route proposed to be replaced by the *Proposed Road Development*. These accidents are composed of a notable 8 fatalities, 8 serious injuries and 56 minor injuries. In acknowledgement of the significant number of Material Damage accidents which were reported to An Garda Síochána but are not collated by the RSA, Sligo County Council have collated same for a trial period of 2008 to 2011 which reveals on average 34 traffic accidents per year resulting in Material Damage.

The proposed route will replace the existing deficient section of the N4 with a Type 2 Dual Carriageway. This will reduce the accident rate, due to a higher accident rate for single carriageway roads, and an increasing risk of certain types of accidents, such as fatal and serious injury accidents as a result of overtaking head on collisions. The Type 2 Dual Carriageway also has the benefit of separating local traffic from national traffic and does not allow for right turning movements such as those which would be required at Ghost Islands on a Single Carriageway road.

Such is the severity of the rate of accidents on the route in combination with the weekly unreported accidents and near misses; a local action group has been vociferously campaigning for the upgrade of this section of the N4. To demonstrate the extent of fatal accidents which have occurred along the existing route, this group have erected white crosses along roadside verges indicating 30 fatalities at different locations over the last forty or so years.

Plate 1-2: Erection of 30th white cross in April, 2013[12]

In addition to recent minor realignment[13] works (at *Springfield Td., Aghalenane Td.* and *Ardloy Td.*), numerous local improvement measures have been carried out by Sligo County Council in recent years which have maximised sightline distances achievable at localised junctions such as at *Drumfin Td., Cloonlurg Td.* and *Carrownagark Td*. These improvements although welcomed do not improve driving conditions or geometric deficiencies for National to National through traffic or National to Local traffic; their primary benefit is to maximise the sight distances currently available on the existing N4 for Local to National traffic.

[11] Compilation of accidents from RSA and CT68 forms prepared by An Garda Síochána.

[12] Picture courtesy of Brian Farrell Photography.

[13] Works carried out at this location were originally part of the current proposal and were undertaken in advance as a localised minor improvement measure.

Plate 1-3: White Crosses erected north of the Ballymote Junction in the townland of Cloonlurg

The safety benefits which will be derived from the incorporation of the *Proposed Road Development* into the National Primary Network are expanded upon in Chapter 4 of this EIS.

1.5.6 Environment

The provision of the *Proposed Road Development* will bring benefits to the existing environment in this area of County Sligo. This will include *inter-alia:*

- A reduction in Noise and Vibration impacts for those numerous properties which are currently adjacent to the existing N4.

In addition, considering that the *Proposed Road Development* will be constructed to the increasingly high standard of environmental mitigation practice there are numerous benefits which will arise to the existing environment. This is particularly true in the case of the management and treatment of road runoff which is currently being discharged untreated and un-attenuated to the Unshin River cSAC/pNHA and the Lough Arrow cSAC/pNHA/SPA. The provision of infrastructure to treat this runoff will have ensuing benefits for the aquatic flora and fauna of these important biodiversity sites.

1.5.7 Accessibility and Social Inclusion

The *Proposed Road Development* will improve road based public transport at a local, regional and national level, by improving safety along this section of the N4 corridor.

The transfer of traffic off the existing N4 will greatly improve the quality of life for properties within the vicinity of the existing route, allowing ease of access to both the local and national network which will improve accessibility to work, education and other activities.

1.5.8 Integration

The *Proposed Road Development* is intended to integrate the recent investments in the N4 and the Major Inter Urban (MIU) corridors, namely the M4, as part of a strategy to provide a consistent quality road link between Dublin and Sligo.

1.5.9 Additional Benefits of the *Proposed Road Development*

The project, when complete, will provide a high quality road for the transport of people and goods in safety and comfort in accordance with national and local objectives.

The generation of traffic as a result of the realignment is likely to be modest though there may be some minor increase due to the reduction in journey times to Sligo which may make it a more attractive commuting town.

The provision of the realignment provides the following key benefits:

- Improves the N4 route to modern day standards including the provision of safe overtaking and appropriate road width;
- Provides a high quality road for strategic routes with reserve capacity for future demand;
- Assists in improving the competitiveness and efficiency of the economy both locally and nationally;
- Reduces travel times and improves access to the north-west region;
- Improves transport infrastructure for local traffic;
- Improves safety along the existing roads and at junctions/accesses;
- Reduces environmental and social impacts on the local residents and communities along the existing N4.

1.6 Government Policy

This section assesses the relevance of national, regional and local planning policies to the *Proposed Road Development*. This includes a review of the:

- National Spatial Strategy for Ireland 2002-2020: People, Places and Potential;
- National Development Plan 2007 -2013;
- Infrastructure Investment Priorities, 2010-2016;
- Regional Planning Guidelines for the Border Region, 2010-2022;
- Border, Regional and Western Regional Operational Programme 2007-2013;
- Smarter Travel. A sustainable Transport Future (2009-2020);
- Forfás Regional Competiveness Agenda, (2010);
- Sligo County Development Plan, 2011-2017;

1.6.1 National Spatial Strategy for Ireland 2002-2020: People, Places and Potential

The National Spatial Strategy (NSS), published in November 2002, is a 20 year broad planning framework for the entire country, identifying development patterns for different areas, and setting indicative policies for the location of different types of development in the future. The NSS guides future infrastructural, industrial, residential and rural development while providing protection for Ireland's cultural, natural and environmental heritage, promoting social inclusion and enhancing quality of life.

The NSS has identified transportation and roads as key elements within the infrastructure of the country. The NSS recognises that highly developed infrastructures are features of strong economic performance and balanced regional development. Quality road networks are therefore crucial to economic development. The NSS supported the implementation of the road investment programme which was outlined within the NDP by recognising that it is a key element in improving regional accessibility and regional development.

In relation to strengthening the West and North West in a National Strategic Context the NSS states:

> *Additional gateways, particularly in the West and North West, where the urban structure is weakest, must be developed. In identifying new gateways, a number of key factors must be taken into account including strategic location, capacity for substantial development, an existing business and innovation dynamic and existing or potential transport linkages.*
> *Critical mass in the West and North West can be strengthened by developing Sligo as a gateway to capitalise on its strategic location and energise its associated hinterland. Building up the national role and scale of Sligo will require, as a first step, the development of a planning, land use and transportation framework. This will provide a focus around which local authorities, business and community interests can reach consensus on the future development of Sligo and utilise its substantial physical capacity for development, while safeguarding its outstanding natural setting.*

Under 3.7, Key Infrastructure, the NSS states:

> *Achieving spatial balance by developing the potential of areas will depend on enhancing capacity for the movement of people, goods, energy and information between different places. Improvements in terms of time and cost, can reduce the disadvantages of distance.*
> *Physical networks of infrastructure such as roads, public transport, energy and communications are of particular relevance to the NSS, since they themselves have a spatial impact and also influence the location, timing and extent of development.*

Under 3.7.1, Transport, the NSS states:

To support balanced regional development, Ireland's transport networks must

- *build on Ireland's radial transport system of main roads and rail lines connecting Dublin to other regions, by developing an improved mesh or network of roads and public transport services;*
- *ensure, through building up the capacity and effectiveness of Ireland's public transport networks, that increases in energy demand and emissions of CO2 arising from the demand for movement are minimised;*
- *allow internal transport networks to enhance international access to all parts of the country, by facilitating effective interchange possibilities between the national transport network and international airports and sea ports;*
- *address congestion in major urban areas by increasing the use of public transport.*

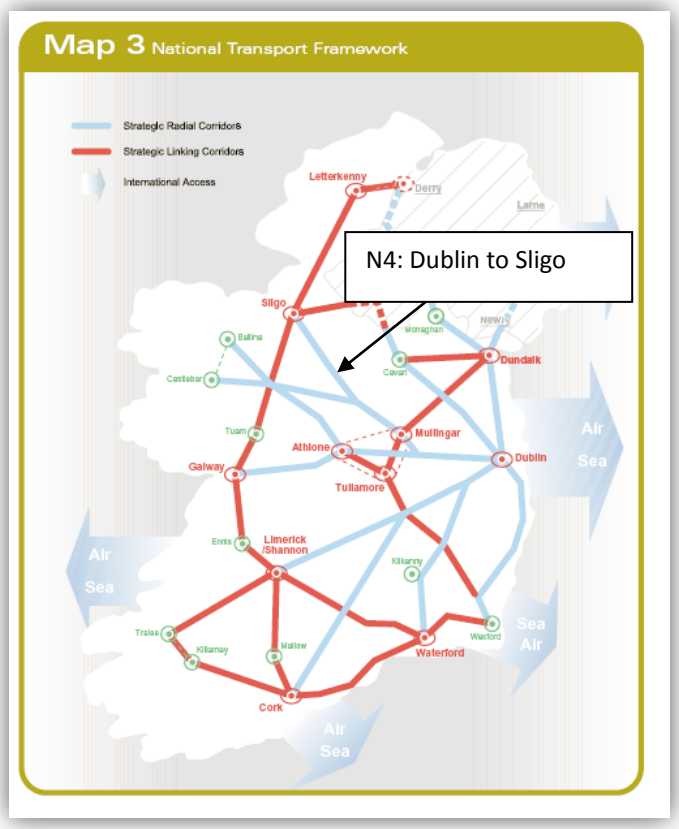
Decisions on land use and development must take account of the existing public transport networks or support the emergence and development of new or augmented networks.
In summary, Ireland's future transport network can be viewed in terms of

- ***strategic** radial **corridors***
- ***strategic** linking **corridors***
- ***strategic** international **access points.***

The N4 is identified as a Strategic Radial Corridor, providing road access to gateways of Sligo and Dublin, and to hubs and other areas in the vicinity of the Border. The NSS states the following should be attained in terms of this particular corridor:

***Corridors to the West (x3)**: good quality road and public transport connections between Dublin, Galway, Mayo and Sligo*

Figure 1: National Transport Framework, (Map 3 of National Spatial Strategy)



In relation to Strategic Infrastructure Priorities and Transport in particular, the NSS states the importance of completing objectives which were identified in the NDP. This is relevant in terms of the N4 and Radial Corridors where it outlines that the NDP *provides for the completion of the main road inter-urban links.* It goes on to suggest that the priorities beyond this in relation to Sligo should be:

> *...improved access to Sligo that builds on recent investment in road and rail routes...*

It is considered that the above outlines the national importance of developing gateways such as Sligo and the central role that effective transport links such as the N4 have in driving such development.

1.6.2 National Development Plan 2007-2013

The National Development Plan (NDP) 2007-2013 although now defunct provides an indication of the need for the *Proposed Road Development* with a particular focus on addressing deficits in the various National Spatial Gateway areas.

Chapter 3 on Regional Development identified the need for a major programme of investment under the plan in infrastructure. In relation to the Sligo Gateway it states:

> *Sligo is a Gateway in the Border Region which occupies a point between the West of the country and the Northwest. With a population of over 20,000 people in 2002, it is by far the largest centre in the area. The population of Sligo County grew by 4.6% to 60,863 persons between 2002 and 2006. Sligo's strengths include a scenic setting and hinterland, recent completion of the inner relief road, and various upgrades to the M/N4 road, the Sligo Institute of Technology, Regional Airports in Sligo and relatively nearby in Knock and strong private investment activity, particularly in the retail and leisure areas. Development challenges principally include implementing measures to bring about increased private housing development and rapid population growth within the Gateway.*

Key development issues and investment requirements over the period of the Plan were identified specifically in relation to the N4 including the following statement:

> *... Completion of the remaining sections of the N4 requiring upgrades...*

In terms of enhancing connectivity, the *Proposed Road Development* will fulfil a key objective in relation to the Development of the Rural Environment as set out in Chapter 4 of the NDP where it states:

> *...The upgrading of national primary and secondary routes with particular regard to enhancing connectivity for rural areas within the Gateway/Hub town catchments;*

The development is also set out as a priority in relation to Economic Infrastructure (Chapter 7):

> *...To create a road network, in line with the timetable in Transport 21, that will see the completion of the major inter-urban routes and will upgrade links generally between the National Spatial Strategy Gateway Centres and improve the non-national road network;*

1.6.3 Infrastructure Investment Priorities, 2010-2016

The Government published its Infrastructure Investment Priorities 2010-2016 on July 26th, 2010. This document outlines the financial framework for capital investment in the period 2010-2016. In relation to *other strategic routes* the document states:

> *Ireland's transport network has been transformed in recent years and investment between now and 2016 will build on these achievements. In total some €12 billion will be invested in building a sustainable and economically valuable transport system – the largest single area of Investment. Continued investment in the remaining road networks will include completion of the major inter-urban routes, progression of the Atlantic Corridor, the N11, the cross-border route linking Dublin to Derry and Donegal and [other strategic routes].*

The Infrastructure and Capital Investment 2012-16: Medium Term Exchequer Framework reviewed this policy in November 2011 identifying remaining gaps which must be addressed to aid economic recovery, social cohesion and environmental sustainability. In relation to national road schemes this recommended *targeting the improvement of specific road segments where there is a clear economic justification*.

1.6.4 Regional Planning Guidelines for the Border region, 2010-2022

The Regional Planning Guidelines (RPGs) is a long term strategic planning document which aims to direct the future growth of the Border Region, and seeks to implement the planning framework set out in the National Spatial Strategy (2002). The Regional Planning Guidelines identified the M4/N4 as a Strategic (Western) Radial

Corridor which connects Dublin to Sligo via the linked Gateway of Athlone/Tullamore/Mullingar, Longford and Carrick-on-Shannon, and as the primary access route to the west of the Border Region.

The N4 Collooney to Castlebaldwin Realignment is listed as one of the major schemes in planning which will have a significant influence on the Border Region in the coming years.

1.6.5 Border, Midlands and Western Regional Operational Programme, EU Regional Policy 2007-2013

In relation to National Primary routes the Border, Regional and Western Regional Operational Programme states that:

> *...by improving access this strategy would also improve access to the region, connectivity within the region and enhance the economic contribution of the designated Gateways and Hubs and maximise the returns to investments made in other infrastructure such as Ports and Airports. This Operational Plan builds on the significant progress already made in developing the roads network and will complement the NDP 2007-13, Transport 21 and the NSS.*

1.6.6 Smarter Travel, a Sustainable Transport Future (2009-2020)

Smarter Travel, a Sustainable Transport Future (2009-2020) is a new transport policy for Ireland introduced by the Government in 2009 to:

- Enhance our communities;
- Improve our environment;
- Make our economy more efficient and competitive, and;
- Significantly add to the equality of life for all our citizens.

The policy document sets out 49 actions identified to achieve these objectives. Development of the N4 Collooney to Castlebaldwin realignment supports a number of those objectives and actions, insofar as:

- The *Proposed Road Development* will ease congestion and pressures on the local road network between the townlands of *Collooney* and *Cloghoge Lower* and in particular to the village of Castlebaldwin. This will provide a safe environment and thus allow for the promotion of local commuting by walking and cycling;
- The reduction in traffic volumes predicted for the existing N4 due to the transference of most traffic to the new alignment, will lead to an improvement of air quality for people living alongside the existing road and in particular to those people living in Castlebaldwin village;

1.6.7 Forfás Regional Competiveness Agenda (2010);

Under the heading *Economic Infrastructures: Access and Connectivity*, Forfás Regional Competiveness Agenda (2010) states that:

> *Although access to the Border region has improved greatly over recent years, significant connectivity issues remain to be addressed. Progress has been achieved in terms of road access over recent years, and there is a clear understanding, north and south of the border, of the main transport corridors that need to be developed. Priority road projects include: A1 (Newry-Belfast), N2 (Dublin-Derry), N14 (Lifford-Letterkenny), N16/A4 (Sligo-Dungannon) and N17 Galway-Sligo.*
> *The main arterial routes to the Border are the M/N1, N2 (A5), M3 and M4 (from Dublin to Louth/Belfast, Monaghan/Donegal/Derry, Cavan and Sligo respectively); the N17 from Galway to Sligo/Donegal; and the A6 from Belfast to Donegal.*

1.6.8 Sligo County Development Plan 2011-2017

1.6.8.1 Sligo County Development Plan 2011-2017

The Sligo County Development Plan 2011-2017 sets out an overall strategy for the proper planning and sustainable development of County Sligo. It is a stated objective of Sligo County Council to bring National Roads up to appropriate standards as resources become available, in order to develop a safe and

comprehensive road system for the county. The N4 Collooney to Castlebaldwin Realignment is a stated objective of the County Development Plan, listed as requiring improvement in Table 8.B. Other relevant statements contained within Section 8 (Transport and Mobility) of the Plan include:

Under section 8.1: Sligo as a regional transportation node, Improvement of road links between the NSS Gateways:

> *Links from Sligo to other NSS Gateways include the N17 to Galway and the N15 to Letterkenny (both forming part of the Atlantic Corridor outlined above), the N4 to Mullingar and the N16 which forms part of the west-east connection from Sligo to the Gateway of Dundalk.*

Under section 8.1.1: Provisions of the Regional Planning Guidelines, Mobility - strategic policies:

> ***SP-MOB-8*** *Protect the traffic carrying capacity of national roads, the level of service they deliver and the period over which they continue to perform efficiently, by avoiding the creation of new access points or the generation of increased traffic from existing accesses onto the N4, N15, N16, N17 and N59 outside the 50 km/h speed limit, in accordance with the DoEHLG's publication Spatial Planning and National Roads (Draft) Guidelines for Planning Authorities.*

Under section 8.3.1: National primary and secondary roads

> *Continuing improvements to the national primary and secondary road network will enable the catchment area of County Sligo to expand – particularly south to parts of Mayo and Roscommon, via the N17 and N4, and north to Donegal, via the N15.*

1.6.8.2 A County Planning Need

In addition to the foregoing the Planning Department of Sligo County Council have prepared a report (Appendix 1.1 contained within Volume 4 of this EIS) which demonstrates the County Planning Need for the *Proposed Road Development*.

The report highlights the important role that Sligo has to play as a designated 'Gateway' in accordance with the NSS and as set out in the Border Regional Planning Guidelines. It outlines concerns that, in terms of economic recovery, current tendencies for economic and regional policy to focus on the major cities will hinder the potential of development in smaller urban centres such as Sligo. In this regard it is considered essential that investment in critical infrastructure such as the N4 takes place.

The spatial development principles of the County Development Plan are closely linked to transport infrastructure. The N4 route is considered to be a vital element of the Core Strategy, including the spatial development framework and the settlement structure. Whilst the development of Sligo as a Gateway is the ultimate aim of the Core Strategy, other settlements play an important complimentary role and are particularly relevant to the N4 project. Collooney and Ballysadare are identified as principal satellites with the function of absorbing development demand in the Sligo sub-region, with Collooney also being identified as having an important retail, industry and enterprise function. The N4 project also involves improved linkages to Ballymote which is designated as a Key Support Town with the capacity to absorb additional housing, retail and industrial development.

Improved accessibility is considered to be a vital aspect of economic development and the upgrading of the N4 would be considered a significant development in the challenge to attract investment to the area. Sligo plays a regionally significant role in relation to industry, public services, retail and tourism, and this could be expanded upon with the provision of improved transport links.

In light of the above it is considered that the N4 route plays a central and significant role in the context of the development of Sligo Gateway and the county as a whole. This in turn has the potential to contribute significantly to balanced regional development as envisaged in the National Spatial Strategy.

It is considered that the proposed N4 Collooney to Castlebaldwin road development is an essential piece of infrastructure which will reduce journey times, improve reliability and improve traffic safety for users. The *Proposed Road Development* should therefore be progressed in the interests of the proper planning and sustainable development of the area.

1.7 Relevant Figures and Appendices

1.7.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 1.0: Site Location Map;

1.7.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS:

Appendix 1.1.: A County Planning Need: Implications of the proposed development for the proper planning and sustainable development of the area.

2 Background to the *Proposed Road Development*

2.1 Introduction

The basis for the current proposal is the result of a Constraints Study Report published in November 2000 and a Route Selection Report published in May 2002. The *Proposed Road Development* is the subsequent result of a design process which commenced in 2005.

Throughout these stages, appropriate statutory and non-statutory bodies, as well as local interest groups and the public have been consulted. These consultations will be expanded upon further in section 2.2.1 of this Chapter and in Chapter 3 of this EIS.

2.1.1 Existing Alignment

The N4 route between *Cloonamahan* and *Cloghoge Lower* currently brings all traffic through a section of road which is deficient in alignment (geometry), cross-section, capacity and junction/direct access arrangements for both the calculated design speed of 100kph and the statutory speed limit of 100kph. In addition the northern section from *Collooney/Toberbride* to *Cloonamahan* although geometrically[14] improved, contains numerous junctions/direct accesses over its short length.

For that geometrically deficient section between *Cloonamahan* and *Cloghoge Lower,* the carriageway width varies from 6.3m to 7.5m with an average verge width of 1.0m. The horizontal and vertical geometry of the existing road provides Stopping Sight Distances (SSD) and Full Overtaking Sight Distances (FOSD) which are completely inadequate for the permitted maximum speed limits over much of the route as outlined in section 2.1.1.1 below.

2.1.1.1 Comparison with design standards: Horizontal/Vertical Geometry & Stopping Sight Distance;

The NRA DMRB specifies a hierarchy of thresholds for the design of roads. These standards represent the various criteria, whose incorporation in the road design would achieve a desirable level of performance in average driving conditions. This is most true in terms of traffic safety, operation, economic effects, environmental effects and sustainability.

> *The first tier of the hierarchy specifies a desirable minimum value which would produce a high standard of road safety and which should be the initial choice. However, the level of service may remain generally satisfactory and a road may not become unsafe where these values are reduced. This second tier of the hierarchy is termed a Relaxation. The third tier of the hierarchy is known as a Departure from standard and is generally only applied in situations of exceptional difficulty.*[15]

To give an indication of the deficiency of the existing route between *Cloonamahan* and *Cloghoge Lower*, it has been recorded in terms of horizontal geometry that circa 15 (no.) of 27 (no.) curves along the route section are within a range which would be considered a departure from standard. Similarly, in terms of vertical crest curvature, 27 (no.) of 79 (no.) curves along the route are within a range which would be considered a departure from standard. These characteristics generally result in poor SSD along the route with circa 7.6% measured to be within the third tier of the hierarchy.

2.1.1.2 Overtaking, junctions and direct access;

On that geometrically deficient section (between *Cloonamahan* and *Cloghoge Lower*), there are continuous centreline road markings over approximately 88% of its length which leads to very restricted opportunities for safe overtaking; in addition it passes through the village of Castlebaldwin which has a speed limit of 50kph. This section of road has 20 junctions with local roads and numerous accesses to houses, businesses and fields

[14] For the purposes of this EIS, the terms *geometric*, *geometrical* or *geometrically* when used shall be interpreted as referring to the geometry (or mathematical make up) of the horizontal and vertical centre line strings.

[15] NRA; DMRB, NRA TD9/12, February 2012.

which will be further elaborated upon within Chapter 3 of this EIS. The junctions between the local roads and the existing N4 are frequently of a poor standard in respect of road width, layout and visibility for vehicles on both the major and minor roads. The high number of road junctions and private accesses gives rise to safety problems, which are exacerbated by the mix of slow and fast moving vehicles. In particular there are a large number of field entrances with direct access onto the existing road. From a safety point of view, field accesses are especially problematic as they encourage slow moving and frequently heavy agricultural traffic onto the high-speed national primary network.

Plate 2-1: Existing access clusters from clockwise at Lackagh, Drumfin Td. (4 no.) and Castlebaldwin

On the section which is geometrically improved, the occurrence of junctions with local roads, direct accesses (including agricultural) is just as prominent as it is on the geometrically deficient section.

2.1.1.3 Traffic and accident;

Chapter 4 of this EIS provides an overview of the existing traffic patterns on the N4 together with the safety benefits which are expected to accrue as a result of the *Proposed Road Development*. Section 1.5.5 of this EIS has already outlined accident statistics which have been collated to date.

2.2 NRA Project Management Guidelines (NRA PMG)

This *Proposed Road Development* had initially been progressed in accordance with the requirements set out in Phase 4 of the NRA Project Management Guidelines (NRA, 2000). However, as agreed with the NRA, development of the design and EIA process has reflected insofar as is possible and practicable the intentions of the new Project Management Guidelines published in 2010.

The following table shows the development stages of a road construction project both in the original and 2010 versions of the NRA PMG:

Table 2-1 National Road Authority PMG's; Project Phases

Phase	2000 Version	2010 Version
Phase 1	Pre-Planning	Development Concept & Feasibility Studies
Phase 2	Constraints Study	Route Selection
Phase 3	Route Selection	Design
Phase 4	Preliminary Design and Land Acquisition Procedures	EIA/EAR & The Statutory Process
Phase 5	Construction Documentation preparation, Tender, Award	Advance Works & construction Documents Preparation, Tender & Award

Phase	2000 Version	2010 Version
Phase 6	Development Construction	Construction & Implementation
Phase 7	Final Account and Closeout	Handover, Review & Closeout

2.2.1 Constraints Study

The Constraints Study for the *Proposed Road Development* was published in November 2000 and was thus carried out in accordance with the 2000 version of the NRA PMG.

The purpose of the Constraints Study for the project was to identify the nature and extent of significant constraints within a defined study area. These constraints were documented and mapped to allow the subsequent development of feasible route options which are described in Chapter 3.

The identified study area as indicated in Fig. 2.1 (Volume 3) was:

> *...determined to the north and south by the improved sections of road which terminate in Doorly to the north and Castlebaldwin to the south. As the option of bypassing Castlebaldwin is to be included in the study, the constraints area commences in the townland of Dromdoney, just south of Castlebaldwin. The constraints study area is confined in the north-east by the Unshin River and a line of drumlins which lie along a north-west to south-east axis. The constraints study area is confined in the north-west by Lough Corran and a line of drumlins which lie along a north-west to south-east axis.*[16]

The Constraints Study published in November 2000 included information on:

- Environmental and Engineering desk studies;
- Site Survey Work;
- Planning searches; and
- Land ownership searches.

It also allowed for the first official public engagement on the project, with the invitation for submissions in August 2000. Direct consultations were also undertaken with agencies such as the North Western Fisheries Board[17], Archaeological and NPWS sections of Duchas[18], Sligo branches of An Taisce, Bird Watch Ireland, Sligo Field Club and the Sligo County Recorder (for botany).

The principal constraints as outlined in the Executive Summary of the Constraints Study Report[19] were as follows:

2.2.1.1 Physical and topographical constraints

> *The presence of drumlins and small lakes will influence the alignment of the route options.*

2.2.1.2 Archaeological constraints

> *There are many listed archaeological sites (Map 7 of the Constraints Study Report) within the constraints study area and every effort will be made to avoid or reduce the impact on these sites.*

2.2.1.3 Ecological constraints

> *A number of areas of ecological sensitivity have been identified (Map 8 of the Constraints Study Report) and the North Western Regional Fisheries board have identified sensitive streams within the area (Map 3 of the Constraints Study Report). Every effort will be made to avoid or reduce the impact on these areas.*

[16] *N4 Realignment, Constraints Study Report;* Sligo County Council, November 2000.

[17] Now known as Inland Fisheries Ireland.

[18] The functions of Duchas now rest with the Department of the Arts, Heritage and Gaeltacht.

[19] Italics below indicate extracts from the Constraints Study Report.

2.2.1.4 Local development and land use

The village of Castlebaldwin is the main settlement within the area and every effort will be made to avoid severance of this community and to minimise the impact on other property owners within the constraints study area.

2.2.1.5 Services

All services have been identified and the principal constraint is the presence of the Sligo-Flagford 110kV line which runs along the north-east boundary of the constraints study area.

2.3 Relevant Figures and Appendices

2.3.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 2.1: Constraints Study Area;

3 Consideration of Alternatives

3.1 Introduction

The Consideration of Alternatives is a key element of the planning process as it recognises the importance of avoiding impacts at an early stage. In terms of its incorporation in Environmental Impact Statement's; it is a statutory requirement under Section 50(2)(d) of the Roads Act, 1993, as amended, that an EIS contains:

> *an outline of the main alternatives studied by the road authority concerned and an indication of the main reasons for its choice; taking into account the environmental effects.*

This Chapter of the EIS demonstrates how the *Proposed Road Development* compares with the alternatives considered by the Local Authority.

The examination of alternatives commenced initially with a Route Selection Process conducted over the period 2001 to 2002. The results of this process were reviewed in the period 2012-2013 through a renewed assessment of the original route options. Additional alternatives in accordance with the NRA Project Appraisal Guidelines (PAG) were also considered including the Traffic Management Alternative.

Although in the case of the *Proposed Road Development* the Consideration of Alternatives began with a selection of route options guided at the time by the NRA PMG (2000); this chapter in recognition of the work which has been undertaken in 2012/2013 will consider the alternatives in accordance (as far as is deemed reasonably practicable) with the NRA Project Management Guidelines (2010) and the NRA PAG. The chapter will also demonstrate the measures which have been applied during Phase 3 and 4 of the NRA PMG outlining how the Preferred Route discreetly evolved into the route of the *Proposed Road Development*.

3.1.1 Preliminary Options Assessment

3.1.1.1 Route Selection Report (2002) and the addendum report (2012/2013)

The aim of the Route Selection Stage[20] was to develop a number of feasible route options in accordance with the requirements of the NRA DMRB while avoiding, where possible, significant constraints identified in the Constraints Study. These options were then vetted based on environmental, economic and operational assessments leading to the identification of a Preferred Route. The proposed route at the time of Route Selection was a Standard Single Carriageway.

In consideration of the fact that the Route Selection Stage for the *Proposed Road Development* dates back to 2002, it was considered prudent for the purposes of the EIS to review the original Route Selection Report and its findings. In this regard an assessment report which supplements information gathered during the Route Selection Stage was undertaken in 2012/2013; this report now forms an Addendum to the original Route Selection Report and provides an overview of the alternatives and how they compare to the *Proposed Road Development* from a current day perspective.

These alternatives were developed within the Constraints Study area and are for the section of the route which is considered to be geometrically deficient in standard, i.e. *Cloonamahan* to *Cloghoge Lower*.

3.1.1.2 NRA PAG Consideration of Alternatives

With cognisance of the NRA PAG which has been published in the interim to the aforementioned Route Selection Report and the consent which is currently being sought; it was deemed responsible to consider additional options which may affect the consideration of alternatives. In this regard and supplementary to the Route Selection Process an appraisal (in accordance with the NRA PAG) was carried out in 2012/2013 of the most appropriate form of improvements required for this section of the existing N4. An overview of the alternatives; together with the assessment carried out is outlined below.

[20] This was concluded in July 2002 with the adoption by Sligo County Council of a Preferred Route.

3.1.1.2.1 *Traffic Management Alternatives*

Traffic Management Alternatives represent those which seek to respond to transportation problems by maximising the value of existing infrastructure. The Traffic Management alternatives can include:

- Removal of bottlenecks through targeted local investment;
- Local road safety improvements;
- Fiscal or Traffic Control measures to manage traffic demand;
- Public Transport Priority, capacity and/or public transport services;
- Corridor or area-wide improvements to pedestrian or cycling provision; and
- Intelligent Transport Systems to improve reliability, safety and operating capacity.

This option is deemed to represent the "best" that can be done using existing infrastructure, it is noted that in some cases this option may also fit into the 'Major Scheme Alternative' outlined below.

Section 2.3.5 of the *Guidelines on a Common Appraisal Framework for Transport Projects and Programme* refers to a Management Option as follows:

> *Investment options will not always represent the most appropriate response to identified needs or objectives. Better management or pricing of existing networks and services may either reduce demand or expand the effective capacity of networks. A management option may also be more environmentally acceptable...*

3.1.1.2.2 *Major Scheme Investment Alternative*

The Major Scheme Investment Alternative is a corridor improvement which can be delivered through a major investment to widen an existing road, or to develop a new alignment. This alternative represents all of the route options considered in the Route Selection Report.

3.1.1.2.3 *Appraisal of Traffic Management Alternative against Major Scheme Investment Alternative*

In 2012, Aecom were procured to undertake a Project Appraisal of the *Proposed Road Development* in accordance with the NRA PAG. As part of this process and in accordance with PAG Unit 4.0, an appraisal was carried out which considered the viability of a Traffic Management Alternative against the aforementioned Major Scheme Investment.

This assessment investigated the potential of an on-line upgrade of the existing N4 to the standards prescribed in the NRA DMRB which would deliver the required levels of service and safety. In summary it was considered that the high level of existing agricultural access (circa 130), junctions (circa 20) and residential/commercial properties (circa 70) fronting onto the existing N4 between *Cloonamahan* and *Cloghoge Lower* would mean that a Traffic Management Alternative would be impracticable as there would be a potential requirement to partially or fully acquire a significant number of residential properties along the route. Additionally as the route would continue to pass through the village of Castlebaldwin, the requirement to maintain the 50kph speed limit in this area would significantly impact upon potential journey time savings from the *Proposed Road Development*.

In this regard, due to the predicted increases in traffic along the route and the major constraints to local improvement, an on-line widening alternative which would constitute a Traffic Management Alternative was not considered viable in terms of delivering the required levels of service.

Plate 3-1: Existing N4 through Castlebaldwin

This assessment reaffirmed that a Major Scheme Investment represented by the original route options selected, remains the optimal investment solution for the *Proposed Road Development.*

3.2 Route Options

3.2.1 Overview

In all five route options consisting of Standard Single Carriageway cross section were considered during the Route Selection Stage. Each route commenced in the townland of *Doorly* and tied back into the N4 at *Carrowkeel (ED Templevanny)*. These options were all considered within the Constraints Study area which is indicated in Fig. 2.1. of Volume 3.

Following assessment of the route options, the optimal or Preferred Route was considered to be a combination of Options 2 and 4, including the northern part of Option 2 to a point at *Aghalenane Td.* and continuing with the southern part of Option 4. The *Proposed Road Development* is an evolvement of this Preferred Route through the design and early EIA stages of the project. For the purposes of this chapter of the EIS and the aforementioned Addendum to the Route Selection Report, the Preferred Route is referred to as Option 6 while the *Proposed Road Development* is referred to as Option 6+.

The following provides a brief overview of the initial 5 options, the Preferred Route and the Route in its current form (the *Proposed Road Development*). Additional information is provided in the *N4 Realignment – Cloonamahan to Castlebaldwin – Route Selection Report* and its 2013 addendum.

3.2.2 Option 1

Option 1 was c. 12.32km in length and passed through the townlands of *Doorly, Lackagh, Knocknagroagh, Drumfin, Cloonlurg, Knockmoynagh, Kilmorgan, Kingsbrook, Cams, Ardlee, Coolskeagh, Lecarrow, Cleavry, Cloghoge Upper* and *Cloghoge Lower*, bypassing the village of Castlebaldwin to the South West and returning to the N4 at *Carrowkeel (ED Templevanny)*.

This option is shown figuratively in Fig. 3.1. of Volume 3.

3.2.3 Option 2

Option 2 with a total length of c. 12.125km traversed west of the existing N4, passing through the townlands of *Knocknagroagh, Drumfin, Cloonlurg, Carrowkeel, Carrownagark, Kingsbrook, Aghalenane, Cams, Ardloy, Coolskeagh, Lecarrow* and *Cleavry, Cloghoge Upper* and *Cloghoge Lower*, bypassing the village of Castlebaldwin to the South West and returning to the N4 at *Carrowkeel (ED Templevanny)*.

This option is shown figuratively in Fig. 3.1. of Volume 3.

3.2.4 Option 3

Option 3 with a total length of c. 11.86km bypasses the small village of *Lackagh* to the East and rejoins the existing road at *Drumfin*. It then followed the existing road all the way to Castlebaldwin passing through the village. This option represents the online option considered during the Route Selection Process which may also partially correspond with the aforementioned Traffic Management Alternative.

This option is shown figuratively in Fig. 3.1. of Volume 3.

3.2.5 Option 4

Option 4 measuring c. 11.87km in length, traverses South East through the townlands of *Doorly, Lackagh, Drumfin, Murillyroe, Behy, Carrowkeel, Knockadoo, Carrownagark, Tawnagh, Springfield, Cloonymeenaghan, Sheerevagh and Drumderry*. It bypasses the village of Castlebaldwin to the North East before rejoining the existing N4 at *Carrowkeel (ED Templevanny)*.

This option is shown figuratively in Fig. 3.1. of Volume 3.

3.2.6 Option 5

Option 5 measuring c. 11.91km traversed South East through the townlands of *Doorly, Lackagh, Drumfin, Murillyroe, Behy, Carrowkeel, Ogham, Tawnagh, Whitehill, Cloonymeenaghan, Sheerevagh and Drumderry, Castlebaldwin,* bypassing the village of Castlebaldwin to the North East before rejoining the existing N4 at *Carrowkeel (ED Templevanny)*.

This option is shown figuratively in Fig. 3.1. of Volume 3.

3.2.7 Option 6: Preferred Route

Option 6 departs to the western side of the existing N4 route at Doorly and extends southwards through *Knocknagroagh, Drumfin, Cloonlurg, Carrowkeel, Carrownagark, Kingsbrook and Aghalenane*. At this point the Preferred Route travels eastwards from *Aghalenane*, through *Ardloy* and *Springfield*, and then veers southwards again, through *Tawnagh, Springfield, Cloonymeenaghan, Sheerevagh, Cloongad, Drumderry, Castlebaldwin* and *Cloghoge Upper* before returning to the existing N4 route at *Cloghoge Lower* just north of *Carrowkeel (ED Templevanny)* where the other route options terminate.

The Preferred Route is shown figuratively in Fig. 3.2. of Volume 3.

3.2.8 Option 6+: The Proposed Road Development

As the design of the *Proposed Road Development* progressed during Phases 3 and 4 of the NRA PMG (2010), the consideration of alternatives was maintained as more detailed site specific information became available and where discrete alignment changes were feasible. This allowed for a subtle evolvement of the route from that which emerged from the Route Selection Report (Option 6). Some changes to the Preferred Route were considered and subsequently incorporated for the reasons which are outlined later in section 3.4 of this Chapter.

This option has become the *Proposed Road Development* and is described figuratively in Fig. 3.2. of Volume 3. This is the route which others are compared to when considering alternatives.

3.3 Comparison of Route Options

This section of the EIS provides information on the alternatives considered during the Route Selection Process using data from the original Route Selection Report (2002), its addendum (2013) and from the Design Phase of the *Proposed Road Development*. This allows the road authority to demonstrate the main reasons why the route of the *Proposed Road Development* is considered to be the optimum one.

3.3.1 Methodology of Assessment

The Route Selection Report set out a methodology which allowed a comparison of route options. This methodology comprised the categories outlined below which are still considered appropriate to allow the road authority demonstrate the reasons behind its choice for the route of the *Proposed Road Development* (Option 6+):

- Engineering Considerations;
- Economic Considerations;
- Environmental Considerations;
- Public Preference;

3.3.1.1 Engineering Considerations

Engineering considerations at the time of Route Selection related principally to Full Overtaking Sight Distance (FOSD), number of junctions, number of accesses and prevailing ground condition's.

The addendum report assessed the route of the *Proposed Road Development* in terms of FOSD. This resulted in the conclusion that the route has superior sight distances (70.5%) in comparison with the other options considered at the time of Route Selection. This is reflected in Table 3-1 below.

Table 3-1: FOSD Comparison

Proposed Route	FOSD	Ranking
Option 1	54.2%	5
Option 2	62.2%	3
Option 3	47.3%	7
Option 4	68.39%	2
Option 5	55.08%	4
Option 6	47.3% to 54.2%[21]	6
Option 6+	70.5%	1

In relation to junctions and direct assesses the addendum report reviewed the current NRA DMRB standards which states that:

> *...where an existing national road is to be improved on-line, there are likely to be existing accesses. Where possible these should be relocated on another road or to a better location onto the national road (such relocation would be regarded as a new or altered access). Where this is not practicable, the layout of the access onto the new road should be designed in accordance with the geometric standards for a new or altered access.*

With cognisance of the foregoing it was considered that all options would now score similarly as they cross a similar number of local roads. This however, would be with the exception of Option 3 which due to the prevalence of significant direct assesses would require additional junction and direct access arrangements which has already been discussed in section 3.1.1.2.3 of this Chapter.

In terms of ground conditions; considering modifications which have been made during Phases 3 and 4 of the NRA PMG as outlined in section 3.4.2, the impact of each of the route options was reassessed in the addendum report using desktop information from soil geology mapping compiled by Teagasc. The results of this as outlined in Table 3-2 confirm that each of the route options encounter areas of soft ground of approximately 20% to 44% of their various route lengths. The *Proposed Road Development* encounters approximately 34% of soft ground along its length mainly between *Doorly Td.* and *Ardloy Td.* Although this is a high percentage, it is the least intrusive of those route options which are located south-west of the existing N4 between the aforementioned townlands.

Table 3-2: Soil and Subsoil Geology

Route Option	% of Soft Ground interpreted from Soil mapping	% of Soft Ground interpreted from Subsoil mapping	Rank
Option 1	40%	44%	7
Option 2	35%	35%	5
Option 3	24%	24.5%	1
Option 4	43%	20%	3

[21] No specific value is given for FOSD in the Route Selection Report; however, the range of values provided has been derived from the Rank which is provided in the Route Selection Report.

Route Option	% of Soft Ground interpreted from Soil mapping	% of Soft Ground interpreted from Subsoil mapping	Rank
Option 5	27%	24.3%	2
Option 6	35%	38%	6
Option 6+	34%	34%	4

3.3.1.2 Economic

Cost Estimates at the time of Route Selection were based on figures set out in the National Roads Needs Study (NRNS, 1998). The result of the estimates which are outlined in Table 3-3 were generally reflective of each route options length, the associated earthworks and number of structures which would be required. The costs indicated that the online option (Option 3) appeared the most economical to construct with other options showing cost increases ranging from 18% to 33%. The Preferred Route showed an increase of 29%. As part of the addendum report, it was not considered necessary to re-cost the options as the figures produced in 2002 allow for a suitable comparable of the various options.

Table 3-3: Estimated Cost of Routes

Proposed Route	Cost (£m)	Ranking
Option 1	25.4	6
Option 2	24.2	4
Option 3	19.1	1
Option 4	22.6	2
Option 5	22.9	3
Option 6	24.7	5
Option 6+	N/A[22]	N/A[22]

Based on the estimates, Donegal National Roads Design Office (as part of the Route Selection Report) carried out a Cost Benefit Analysis on each of the route options. The results of the exercise are outlined in Table 3-4 and revealed that the benefits of the most economical option would be much less in the overall term of the project where compared with Option 1 which would deliver the highest level of benefits. It was indicated that the Preferred Route would provide benefits which would be in the order of 14% less than those provided by Option 1.

Table 3-4: Benefits and Ranking

Proposed Route	Benefit (£m)	Ranking
Option 1	11.0	6
Option 2	12.9	4
Option 3	11.8	5
Option 4	15.1	1
Option 5	14.7	2
Option 6	13.0	3
Option 6+	N/A[22]	N/A[22]

Although the foregoing does not represent a comparison for Option 6+ as it had not evolved at the time of Route Selection, the preceding section 3.3.1.1 illustrates that savings will be realised as a result of reduced soft

[22] N/A as option 6+ had not evolved at the time of Route Selection.

ground conditions encountered in comparison to the Preferred Route (as a result of design modifications made to the Preferred Route during the design stage). This would bring the route of the *Proposed Road Development* more in line with the other higher placed routes in terms of economic considerations.

3.3.1.3 Environmental

In terms of environmental effects the following outlines how the alternative routes compare with the *Proposed Road Development* based on information from the Route Selection Report and more significantly from the 2012/2013 review carried out (The addendum report).

3.3.1.3.1 *Impact on Archaeology*

The Route Selection Report in carrying out significant field studies recognised the archaeological richness of the existing environment in the vicinity of the *Proposed Road Development.* In order to update this assessment, a review was carried out in the addendum report which focussed on the most up to date desk study information available in 2012. This included a review of available information including *Records of Monuments and Places for County Sligo*, *Records of Protected Structures for County Sligo (2005 – 2011)* and *National Monuments for County Sligo (2009 – 2012)*.

Based on this information and in terms of potential direct impacts; Table 3-5 indicates that Options 1, 2, 6 and 6+ all would appear to have the least impact on Archaeological sites. It was also noted during the 2012 assessment that the Castlebaldwin Fortified House would be in the viewshed of options which run to the east of the existing N4 including Option 6+, but, as described in the Route Selection Report would not require any ground disturbance in the vicinity of this structure.

Table 3-5: Impact of route options on listed archaeological monuments

Route Option	No. of listed monuments within 25m	No. of listed monuments between 25m and 50m	Rank[23]
Option 1	1	1	1
Option 2	1	1	1
Option 3	2	0	2
Option 4	2	5	4
Option 5	2	4	3
Option 6	1	1	1
Option 6+	1	1	1

Considering the above it was concluded that; the *Proposed Road Development* remains a good route overall from an archaeological, architectural and cultural heritage perspective as is reflected in Table 3-5.

3.3.1.3.2 *Impact on Ecology*

Of all the environmental disciplines, ecology represents the area where most change has occurred in the intervening years from the time of the Route Selection. The reasons for this are principally due to changes to European and Irish legislation and the effects same have had on designated sites, sensitivities to specific elements of Flora & Fauna and the associated environmental guidelines that have been published in line with the legislative changes and greater environmental awareness.

In this regard an ecological evaluation with regard to ecological constraints was undertaken with reference to the National Road Authority's *'Guidelines for Assessment of Ecological Impacts of National Road Schemes Rev 2' (NRA, 2009)'.* In line with this guidance the level of impact and its significance with regard to each Route Option was applied with the assumption that general mitigation measures, following relevant NRA environmental guidance, would be implemented.

[23] Similar Ranks have been scored where impacts are considered similar.

With reference to the Guidelines and in particular to *Figure 5: Consideration of European Sites during Route Corridor Selection*, there is a clear instruction that where proposed routes may adversely affect the integrity of European Sites the following approach in Route Selection must be undertaken:

> *Disregard all feasible alternative solutions affecting the integrity of the European site and continue with alternatives that do not.*

The addendum report provides a quantifiable evaluation of the potential for the various route options to affect sensitive ecological receptors. Included in the basic addition of ecological receptors, is a weighting in terms of geographic importance.

From a review of the route options (and based on the assumption that it would be possible to provide similar levels of design mitigation on each of the alternative Route Options to that which is provided on the *Proposed Road Development)* it was considered that it would be likely that all of the routes could be shown, beyond reasonable scientific doubt not to pose a risk of giving rise to impacts affecting the conservation status of qualifying interests or conservation objectives with regard to integrity-level impacts affecting any European site. Taking cognisance of this, but with regard to minimising the risk to adverse effects on designated European sites, route options that require direct landtake within designated European sites (i.e. route options 3, 4 and 5) were negatively weighted. This is with reference to crossings of the Turnalaydan Stream and the Drumfin River which are designated within the River Unshin cSAC. It is noted that the permanent or significant loss of Annex I habitat or permanent or significant effects on the Annex II species listed as qualifying interests of this site which would constitute an integrity level impact would be unlikely at the proposed crossing points.

In terms of undesignated sites of National (and International) Importance, Option 5 and Option 6+ were deemed to have the least impact. Route Option 3, although potentially affecting the least number of sites, would have the potential for direct and significant impacts on the Loughymeenaghan wetland site, which is evaluated as being of international importance in the County Sligo Wetland Survey Report (Wilson *et. al*., 2011).

All the proposed route options require crossings of 2 watercourses identified as being of County Importance; the potential for significant effects arising at these watercourse crossings is evaluated as being not significant. Route options 3, 4 and 5 do not give rise to any further potential impacts on sites of County Importance. Options 1 and 6+ may potentially affect one additional site of County Importance.

All the route options require crossings of minor watercourses identified as being of Local Importance (higher value). The potential for significant impacts at these watercourses is evaluated as being unlikely. Route options 4, 5, 6, and 6+ all require additional landtake within Drumderry Marsh, a wetland site evaluated as being of Local Importance (higher value).

The results of this assessment are outlined in Table 3-6 and indicate that each of the alternatives have a greater impact on the ecological environment when compared with the *Proposed Road Development* (Option 6+).

Table 3-6: Impact of route options on Ecology

Route Option	Significant Impact on designated European Site	Sites with direct impact on a European Site	Significant Impacts on a Nationally designated Site	Significant Impact on a feature of International/ National importance	Significant Impact on a feature of County Importance	Significant Impact on a feature of County Importance	Rank
Option 1	0	0	0	3	1	0	2
Option 2	0	0	0	3	2	0	3
Option 3	0	1	0	2	0	0	7
Option 4	0	1	0	3	0	1	6
Option 5	0	1	0	2	0	1	5
Option 6	0	0	0	4	2	1	4
Option 6+	0	0	0	2	1	1	1

3.3.1.3.3 *Hydrology, Flooding & Hydrogeology*

3.3.1.3.3.1 *Hydrology*

The original Route Selection Report did not specifically consider impacts of a Hydrological nature. The addendum report in the ecological section considers impacts on the aquatic environment which for the purposes of demonstrating comparisons is deemed adequate for Hydrology.

3.3.1.3.3.2 *Flooding*

The addendum report undertook an assessment of Flood Risk to each of the Route Options. This was based on a review of OPW Preliminary Flood Risk Assessment mapping, NRA National Network Flood Risk Mapping and detailed FRA mapping which was available from the design process of the *Proposed Road Development*. The following is an overview of identified localised flood plains (associated with rivers and streams) in the vicinity of the Route Options.

- Unshin River;
- Turnalaydan Stream;
- Drumfin River;
- Springfield Stream; and
- Lissycoyne Stream;

The results of the assessment are outlined in Table 3-7. This indicates that the online option 3 would be the most favourable followed by options 2 and 1. The preferred route and the *Proposed Road Development* are medium preferences followed by options 4 and 5.

Table 3-7: Overall Ranking

Route Option	Identified Flood Plain					OVERALL
	Unshin River	Turnalaydan Stream	Drumfin River	Springfield Stream	Lissycoyne Stream	
1	1	4	4	1	1	3
2	1	4	3	1	1	2
3	1	2	1	2	1	1
4	5	2	5	2	3	5
5	5	2	5	3	3	6
6	1	4	3	3	3	4
6+	1	4	3	3	3	4

3.3.1.3.3.3 *Hydrogeology*

In terms of Hydrogeology, the aforementioned ecological section also deals with impacts on Ground Water Dependent Ecosystems. In a broader sense the aquifer and karst sensitivities for each of the route options are generally similar, that is with the exception of Option 3 which would most likely require less excavation and thus potentially fewer impacts on the Hydrogeological environment.

3.3.1.3.4 *Impact on Air Quality*

The DMRB at the time of Route Selection recommended a generalised appraisal of route options by banding properties up to 200m from roadside, with pollutant weightings given to each band, so that total numbers and total changes in pollution levels could be compared.

In recognition of property increases since 2002, the addendum report reviewed the numbers of properties within the various bands and reapplied the 2002 Air Quality criteria the results of which are as outlined in Table 3-8. In applying these changes updated *'NRA Guidelines for the treatment of Air Quality during the planning and construction of National road Schemes'* were considered, however, considering the nature of the existing environment which is predominately rural in nature in combination with the *Proposed Road*

Developments characteristics which will largely provide for free-flowing traffic movements it was deemed unnecessary to apply additional criteria as this ultimately would not influence the final outcome.

This reaffirms as expected that Option 3 affects the most properties from the point of view of reduction in Air Quality, while the *Proposed Road Development* (Option 6+) has the least impact.

Table 3-8: Impact of route options on Air Quality (2012)

Route Corridor	Number of Properties Sensitive to Air Quality Within 50m	Number of Properties Sensitive to Air Quality Within 50-100m	Number of Properties Sensitive to Air Quality Within 100-200m	PM	NO^2	Ranking
PM Weighting	1	0.65	0.55	Weighted Total	Weighted Total	
NO^2	1	0.8	0.65	No. of houses(0-200m)	No. of houses(0-200m)	
Option 1	13 (13) (13)	29 (18.85) (23.2)	50 (27.5) (32.5)	59.35	68.7	4
Option 2	12 (12) (12)	28 (18.2) (22.4)	56 (30.8) (36.4)	61.0	70.8	5
Option 3	50 (50) (50)	22 (14.3) (17.6)	48 (26.4) (31.2)	90.7	98.8	6
Option 4	9 (9) (9)	11 (7.15) (8.8)	32 (17.6) (20.8)	33.75	38.6	2
Option 5	9 (9) (9)	15 (9.75) (12)	40 (22.0) (26.0)	40.75	47	3
Option 6	1 (1) (1)	10 (6.5) (8.0)	25 (13.75) (16.25)	20.60	25.25	1
Option 6+	1 (1) (1)	10 (6.5) (8.0)	25 (13.75) (16.25)	20.60	25.25	1

3.3.1.3.5 *Impact due to Noise*

The original Route Selection Report compared the number of houses within 300m of each of the different route options; these were further assessed into bands of 0m - 50m, 50m - 100m, 100m - 200m and 200m – 300m. In recognition of property increases since 2002 and the additional guidelines which are now available, a 2012 review carried out a similar banding exercise to that outlined above with a 2012 base, it however extended to calculate Potential Impact Rating (PIR) in accordance with the *NRA Guidelines for the Treatment of Noise and Vibration of National Road Schemes* published in 2006 as outlined in Table 3-9 below.

Table 3-9: Impact of route options in relation to Noise (2012 review)

route options	Bands multiplied by relevant rating factor				PIR Total	Rank
	0 to 50m	50 to 100m	100 to 200m	200 to 300m		
Option 1	52	87	100	42	281	4
Option 2	48	84	112	44	288	5
Option 3	200	66	96	40	402	6
Option 4	36	33	64	57	190	2
Option 5	36	45	80	35	196	3
Option 6	4	27	50	57	138	1
Option 6+	4	27	50	57	138	1

Based on PIR values, the Preferred Route and the route of the *Proposed Road Development* are rated as having the least impact in terms of noise. It is also notable that this route option has the lowest PIR in the 0 – 50m, 50 to 100m bands and 100m to 200m bands, i.e. the bands in which mitigation is most likely to be required. Therefore, on the basis of the band count numbers and subsequent PIR calculations for the entire length of the route options, Option 6 and 6+ are ranked as the best route in terms of noise and vibration.

3.3.1.3.6 *Impact on Landscape and Visual*

The Route Selection Report (2002) noted that the routes passed through an area generally classified as *Normal Rural Landscape* within the County Development Plan with the exception of one area comprising the wetland areas of (and surrounding) Boathole Lough and Lough Corran which was considered to be *Sensitive Rural Landscape* and which was impacted on by route options 1 and 2 (this forms part of the Preferred Route at this location). It also identified a scenic route which passes through Castlebaldwin in a south-west/north-east direction and which would be impacted on by each of the route options.

In general the Route Selection Report outlined the most distinctive features of the landscape in this area to be

> *...drumlins and small lakes that generally lie along a north-west to south-east axis. A particularly fine group of drumlins is seen north and east of Riverstown. Travelling in a southern direction there are views of Keshcorran and the Bricklieve Mountains to the southwest and intermittent views of Carran Hill to the east. To the north the Ox Mountains, Crockauns, Killerry Mountain and Benbulbin are all visible in fine weather.*

Considering the fact that visual impacts were not considered in the original Route Selection Report, the addendum report in 2013 undertook a renewed assessment which focussed on both Landscape and Visual from a current day perspective.

3.3.1.3.6.1 *Visual Impacts*

The focus of the 2013 assessment involved an examination of:

- The number of properties which are anticipated to experience considerable visual impacts which are defined as impacts ranging from Moderate Adverse to Profound Adverse as a result of the *Proposed Road Development*.; and
- The potential impacts of the proposed alternative route options on designated scenic routes, views of road users and from heritage and amenity features. The assessment distinguishes between potential higher ranging impacts (Moderate Adverse or higher) or lower ranging impacts (Slight Adverse or lower) or no impacts.

In relation to visual impacts to occupied properties, Option 3 is anticipated to affect the highest number of properties in relation to considerable adverse visual impacts and is the least preferred route option in this category. The route alignment with the least number of occupied properties likely to experience considerable impacts is Option 6 (and Option 6+) followed closely by Option 2.

In relation to visual impacts on road users, heritage sites and designated routes, online Option 3 is the preferred option. It avoids largely the disturbance of adjacent landscape features or changes to the wider setting of the heritage sites. All other offline options are expected to result in considerable visual impacts to road users. The second preferred option is Option 6+, due to its lower ranging visual impacts to the heritage sites. Considerable visual impacts would be expected to arise from Option 1 and Option 2 on the Carrowkeel Cemetery National Monument (NM) site due to their close proximity to the foothills of the Bricklieve Mountains. Options 4, 5, 6 and 6+ would pass the Castlebaldwin House (NM) Heritage site at close proximity in conjunction with the existing N4 alignment and are also expected to result in higher grade visual impacts at this location.

Table 3-10: Impact of route options in relation to visual effects

Route Option	Visual Receptors					
	Total number of properties affected	Designated Scenic Routes	Castlebaldwin House (NM) Heritage Site	Carrowkeel Passage Cemetery (NM) Heritage Site	Road Users	Cumulative Visual Impacts
Option 1	51	Low	None	High	High	Low
Option 2	41	Low	None	High	High	Low
Option 3	66	None	Low	Low	Low	None
Option 4	59	Low	High	Low	High	Low

Route Option	Visual Receptors					
	Total number of properties affected	Designated Scenic Routes	Castlebaldwin House (NM) Heritage Site	Carrowkeel Passage Cemetery (NM) Heritage Site	Road Users	Cumulative Visual Impacts
Option 5	51	Low	High	Low	High	Low
Option 6	40	None	Low	Low	High	Low
Option 6+	40	None	Low	Low	High	Low

3.3.1.3.6.2 *Landscape Impacts*

The Landscape assessment focussed on the physical characteristics of each of the route options and the most distinctive landscape features within the Study Area.

In terms of physical characteristics:

- Option 1 is marginally longer than all other options with the highest number of river crossings, a medium number of road crossings, medium number of cut and fill areas and a medium value for maximum level of cut. This option has however the second highest maximum level of fill;
- Option 2 has the third longest road length, the second highest number of road crossings, the third highest number of river crossings and second lowest maximum level of cut. It has the lowest number of cut and fill areas but the highest maximum level of fill;
- Option 3 is shortest in length by a marginal distance but requires; the highest number of road crossings, the second highest number of river crossings and the highest number of cut and fill areas (26). It also has the second highest maximum level of fill. For these reasons it is the least preferred route option in this category;
- Option 4 is the second shortest option with a medium number of road and river crossings, cut and fill areas and medium values for maximum levels of cut and fill;
- Option 5 is slightly longer than the shortest options but has the least number of road and river crossings and cut and fill areas. It has medium values for maximum levels of cut and fill. Option 5 is the overall preferred option in this category;
- Options 6 and 6+ require the least number of road and river crossings but the second highest number of cut and fill areas. It also has the highest maximum levels of cuts but the second lowest maximum level of fills.

In relation to anticipated impacts to landscape features the preferred option is Option 3, which avoids largely any higher grade impacts to existing landscape features. This option would, however, require largely the removal of most of the existing roadside vegetation and is the route option with the highest predicted losses of the existing hedgerow network in the study area. Option 5 is the preferred offline option in this category with the least number of macro landscape features impacted on. It also avoids the only 'Sensitive Rural Landscape Area' in the study area. The least preferred options in relation to landscape impacts to macro landscape features is Options 6 and 6+ followed by Option 2. These route alignments would affect the highest number of macro landscape features including the 'Sensitive Rural Landscape' at Lough Corran. Option 1 affects a slightly lower number of landscape features but would have a higher impact on the 'Sensitive Rural Landscape' at Lough Corran.

Table 3-11: Landscape Impacts Ranking

Route Option	Ranking						
	Route Length	Road Crossings	River Crossings	Cut and Fills	Macro Landscape Features	Hedgerow and Roadside vegetation	Cumulative Impacts
Option 1	4	4	4	3	3	1	2
Option 2	2	5	2	1	5	1	3
Option 3	1	6	3	5	1	2	1
Option 4	1	3	2	3	4	1	5
Option 5	1	1	1	2	2	1	2
Option 6	3	2	1	4	6	1	4
Option 6+	3	2	1	4	6	1	4

3.3.1.3.6.3 *Overall Ranking*

Of the assessment categories examined above, offline route corridor Option 5 to the east of the existing N4 is the favoured or second favoured option in 11 out of 12 categories and is in relation to visual and landscape impacts the overall optimal option. It is one of the shortest route options with the least or second least number of road and river crossings, second least number of cut and fill areas and is the option with the least anticipated impacts in relation to the macro landscape and second least cumulative landscape and visual impacts. Its anticipated visual impact is rated slightly higher in the categories of occupied properties and in relation to the Castlebaldwin heritage (Fortified House) site.

The remaining online and offline route options will result in considerable visual or landscape impacts in some of the assessed landscape and visual impact categories, but are in all cases also the favoured or second favoured options in other categories and therefore differences between the different route corridor options in the overall rankings tends to be slight.

Offline route corridor Option 1 to the west of the existing N4 is the second most favourable route in terms of landscape and visual impacts. It is the joint favoured overall option in relation to visual impacts and the second favoured option in relation to overall landscape impacts. It is slightly longer than all other options and has the highest number of river crossings but is the second favoured route in relation to cumulative impacts and visual impacts to occupied properties. It is a medium scoring option in other categories.

Offline route corridor Option 2 to the west of the existing N4 is a medium scoring route option in relation to landscape and visual impacts. Option 2 is slightly longer than all other options and has the highest number of road crossings but has lower anticipated impacts in relation to cumulative landscape and visual impacts and visual impacts to occupied properties. Option 2 is together with option 6+ the third favoured route option.

Online Option 3 is the least favoured option in relation to visual impacts to occupied properties, number of road crossings, number of cut and fill areas and impacts to the hedgerow and roadside vegetation network. This is considered to outweigh higher preference scorings in other categories and this option is judged to be the least preferred option overall.

Offline Option 4 to the east of the existing N4 is the least favoured option in relation to cumulative landscape and visual impacts and the second least favoured option in relation to visual impacts to occupied properties and landscape impacts to macro landscape features and is overall the second least favoured option.

Option 6 and Option 6+ alternating to the east and west of the existing N4 is the favoured route in relation to visual impacts to occupied properties and scenic routes and heritage sites compared to the other offline options and requires the least number of river crossing and second least number of road crossings. Its overall route length and number of cut and fill areas is, however, higher than some of the comparator route options. It is also considered to result in higher cumulative impacts and is the least favoured route in relation to impacts to landscape features. In the overall assessment it is a medium scoring option and with route option 2 is the third favoured option.

Table 3-12: Overall Landscape and Visual Route Options Ranking

Route Option	Overall Rank
Option 1	2
Option 2	3
Option 3	5
Option 4	4
Option 5	1
Option 6	3
Option 6+	3

3.3.1.3.7 *Socio Economic Impacts*

The addendum to the Route Selection Report considered an up to date review of Socio Economic factors including a consideration of:

- Regional Context;
- Economic Activity and Tourism;
- Demography;
- Residential and Business Properties;
- The Business Community;
- Tourism and Recreation;
- Community Facilities and Community Impacts; and
- Planning Policy and Planning Permissions;

This reviewed analysis revealed that Options 1 and 2 run through lands which are zoned for residential use and are adjacent to the existing primary school facility on the south west side of the village as well as a recently constructed housing estate. Options 4, 5 and the 6 provide the greatest benefit to the village of Castlebaldwin as these options are located to the northeast side of the existing N4 thereby allowing the village to develop in accordance with the proposed mini plan which forms part of the Sligo County Development Plan (2011-2017). All routes will have a similar impact on retail and commercial activity. The aims and objectives of the Sligo County Development Plan as well as the Castlebaldwin Mini Development Plan (2011-2017) in terms of National Roads objectives are met with the Preferred Route. The Preferred Route (and the route of the *Proposed Road Development*) is the only route which has been vetted in terms of planning permissions since the adoption of the route in 2002.

Taking the above into account, it is considered that all options will improve socio economic aspects in the vicinity of the area. However, options 6 and 6+ would appear to be the most preferred considering that they have been audited for planning permissions over the last 11 years while option 3 is likely to be the least preferable considering that many properties would be affected and that existing businesses on the road would be likely to lose passing trade due to access restrictions.

Table 3-13: Socio-Economic, route options Rank

Route Option	Rank
Option 1	3
Option 2	3
Option 3	2
Option 4	2
Option 5	2

Route Option	Rank
Option 6	1
Option 6+	1

3.3.1.3.8 *Impact on land and Dwellings (Agriculture & Non-Agriculture Property)*

3.3.1.3.8.1 *Agriculture*

Agronomy considerations were incorporated within the Route Selection Report in the form of an assessment carried out by an appointed specialist. Comparisons of route options are presented in Table 3-14 with a severance rating of 1 indicating least impact and a rating of 5 indicating the most impact.

Table 3-14: Impact of route options on Land and Dwellings

Route Option	Severance Rating
Option 1	3
Option 2	5
Option 3	1
Option 4	2
Option 5	4
Option 6	Not Ranked
Option 6+	Not Ranked

The Preferred Route at the time was not ranked, however, a report on the Preferred Route at the time concluded that impacts would generally be of a mild to moderate nature with only 4% of properties expected to experience severe severance.

The addendum report reviewed the land ownership details along all route options by comparison of current land registry mapping with land ownership mapping used for the Route Selection Report analysis. The results of this analysis indicated that some changes had occurred with regards to land ownership along the route, however, it was found that the size of individual farm holdings in the main remained similar to those assessed for the Route Selection Report. Therefore the foregoing results were considered appropriate as a demonstration of the main alternatives considered by the Road Authority.

3.3.1.3.8.2 *Non-Agricultural Property*

Considering the significant amount of private developments since the Route Selection Stage, the addendum report undertook a detailed assessment of all route options using combinations of a desktop study, a roadside inspection and local knowledge of the study area.

The assessment was carried out under the following headings:

- Acquisition of residential property
- Acquisition of non-residential property
- Property impact to gardens
- Property within 50m of the route option

The conclusions for this assessment and the associated rankings for non-agricultural property are shown in Table 3-15 below. This indicates the significant impacts which Option 3 would have on the properties which currently adjoin it, while also demonstrating that Option 6 and 6+ provide for the least impact on Non Agricultural Properties.

Table 3-15: Impacts on Non-Agricultural property for each route option

Route Options	Property Acquisition (no.)		Property impacts to gardens (no.)	Non-agricultural property 0-50m (no.)	Rank
	Residential property	Non-residential property			
Option 1	11	19	6	15	4
Option 2	11	26	6	16	5
Option 3	41	72	7	74	6
Option 4	9	14	4	15	2
Option 5	11	13	5	15	3
Option 6	2	4	2	2	1
Option 6+	2	4	2	2	1

3.3.2 Considered Submissions

As part of consultation with various statutory and non-statutory bodies during the Route Selection process, responses were received and considered from the following bodies:

(1) Department of the Arts, Heritage, Gaeltacht and the Islands;
(2) The North Western Regional Fisheries Board;
(3) An Taisce, The National Trust for Ireland;

3.3.3 Public Opinion

Public Participation in the Route Selection Process included two separate public consultations. The first consultation was based on the initial 5 route options and was held during the period 14th May 2001 to 15th June 2001. This allowed for the public opinion to be considered within the methodology for selection of the Preferred Route which is stated in the Route Selection report as follows:

The preferred route takes into account the concerns of the public in relation to land severance…

The second consultation presented the Preferred Route Corridor to the public in March 2002. The results of this consultation allowed for modifications to be made to Preferred Route prior to its adoption by Sligo County Council.

3.3.3.1 Conclusion of Route Selection Process

Based on the Route Selection Report and its 2013 addendum, Table 3-16 outlines the aptness of the route to be maintained as the optimal location for the *Proposed Road Development*.

It is generally apparent from the foregoing and the chart provided in Table 3-16 that the route of the *Proposed Road Development* scores high preference ratings for the majority of criteria with the exception of some medium scores on Ground Conditions, Hydrology, Flooding, Hydrogeology, Landscape and Agricultural Property impacts. The economical benefits of the *Proposed Road Development* are considered to be on the threshold of high to medium preference while the comparable cost is considered to be on the threshold of medium to high.

The most comparable alternatives to the *Proposed Road Development* are Options 4 and 5 which both run wholly to the east of the existing N4. The categories which make these options comparable to the *Proposed Road Development* would mainly relate to ground conditions and cost, however, in both of these categories the *Proposed Road Development* still compares well. The most severe impacts of both of these options which ultimately make them both unfavourable relate principally to the crossing of and the direct landtake required within the Unshin River cSAC/pNHA.

Table 3-16: Performance of the Route of the Proposed Road Development in comparison to original route options.

Category	Criteria	Rank							Comment
		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 6+	
Engineering Assessment	FOSD	5	3	7	2	4	6	1	Score from 2002 RSR and 2013 addendum report
	Number of Junctions	1	1	5 to 7	1	1	1	1	Score from addendum report 2013
	Number of Accesses	1	1	5 to 7	1	1	1	1	Score from addendum report 2013
	Ground Conditions	7	5	1	3	2	6	4	Score from addendum report 2013
Economics	Cost	6	4	1	2	3	5	4 to 5	Score from RSR 2002
	Cost Benefits	6	4	5	1	2	3	2 to 3	Score from RSR 2002
Environment	Impact on Archaeology	1	1	2	4	3	1	1	Score from 2002 RSR and 2013 addendum report
	Ecology	2	3	7	6	5	4	1	Score from addendum report 2013
	Hydrology	3 to 4	3 to 4	1 to 2	3 to 4	3 to 4	3 to 4	3 to 4	Score from addendum report 2013
	Flooding	3	2	1	5	6	4	4	Score from addendum report 2013
	Hydro Geology	3 to 4	3 to 4	1 to 2	3 to 4	3 to 4	3 to 4	3 to 4	Score from addendum report 2013
	Air Quality & Climate Change	4	5	6	2	3	1	1	Score from addendum report 2013
	Noise & Vibration	4	5	6	2	3	1	1	Score from addendum report 2013
	Landscape and Visual	2	3	5	4	1	3	3	Score from addendum report 2013
	Socio Economic	3	3	4	2	2	1	1	Score from addendum report 2013
	Agri. Property	3	5	1	2	4	3	3	Score from addendum report 2013 (Option 6/6+ interpreted)
	Non Agri. Property	4	5	6	2	3	1	1	Score from addendum report 2013

Table 3-17: Legend for Table 3-16

Legend for Table 3-16					
High Preference: Applied for Rankings/Ratings of 1 to 2.		Medium Preference: Applied for Rankings/Ratings of 3 to 4.		Low Preference: Applied for Rankings/Ratings of 5 to 7.	

3.4 Application of Design Alternatives

3.4.1 NRA Standards

There have been numerous changes to NRA standards since the emergence of the Preferred Route; these changes have resulted in modifications to the route as outlined in the following paragraphs;

3.4.1.1 Road type

The rational which determined the evolvement of the road type from the time of Route Selection to the current time stems from the NRA's consideration of new road types in the mid part of the 2000's. This was in acknowledgement of the fact that there was a large gap, in terms of capacity, cost and safety, between the Standard Single Carriageway and a Dual Carriageway with at grade junctions.

This led the NRA to develop other new divided road categories, which provided a capacity range between that of a single carriageway and a dual carriageway, i.e. between 11,600 and 26,500 AADT. This resulted in the development of the Type 2 Dual Carriageway which was piloted on the N4 Dromod/Roosky Bypass and incorporated into the DMRB in 2007. This Type of road was derived principally from the Swedish experience of similar roads which provided the following benefits over a Standard Single Carriageway Road:

- Segregation benefits of a dual carriageway;
- Reduction in the severity of all accidents;
- Reduction in number of head on collisions;
- Reduction in driver frustration by provision of overtaking opportunities;
- Elimination of uncontrolled right turning movements;
- Controlled access onto national routes.

3.4.1.1.1 *Incremental Analysis*

The selection of the Road Type for the *Proposed Road Development* was based on an incremental analysis approach adopted in accordance with the advice of the NRA PMG (2010). This was in recognition of the fact that AADT threshold flows outlined in NRA DMRB TD 09/12 should be used as a guide only in the selection of different road types. This is as advised by the NRA Project Appraisal Guidelines (PAG Unit 4: Definition of Alternatives). The analysis was carried out by Aecom in consultation with the design team and was supported by the traffic models developed as part of the project.

Having regard to the provisions of NRA TD 09/12 and considering the range of traffic figures currently using and predicted to use the *Proposed Road Development* it was determined that the most appropriate road types would be the Standard Single Carriageway or the Type 2 Dual Carriageway. The analysis thus sought to compare these two road types.

The following summarises the results of this assessment, which considered the route in 2 separate segments in recognition of the geometric improvements which have been carried out on the portion between *Collooney/Toberbride Td.* and *Doorly Td*. The geometrically deficient section is initially considered.

3.4.1.1.1.1 *Cloonamahan Td. to Cloghoge Lower Td.: Geometrically Deficient Section*

- Based on National Parameter values extracted from the NRA PAG, the Type 2 Dual Carriageway has significantly lower (50%) accident rates than the Type 1 Single Carriageway as per Table 3-18, moreover, indices indicate that in an accident the average number of casualties are likely to be significantly lower for an accident which occurs on a dual carriageway;
- The analysis suggests that the dual carriageway option will result in daily journey time savings of over 28 hours in 2032 when compared to the single carriageway option, equating to a daily journey time saving of approx 3-4%;
- Travel distance and average speed remain reasonably constant for both road types;
- The aforementioned guidelines in NRA TD 09/12 advise that a Type 1 Single Carriageway road will operate at LOS D up to an AADT of 11,600. The demand forecasts suggest that the existing N4 (Do-Minimum) will experience AADT of 11,600 under medium growth conditions in the design year of 2032 in the townland of *Drumfin*;
- The economic effects of developing a Type 2 Dual Carriageway over a Standard Single Carriageway are of a modest nature (c. 3-4% greater expenditure of Total Scheme Budget) considering the total additional cross sectional area required is only 3.2m.

Table 3-18: Accident Rates by Road Types[24]

Road Type	Accident Rate PIA/mvkm
Speed Limit	>60kph
2 lane Single Carriageway	0.111
Dual Carriageway	0.056

Table 3-19: Average Number of Casualties per Accident[25]

Road Type	Casualties per PIA		
Speed Limit >60kph	Fatal	Serious	Minor
2 lane Single Carriageway	0.106	0.219	1.295
Dual Carriageway	0.075	0.104	1.202

[24] Extracted from Unit 6.11 the NRA PAG.

[25] Extracted from Unit 6.11 the NRA PAG.

3.4.1.1.1.2 *Collooney/Toberbride Td. to Cloonamahan Td.: Geometrically Improved Section*

An NRA Peer Review process undertaken in early 2013 suggested that the intended commencement point (at that time) for the *Proposed Road Development* at *Cloonamahan Td*. would leave a c. 2.2km section of single carriageway with numerous direct accesses in place which may in the long term, impact on connectivity and level of service provided by the N4. This would be in addition to an inconsistency of layout insofar as a short section of single carriageway with direct access would separate two considerable lengths of divided roadway.

The additional key findings of the assessment are outlined below;

- Based on National Parameter values extracted from the NRA PAG, the Type 2 Dual Carriageway has significantly lower (50%) accident rates than the Type 1 Single Carriageway as per Table 3-18, moreover, indices indicate that in an accident the average number of casualties are likely to be significantly lower for an accident which occurs on a dual carriageway;
- Travel distance and average speed remain reasonably constant for both road types;
- The NRA DMRB TD09/12 gives a guideline that a Type 1 Single Carriageway road will operate at LOS D up to an AADT of 11,600. The demand forecasts suggest that the existing N4 (Do-Minimum) will experience AADT of 13,000 under medium growth conditions in the design year of 2032 in the townland of Ardcurley;
- Local traffic which currently has access directly onto the N4 will experience a slight disbenefit as these accesses would be relocated to a new location on the network.

Considering the foregoing it was decided, that the road type for the *Proposed Road Development* be changed from a Standard Single Carriageway to a Type 2 Dual Carriageway between tie in roundabouts at the existing N4/N17 junction (*Collooney/Toberbride Td.)* and at *Castlebaldwin Td.* The decision was based primarily on the long term safety benefits which will accrue from segregating carriageways. In relation to the existing geometrically improved section the decision was similarly based on safety considerations and in order to ensure consistency of layout providing an unbroken dual carriageway layout between Sligo town and Castlebaldwin.

The aforementioned roundabouts will provide for an opportunity to clearly define the change in road type from a Standard Single Carriageway to a Type 2 Dual Carriageway in *Collooney/Toberbride Td* and from a Type 2 Dual Carriageway to a Standard Single Carriageway in the townland of *Castlebaldwin Td*. By way of comparison, Fig. 3.3 contained within volume 3 of this EIS demonstrates figuratively and through the use of specially developed photomontages, the relatively modest cross sectional difference between the Standard Single Carriageway and the Type 2 Dual Carriageway[26]. A Type 1 Dual Carriageway is also shown to demonstrate its dimensional difference with the Standard Single Carriageway.

3.4.1.2 Junction Strategy

In terms of junction strategy the NRA DMRB has evolved in terms of design standards since the period of the Route Selection Process. In this regard the DMRB now restricts provision of Major/Minor priority junctions to situations where the design flow in the minor road is not expected to exceed about 300 vehicles 2 way AADT, and that on the major road is not expected to exceed 13,000 vehicles 2-way AADT; moreover, cross roads are now prohibited for proposed new developments. In relation to direct access, the NRA DMRB (TD 41/42 12) states that:

> *there is a potential saving in collisions where there is a reduction in the number of lightly trafficked direct accesses and minor junctions made directly on to each national road. Such accesses can be joined together with a link or service road before they join the main carriageway of the national road. Options for such indirect connections should always be explored, as should providing the access from the local road network.*

Table 3-20 outlines the local road treatments/junction arrangements at the time of the Preferred Route selection and the current status following the design of the *Proposed Road Development*.

[26] The wire rope segregating barrier type depicted in the Photomontage is for indicative purposes only.

Table 3-20: Changes to Local Road treatment from that considered at Route Selection Stage

Road Number	Local Road Treatment/Junction Arrangement during Route Selection Report	Proposed Arrangement
L55015-0	Underbridge	Underbridge
L55016-0	Road Closed	Overbridge
L5502-0	Underbridge	Overbridge
L1502-32	Grade Separated Junction	Compact Grade Separated Junction
L5402-0	Underbridge	Underbridge
L54033-0	Underbridge	Underbridge
Existing N4 (*Ardloy Td.)*	Underbridge	Underbridge
L5401-0	Underbridge	Underbridge
L54041-0	Road Closed	Road Closed
L1404-0	Overbridge	Roundabout Junction

3.4.2 Environmental

In recognising the fact that avoidance is the most effective way of mitigating environmental Impacts, the design remained to a degree flexible during the initial stages of Environmental Impact Assessment. Interaction between the design team and the various sub-consultants allowed for the identification of potential significant impacts from initial designs which could be eliminated or reduced by modifications to the design while maintaining the general alignment of the Preferred Route. Examples of the main modifications made to the design for this purpose are outlined below.

3.4.2.1 Horizontal Alignment

Table 3-21 below outlines reasons for and locations of changes made to the horizontal alignment to avoid/reduce environmental impacts. These changes are outlined figuratively in Fig. 3.2. of Volume 3.

Table 3-21: Horizontal Alignment, changes to avoid/reduce environmental impacts

Location	Reason for alteration	Design measure adopted
Doorly, Lackagh & Knocknagroagh Td.	To avoid and reduce direct impacts on the undesignated ecological site described in the EIS as Lackagh Fen and attributed the ecological value of being important at the National scale. This design change also provides the dual benefit of reducing volumes of PEAT material generated by the *Proposed Road Development*.	The geometry of the alignment was modified to facilitate the moving of the road footprint to the west of the centreline of the Preferred Route; thereby significantly avoiding direct impacts on Lackagh Fen.
Drumfin & Cloonlurg Td.	To reduce volumes of unsuitable subsoil and PEAT material generated by the *Proposed Road Development*.	The geometry of the alignment was modified to facilitate the moving of the road footprint to the west of the Preferred Route, thereby reducing volumes of PEAT generated by the *Proposed Road Development*.
Kingsbrook & Aghalenane Td.	To avoid and reduce direct impacts on the undesignated ecological site described in the EIS as Ardloy & Aghalenane Loughs and attributed the ecological value of being important at the International scale. This design change also provides the dual benefit of reducing volumes of PEAT material generated by the *Proposed Road Development*.	The geometry of the alignment was modified to facilitate the moving of the road footprint to the west of the centreline of the Preferred Route, thereby avoiding direct impacts on Ardloy & Aghalenane Loughs.

3.4.2.2 Vertical Alignment

Although changes to the vertical alignment do not impact as significantly on the location of the route, they are none the less important in avoiding/reducing indirect impacts on the environment, particularly where there is a risk of intercepting karstic groundwater flows or encountering flood plains. Table 3-22 outlines measures which have been taken during the design process to avoid/reduce impacts on the environment through the modification of the vertical alignment.

Table 3-22: Vertical Alignment, changes to avoid/reduce environmental impacts

Location	Reason for change	Design measure adopted
Doorly Td.	To reduce the potential for indirect impacts to ground water contributions to Lackagh Fen. Particularly in order to reduce the risk of encountering karstified bedrock.	The vertical alignment was raised in road cut areas at c. Ch. 2,850m and c. Ch. 3,100m above predicted saturated bedrock level.
Knocknagroagh Td.	To reduce the potential for indirect impacts to ground water contributions to Lackagh Fen. Particularly in order to reduce the risk of encountering karstified bedrock.	The vertical alignment was raised in road cut areas at c. Ch. 4,000m above predicted saturated bedrock level.
Cloonlurg Td.	To avoid/reduce potential flooding impacts as a result of a flood plain identified during the design phase.	The vertical alignment was raised in road fill areas at c. Ch. 6,700m and c. Ch. 7,500m to a level which is predicted to be above the potential Flood levels.
Carrownagark Td.	To avoid/reduce potential interception of groundwater contributions to Carrownagark Group Water Supply scheme.	The vertical alignment was raised in road cut areas at c. Ch. 8,250m above predicted saturated bedrock level.
Ardloy & Springfield Td.	To reduce the potential for indirect impacts as a result of impacts to surface water contributions to the Turlough and Swallow Hole Complex at Tawnagh.	The vertical alignment was maintained above saturated bedrock level at c. Ch. 10,400m.

3.4.3 Liaison

Project Liaison has been ongoing and continuous through the interaction of the Project Liaison Officer with landowners who are affected by the route and through the EIS coordinators (and various environmental specialists) interaction with various statutory bodies. These liaisons have in instances aided in the design process and influenced some decisions relating to farm accommodation tracks and the environmental design considerations described in section 3.4.2.

In recognition of the *ad-hoc* nature of these consultations, the time lapse since the original statutory public consultation and the design changes which have been applied during the EIA/design process, a Project Information evening was held in November 2013, this allowed for the consideration of final modifications to be made to the design prior to the publication of statutory documents.

3.5 The Online Upgrade

The alternatives in terms of the mainline alignment on the geometrically improved section between *Collooney/Toberbride Td.* and *Cloonamahan Td.* were dictated by:

- the current provision of a horizontal alignment which is adequate to accept the geometry of a Type 2 Dual Carriageway; and
- the constraints which occur to the east and west of the existing N4 meaning an offline alternative was not viable. These constraints include Markree Demesne, clusters of houses in *Mullaghnabreena Td.* to the east and Toberscanavan Loughs to the west.

The layout and configuration of the local area network were dictated initially by the objective to separate the local traffic from the national traffic, thus ensuring the consistency of the Type 2 Dual Carriageway is maintained for the overall length of the route.

A value engineering exercise which considered costs, access arrangements and local journey travel impacts was carried for this section of the route, the result of which is the arrangement outlined in Fig. 3.4. of Volume 4 and described further in Chapter 4 of this EIS.

3.6 Figures and Appendices

3.6.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 3.1: Route Options;

Fig. 3.2: Preferred Route and Design Alternatives;

Fig. 3.3: Alternative Mainline Cross Section Comparisons;

Fig. 3.4: Alternatives: Online Upgrade;

Other relevant figures include:

Fig. 2.1: Constraints Study Area

4 Description of the *Proposed Road Development*

4.1 Introduction

This Chapter provides a description of the Design[27] for the *Proposed Road Development* including *inter-alia* details of road type, existing and projected traffic projections, safety benefits, engineering features, environmental design considerations, landtake requirements, construction and operational requirements.

The descriptions of the main elements of the design are presented in the following paragraphs covering the route from north to south. References are made herein and throughout the EIS to chainages (Ch.) denoting the distance in metres along the mainline, these quoted chainages should be considered as an approximate position only of the appropriate feature or element being described.

Ch. 0m occurs in the townland of *Toberbride* with chainages increasing as one travels south; however, this is with the exception of a section of alignment occurring north of Ch. 0m which extends negatively for a distance of -190m to the centre of the existing N4/N17 roundabout in the townland of *Collooney/Toberbride*. These negative Ch. values form part of the *Proposed Road Development* and are provided for geometric purposes in order to tie the mainline alignment into the aforementioned roundabout, they are presented on the drawings contained in volume 3 with a blue background to clarify their extent.

The chainages and link lengths described within this chapter have been rounded for reasons of clarity. A fuller representation of chainages and lengths may be obtained from the drawings included in Volume 3 of this EIS.

4.2 Road Type and Cross Section

The following outlines the Road Type of the *Proposed Road Development*.

4.2.1 Type of Road

4.2.1.1 Outline

As outlined in Chapter 3 the mainline realignment will comprise two separate forms of Road Type with the change in cross section defined by a roundabout in the townland of *Castlebaldwin*.

Approximately 13.82km of the proposal consists of a Type 2 Dual Carriageway commencing at the existing N4/N17 roundabout[28] in the townland of *Collooney/Toberbride* and extending to a proposed roundabout in the townland of *Castlebaldwin.* The *Proposed Road Development* will tie back into the existing N4 to the south of the aforementioned roundabout with a Standard Single Carriageway alignment measuring approximately 0.89km in length before its conclusion in *Cloghoge Lower Td*.

The Type 2 Dual Carriageway road consists of two lanes in both directions. For safety reasons a 4 lane undivided road is considered unacceptable on rural sections of the network where a 100kph speed limit applies. Therefore, on this type of road it is proposed to use a segregating barrier within the paved median to separate the traffic streams. Cyclists and pedestrians will be encouraged by signage to use an alternative route, for example the old national primary route.

The road is designed so as to minimise the number of junctions and to provide drivers with straightforward junction layouts. There will be no gaps provided in the central reserve and there will be no direct access from land or houses onto the road.

The section of road which is proposed to be Standard Single Carriageway will be commensurate with the existing improved section (Curlew Mountains Bypass) of the National Primary route at *Cloghoge Lower Td*. This consists of a single carriageway and hard shoulder in each direction.

[27] Design means a design to satisfy the requirements of Phase 3 of the NRA Project Management Guidelines.

[28] Physical works start at the Inscribed Circle Diameter of the roundabout.

Lay-by's will be provided corresponding to Type D as per NRA DMRB TD 69/10 which will be 4m wide[29] and 30m long with a 45m diverge taper and a 25m merging taper. These Lay-By's will be provided at locations of not more than 2.5km centres along the mainline of the *Proposed Road Development*.

For safety reasons, hard standings within verges will be provided for emergency breakdown usage. These hard standings will be a minimum of 1.2m wide and will be of light construction such as compacted cement bound granular material.

4.2.2 Description of alignment

The alignment which is indicated in plan and geometric terms in Figures 4.1.1-4.1.8 and 4.2.1-4.2.8 respectively (Volume 3 of this EIS) has been designed to produce a continuous flowing arrangement throughout. The following gives a brief drive-through perspective of its main characteristics as it transverses from north-west to south-east alternating as outlined from Type 2 Dual Carriageway to Standard Single Carriageway.

4.2.2.1 Section 1

4.2.2.1.1 *Type 2 Dual Carriageway*

The initial section of the *Proposed Road Development* includes a full online upgrade of the existing N4 between its commencement point at the N4/N17 roundabout and c. Ch. 2,430m where it begins to divert offline. This online section includes:

- Widening of the existing Standard Single Carriageway road to a Type 2 Dual Carriageway cross sectional width;
- Modification of the vertical curvature of the existing N4 to provide cover for underbridges and culverts with an emphasis also of eliminating flat spots on the superelevation transition areas of horizontal curves;
- Closure of all existing direct accesses on the route and collection of the severed local network west to east and *vice-versa* via the following:
    - A parallel link road east of the proposed N4 (eastern parallel link road) which will tie the existing N4 into the existing N4/N17 roundabout via an additional roundabout (and additional link described below) provided in the townland of *Toberbride* and located to the south-east of the existing business/enterprise estate. The link road measures c. 2.950km in length and will over this distance collect the L7611-0, the L-76121-0, numerous residential and agricultural accesses while also accommodating the provision of a 3m wide cycle track. In general it follows the existing topography as closely as possible with the exception of a fill section located in the vicinity of the *Toberbride/Mullaghnabreena* townland boundary which is required to maintain a suitable vertical gradient.
    - The aforementioned link will tie into the existing N4/N17 roundabout via the Toberbride East-West Link which will include the upgrade of the existing private road between the aforementioned roundabout and the Toberbride (East) Junction. This link measures c. 320m in length;
    - A link measuring c. 260m in length between the aforementioned eastern parallel link road and the L-7611-0 which will itself receive minor improvements. This link will cross on embankment over the proposed N4 via an overbridge (Toberbride Overbridge);
    - A western parallel link road between a proposed roundabout (Cloonamahan Junction, North) in the townland of *Cloonamahan* which will connect the L-3606-9 (which will itself receive localised improvements) with an additional roundabout provided south-west of the proposed N4 in the townland of *Doorly* (Doorly Junction). This link will also collect the L-14019-0 and numerous residential and agricultural accesses, it will be connected underneath the proposed N4 to the eastern parallel link road via the Doorly Underbridge (North);

Before diverting offline, the online section from its commencement point travels in a southerly direction, where at c. Ch. 280m it intercepts the aforementioned link between the L-7611-0 and the eastern parallel link which is designed to pass over the proposed N4 on an overbridge, embankments and approach road

[29] Including hardstrip.

measuring some 230 metres in length (Toberbride Overbridge). The proposed mainline begins to change direction at c. Ch. 700m to a more south-easterly one passing to the east of Toberscanavan Loughs at c. Ch. 1,300-1,550m before passing over the aforementioned link between the eastern and western parallel links at c. Ch. 2,500m which is accommodated by a road underbridge (Doorly Underbridge, North).

The online upgrade concludes at c. Ch. 2,430m and the realignment continues with an offline section which is described below:

- The alignment diverts offline in a south-south-easterly direction at c. Ch. 2,430m in the townland of *Doorly.* The proposed route continues to pass over the L55015-0 which will be maintained via an underbridge (Doorly Underbridge, South) in order to restore access to agricultural land to the south-west of the proposed alignment. It then continues in a south-south/easterly direction passing to the west of Lackagh Fen and continuing through the townlands of *Doorly* and *Knocknagroagh*, where at c. Ch. 4,020m the local tertiary road L-55016-0 is realigned and designed to pass over the proposed N4 on an overbridge (Knocknagroagh Overbridge) and embankments. This local road is being realigned northwards to form a Major/Minor priority junction with the existing N4 approximately 30 metres north north-west of its existing location;
- The proposed N4 design continues through a more south-easterly direction across agricultural land to c. Ch. 4,440m in the townland of *Knocknagroagh* where it passes over the Turnalaydan Stream (or Lough Corran Outflow). A river diversion and clear span river bridge is being provided at this location;
- It continues to pass to the East of Boathole Lough and Lough Corran while maintaining a south-easterly direction through agricultural and bog land in the townland of *Drumfin*, where at c. Ch. 5,570m the local secondary road L-5502-0 (known locally as the Bog Road) is realigned and designed over c. 500m to pass over the proposed N4 on an overbridge (Drumfin Overbridge, North) and embankments;
- The design continues to maintain its direction passing through agricultural land in the townland of *Drumfin* where at c. Ch. 6,600m the local primary road L-1502-32 is realigned and designed over c. 700m to pass over the proposed N4 on an overbridge (Drumfin Overbridge, South) and embankments. This point provides a strategic location for the only junction on the Type 2 Dual Carriageway which is provided in the form of a Compact Grade Separated Junction (CGSJ) allowing access to the rural hinterland including the nearby towns of Ballymote and Riverstown;
- Continuing in a more south-easterly direction the design passes through the townland of *Cloonlurg* across some agricultural land but mainly forestry. It passes under a 220 kV line at c. Ch. 7,120m which will be required to be raised in advance of the main construction contract. At c. Ch. 7,360m it crosses a river (marked on OSi maps as the Arrow or Unshin River but known for the purposes of this EIS as the Drumfin River) on embankments. A clear span river bridge is being provided at this location.
- The alignment maintains its general direction passing through agricultural land in *Carrowkeel* and *Carrownagark* to c. Ch. 8,630m where it crosses on embankment over local secondary road L-5402-0. The local road will remain online and will be directed under the proposed N4 via an underbridge (Carrownagark Underbridge);
- The alignment continues through agricultural land and some recently planted forestry in *Kingsbrook Td.* to c. Ch. 9,300m where it crosses on embankment over local tertiary road L-54033-0. The local road is being realigned slightly to the east and will be directed under the proposed N4 via an underbridge (Kingsbrook Underbridge);
- The alignment changes to a more easterly direction via the application of a left hand horizontal curve through *Aghalenane Td.* passing Aghalenane & Ardloy Loughs which are to the north-east of the proposed route. It continues through *Kingsbrook* and *Ardloy Td.* to c. Ch. 10,220m where it crosses on embankment over the existing N4. The existing N4 which has been recently realigned will pass under the proposed realignment via an underbridge (Existing N4: Ardloy Underbridge). At c. Ch. 10,800m the alignment crosses on embankment over local secondary road L-5401-0. The local road will remain online and will be directed under the proposed N4 via an underbridge (Tawnagh Underbridge);
- The alignments direction gradually changes to a south-easterly one via a right hand horizontal curve though the townlands of *Springfield* and *Tawnagh* and continues to maintain this direction passing through agricultural land in the townlands of *Cloonymeenaghan* and *Sheerevagh* to c. Ch. 12,330m where it crosses on low embankment over local tertiary road L-54041-0. This local road is being closed as alternative access to the surrounding hinterland is available via local primary road L-5404-0;
- The alignment continues in a south-easterly direction through agricultural land in the townlands of *Sheerevagh* and *Drumderry* where a right hand horizontal curve gradually begins to change its

direction to a more southerly one severing local road L-1404-0 at c. Ch. 13,530m. A roundabout (Castlebaldwin Junction) is proposed at c. Ch. 13,630m in the townland of *Castlebaldwin* which allows for the re-linking of the aforementioned local road providing an access point to Castlebaldwin and the surrounding hinterland. This point marks the end of the Type 2 Dual Carriageway.

4.2.2.2 Section 2

4.2.2.2.1 *Standard Single Carriageway*

The tie-in to the existing national primary network will be via a Standard Single Carriageway re-commencing from the aforementioned roundabout. The alignment continues from the roundabout in a southerly direction passing Castlebaldwin House (National Monument no. 373, as described in Chapter 15 of this EIS) to the east before continuing through agricultural land in the townlands of *Castlebaldwin* and *Cloghoge Upper.* It ties back into the existing N4 in a south easterly direction in the townland of *Cloghoge Lower* concluding at c. Ch. 14,522m.

4.2.3 Cross Section

4.2.3.1 Type 2 Dual Carriageway

The proposed Type 2 Dual Carriageway cross section provided between the two aforementioned roundabouts is outlined in Figure 4.4.1, (Volume 3) and consists of a 21.5m total cross sectional width comprising:

- 2 x 7m paved two-lane carriageway sections;
- 2 x 0.5m paved hard strips;
- 1.5m paved central median with a segregating safety barrier;
- 2 x 2.5m grass verges.

4.2.3.2 Standard Single Carriageway

The proposed Standard Single Carriageway cross section provided to the south of the Castlebaldwin Junction (roundabout) is outlined in Figure 4.4.1, (Volume 3) and consists of an 18.3m total cross sectional width comprising:

- 2 x 3.65m paved single-lane carriageway sections;
- 2 x 2.5m paved hard shoulders;
- 2 x 3m grass verges.

4.2.3.3 Other Road cross sections

The proposed cross-sections of realigned local roads, compact connector roads and access tracks are shown in Figure 4.4.2 (Volume 3). In the case of local roads and compact connector roads, these generally consist of carriageways in each direction with hard strips; that is with the exception of the Eastern Parallel Link which will be provided with a cycle track (two way) adjacent to the south bound carriageway. The access tracks generally consist of a 4m road with pull in bays at between c. 200m to c. 250m centres.

4.3 Existing and Projected Traffic Conditions

4.3.1 General

As part of the Design stage for the *Proposed Road Development* an assessment of existing and projected traffic flows has been made to determine the volumes that would be expected to transfer to the proposed route and those volumes of traffic which would be expected to continue to use the local road network. This is presented in the form of a Traffic Model which predicts traffic flows and journey times.

The following provides an overview of information which is of most relevance in terms of describing the potential effects on the existing network. Traffic information is based on 2008 traffic count data (which was confirmed to represent current day usage via a 2012 check). Where comparisons are made between the Do-Minimum and Do-Something scenarios, this is based on the 'year of opening' Figures of 2017 under a Medium Growth scenario.

4.3.2 Data Collection

Aecom who undertook the traffic model carried out a series of traffic surveys to ensure that a full understanding of the current traffic situation could be established. This included a series of manual counts supplemented by Automatic Traffic Counters as outlined in Table 4-1. This survey extended to include sections of two additional *Proposed Road Developments* on the N17; thus providing traffic information for an area cordoned by the towns of Collooney, Tobercurry, Ballymote, Castlebaldwin and Riverstown including data on cross country trips between these towns.

Table 4-1: Traffic Count Locations

Location	Junction Type	Survey Type
N17/R293	3 arm junction	MCC
R294/N17	3 arm junction	MCC
N17/R294 (Teeling Street)	3 arm junction	MCC
Wolf Tone Square/Ballymote Road	3 arm junction	MCC
Teeling St./Mountain Road	3 arm junction	MCC
R294/Wolf Tone Square	3 arm junction	MCC
N17/Cloonacool Road	3 arm junction	MCC
N4/Cloonlurg	3 arm junction	MCC
N4/Drumderry	3 arm junction	MCC
R293/R296/R295	3 arm junction	MCC
N4/Murillyroe	3 arm junction	MCC
N17 (North of Tobercurry)	2-way Link	ATC
N17 (Sligo)	2-way Link	ATC
N4 (South of Collooney)	2-way Link	ATC

In addition to the counts; a Journey Time Survey was also carried out in 2013 to ensure the travel time on existing road is reflected within the base model. The N4 was surveyed from a start point at *Toberbride* to its end point at *Cloghoge Lower* which revealed an average travel time of 668 seconds.

4.3.3 Traffic Flows

4.3.3.1 Future Year Model Development

The future year 'Do-Minimum' network includes the 2008 existing road network with no further road infrastructure improvements, whilst the future year 'Do-Something' network includes all the assumptions of the 'Do-Minimum' network plus the N4 Collooney to Castlebaldwin *Proposed Road Development*.

For all national primary roads the NRA specifies that the design year is 15 years from the date that the new section of road is opened to traffic. The opening year for the *Proposed Road Development* is 2017; as such the design year is 2032. In order to produce traffic flows for the design year (2032) traffic growth projections from the forecast year of 2025 up to the design year of 2032 were made.

4.3.3.2 Traffic Projections and effects on the existing network

The forecast AADT (provided in Fig. 4.5 and 4.5.1 of Volume 3) provides an overview and describes the effect's which the *Proposed Road Development* may have on the existing road network.

Generally, in terms of the existing N4 it is predicted that in the 'year of opening' the changes indicated in Table 4-2 are likely to occur along sections of the existing route. Table 4-3 indicates the effect which the *Proposed Road Development* is likely to have on the existing local road network considering that there may be a change in trip patterns as a result of junctions provided on the new route.

Table 4-2: Existing N4: Effects of the Proposed Road Development

Location	Forecast AADT[30]		% Change
	Do Min	Do Some	
Existing N4 Drumfin Td.	10,200	2,000	-80.4%
Existing N4 Cloonlurg Td.	7,900	100	-98.74%
Existing N4 Drumderry Td.	8,100	200	-97.6%

Table 4-3: Existing Local Network: Effects of the Proposed Road Development

Location	Forecast AADT		% Change
	Do Min	Do Some	
L1302-0 to Lisconny	700	700	0%
L1401-0 to Riverstown	1,900	1,900	0%
L1502-32 to Ballymote	1,300	1,600	+18.75%
L5401 to Riverstown	200	200	0%
L1403-0 to the R284	800	600	-25%
L1404-0 to Ballymote	800	500	-37.5%

The traffic model thus shows that for the majority of the existing N4 between the *Proposed Road Developments* tie in points, that there will be substantial reductions in traffic volumes particularly to the south of the existing N4's junction with the L-1502-32. The traffic model also predicts that there will continue to be activity from the village of Riverstown in the direction of Sligo on the existing route, however, there will be adequate capacity to safely cater for this volume of traffic on the existing route particularly insofar as the status of the route will be downgraded to Local Primary on completion of the *Proposed Road Development*. In terms of the existing local road network the traffic model indicates in general that there will be little change in trip patterns on the existing roads, with the exception of a marginal change in trip patterns to Ballymote balanced by a reduction of 300 AADT on the L-1404-0 (to the west of Castlebaldwin village) and a similar resulting increase on the L-1502-32.

4.3.3.3 Effect on National to National road traffic

4.3.3.3.1 *Journey Time*

The traffic model shows that the proposed realignment is an attractive option for through traffic. The *Proposed Road Development* would provide a substantial improvement in journey times on the existing N4. The following are the predicted 2017 (year of opening) journey times to travel between the existing N4/N17 roundabout in *Collooney/Toberbride Td.* and *Cloghoge Lower Td.*:

Do Minimum: 681 seconds

Do Something: 566 seconds

Time saving: 115 seconds

This shows a time saving of 115 seconds (1.9 minutes) or 17% of existing journey time which is an appreciable time saving.

4.4 Road Safety

Based on projections outlined in the traffic model and indicated in Table 4-2 and Table 4-3, it is expected that the *Proposed Road Development* will provide considerable safety and amenity benefits to future users of the existing route while maintaining to a large degree existing travel patterns of users on the existing local roads.

[30] Based on 2017 Medium Growth Predictions.

For long distance through traffic, the use of a Type 2 Dual Carriageway with a central reserve segregating barrier will remove the possibility of head-on collisions leading to a reduction in the number and severity of accidents.

Users of the current N4 route making short local trips will find it safer to access and exit the road network as a result of the substantial decrease in traffic volumes and the lower speed limit on what will be the re-designated local road. The provision of a Compact Grade Separated Junction (CGSJ), a roundabout and the removal of numerous private and minor access points means that dangerous at-grade crossing manoeuvres will be eliminated. The Cost Benefit Analysis undertaken by Aecom as part of the Project Appraisal for the *Proposed Road Development* indicates that; when compared with the Do-Minimum scenario, the proposal will bring about a net reduction of 280 accidents over a 60 year lifetime (including a statistical reduction of 29 fatal casualties, 96 serious causalities and 975 slight causalities). This will contribute €32.444m (High Traffic Growth Scenario) to the Present Value of Scheme Benefits (PVB). The accidents component of the overall PVB is 30-35%, meaning that accident savings from the proposal will account for a significant proportion of the total scheme benefits. The scheme will therefore bring about a 9% reduction in all accidents and a 12% reduction in fatal accidents over the appraisal period.

4.5 Road Network of the *Proposed Road Development*

4.5.1 Road Network

The main physical elements of the proposed Road Network include:

- The proposed N4; and associated
    - Side Roads (including closures), junctions and associated structures;
    - Access Tracks (farm, domestic and drainage service);

The general characteristics of these elements are described in sections 4.5.1.1, 4.5.1.2 and 4.5.1.3.

4.5.1.1 Proposed N4

As already outlined in section 4.2.1, the proposed N4 shall consist of the following Road Types:

- The construction of c. 13.82km of a Type 2 Dual Carriageway pavement cross section with a segregating central median barrier between the existing N4/N17 roundabout and the Castlebaldwin Junction;
- The construction of c. 0.89km of new route with Standard Single Carriageway pavement cross section south of the Castlebaldwin Junction;

4.5.1.2 Intersection of Local Roads

The design of the mainline has required considered treatment of the local roads which the proposed N4 intercepts. The following gives an overview of these intersections and the measures which have been applied in their treatment. The rationale behind the measures applied and specific impacts of the intersections are outlined in section 4.6 of this Chapter.

- The closure of local road L-7611-0 in *Toberbride Td*. and the provision of an alternative link via an overbridge (Toberbride Overbridge) at c. Ch. 280m and the Eastern Parallel Link;
- The closure of local road L-7612-0 in *Mullaghnabreena Td*. and the provision of an alternative link via an overbridge (Toberbride Overbridge) at c. Ch. 280m and the Eastern Parallel Link;
- The closure of local road L-76121-0 in *Toberbride Td*. and the provision of an alternative link via the Eastern Parallel Link;
- The closure of local road L-3606-9 in *Cloonamahan Td*. and the provision of an alternative link via the Western Parallel Link, the Doorly Junction, the Doorly Underbridge (North) and the Eastern Parallel Link;
- The closure of local road L-14019-0 in *Cloonamahan Td*. and the provision of an alternative link via the Western Parallel Link, the Doorly Junction, the Doorly Underbridge (North) and the Eastern Parallel Link;

- The closure of local road L-55015-0 in *Doorly Td*. and the provision of an alternative link to farmlands via an underpass (Doorly Underbridge, South) in the townland of *Doorly*;
- The closure of local road L-55016-0 in *Knocknagroagh Td.* and the provision of an alternative link via an overbridge (Knocknagroagh Overbridge) at c. Ch. 4,020m;
- The closure of local road L-5502-0 in *Drumfin Td.* and the provision of an alternative link via an overbridge (Drumfin Overbridge (North)) at c. Ch.5,570m;
- The provision of a Compact Grade Separated Junction (Drumfin/Cloonlurg Junction) in the townlands of *Drumfin* and *Cloonlurg;*
- The closure of local road L-1502-32 at *Drumfin Td.* and the provision of an alternative link via an overbridge (Drumfin Overbridge (South)) at c. Ch. 6,600m which will form part of the above CGSJ;
- The closure of local road L-5402-0 at *Carrownagark Td.* and the provision of an alternative link via an underbridge (Carrownagark Underbridge) at c. Ch. 8,620m;
- The closure of local tertiary road L-54033-0 at *Kingsbrook Td.* and the provision of an alternative link via an underbridge (Kingsbrook Underbridge) at circa c. Ch. 9,310m;
- The provision of an online underbridge (Existing N4, Ardloy Underbridge) in the townland of *Ardloy* at c. Ch. 10,230m to accommodate the crossing of the existing N4;
- The closure of local road L-5401-0 in *Tawnagh Td.* and the provision of an alternative link via an underbridge (Tawnagh Underbridge) at c. Ch. 10,800m;
- The closure of local tertiary road L-54041-0 in *Sheerevagh Td*. at c. Ch. 12,340;
- The provision of a roundabout (Castlebaldwin Junction) in the townland of *Castlebaldwin* at c. Ch. 13,630m;
- The closure of local road L-1404-0 at *Drumderry Td.* and the provision of alternative links which will form part of the Castlebaldwin Junction (roundabout);
- The closure of a section of local road L-1403-0 at *Annaghcor Td.* and the provision of an alternative link to the realigned L-1404-0;
- The closure of a section of local road L-58015-0 at *Cloghoge Upper Td.* and the provision of an alternative link via the existing N4;

4.5.1.3 Access Tracks (agricultural, domestic and drainage service)

Access tracks will be provided in the cases where access to agricultural land is severed, where domestic entrances are affected, or, where service access is required to proposed constructed wetland attenuation facilities and petrol interceptors/bypasses:

- An access track serving development lands (business and enterprise) will be provided to the east of the proposed route in the townland of *Toberbride* with access provided via the Toberbride east-west link (on the north side);
- An access track serving development lands (business and enterprise) will be provided to the east of the proposed route in the townland of *Toberbride* with access provided via the Toberbride east-west link (on the south side);
- An access track serving development lands (business and enterprise) will be provided to the east of the proposed route in the townland of *Toberbride* with access provided via the eastern parallel link;
- An access track serving agricultural property will be provided to the west of the proposed route in the townland of *Toberbride* with access provided via an existing private Right of Way which will become public on completion of the project;
- An access track serving domestic and agricultural/equine properties will be provided to the west of the proposed route in the townland of *Toberbride* with access provided via a new link between the L-7611-0 and the Eastern Parallel Link.

  In addition to the main track two additional access tracks are provided off the main track to domestic properties in *Toberbride*;

- An access track serving a domestic property will be provided to the west of the proposed route in the townland of *Toberbride* with access provided via a new link between the L-7611-0 and the Eastern Parallel Link;
- An access track serving a domestic property will be provided to the west of the proposed route in the townland of *Mullaghnabreena* with access provided via the existing L-7612-0;
- An access track serving an agricultural property will be provided to the east of the proposed route in the townland of *Ardcurley* with access provided via the Eastern Parallel Link;
- An access track serving a local authority transient site will be provided to the west of the proposed route in the townland of *Cloonamahan* with access provided via the L3606-9;
- An access track serving agricultural property will be provided to the east of the proposed route in the townland of *Ardcurley* with access provided via the Eastern Parallel Link;
- An access track serving a constructed wetland attenuation facility, agricultural property and the rear entrance to Markree Demesne (including a gate-house) will be provided to the east of the proposed route in the townland of *Ardcurley* with access provided via the Eastern Parallel Link;
- An access track serving agricultural property will be provided to the east of the proposed route in the townland of *Ardcurley* with access provided via the Eastern Parallel Link;
- An access track serving domestic and agricultural property will be provided to the west of the proposed route in the townland of *Doorly* with access provided via the proposed Doorly Junction;
- An access track serving agricultural properties will be provided to the west of the proposed route in the townland of *Doorly* with access provided via the proposed Doorly Junction;
- An access track serving a constructed wetland attenuation facility will be provided to the west of the proposed route in the townland of *Doorly* with access provided via the L-55015-0;
- An access track serving agricultural property will be provided to the east of the proposed route in the townland of *Knocknagroagh* with access provided via the proposed new link of the L-55016-0;
- An access track serving a constructed wetland attenuation facility, domestic properties and agricultural property will be provided to the east of the proposed route in the townland of *Knocknagroagh* with access provided via the proposed new link of the L-55016-0.

  The foregoing access track will also provide a link via an existing section of the L-55016-0 to an additional access track provided to the east of the proposed route in the townland of *Knocknagroagh* which will accommodate a constructed wetland attenuation facility;
- An access track serving a constructed wetland attenuation facility and agricultural properties will be provided to the south-west of the proposed route in the townland of *Drumfin* with access provided via the L-5502-0;
- An access track serving a constructed wetland attenuation facility and agricultural properties will be provided to the south-west of the proposed route in the townlands of *Drumfin* and *Cloonlurg* with access provided via the L-1502-32;
- An access track serving a constructed wetland attenuation facility and agricultural properties will be provided to the south-west of the proposed route in the townland of *Carrownagark* with access provided via the L-5402-0;
- An access track serving a constructed wetland attenuation facility will be provided to the north-east of the proposed route in the townlands of *Carrownagark* and *Kingsbrook* with access provided via the L-5402-0;
- An access track serving agricultural property will be provided to the south-west of the proposed route in the townland of *Kingsbrook* with access provided via the L-54033-0;
- An access track serving a constructed wetland attenuation facility and agricultural property will be provided to the north of the proposed route in the townlands of *Ardloy* and *Aghalenane* with access provided via the existing N4;

- An access track serving a constructed wetland attenuation facility and agricultural property will be provided to the north of the proposed route in the townlands of *Springfield/Tawnagh* with access provided via the L-5401-0;
- An access track serving agricultural properties will be provided to the north-east of the proposed route in the townlands of *Tawnagh* and *Cloonymeenaghan* with access provided via the L-5401-0;
- An access track serving agricultural property will be provided to the south-west of the proposed route in the townlands of *Sheerevagh, Cloongad* and *Cloonymeenaghan* with access provided via the L-54041-0;
- An access track serving a constructed wetland attenuation facility and agricultural property will be provided to the north-east of the proposed route in the townlands of *Sheerevagh* and *Drumderry* with access provided via the L-54041-0;
- An access track serving agricultural properties will be provided to the west of the proposed route in the townland of *Drumderry* with access provided via the existing L-1404-0.
- An access track serving domestic and agricultural property will be provided to the east of the proposed route in the townland of *Drumderry* with access provided via the realigned L-1403-0/L-1404-0;
- Two number access tracks serving domestic properties will be provided to the east of the proposed route in the townland of *Annaghcor* with access provided via the realigned L-1403-0/L-1404-0. These accesses will replicate the existing accesses onto the L-1403-0;
- An access track serving agricultural and domestic properties will be provided to the east of the proposed route in the townland of *Annaghcor* with access provided via the realigned L-1403-0;
- An access track serving a constructed wetland attenuation facility and agricultural properties will be provided to the east of the proposed route in the townland of *Cloghoge Upper* and *Cloghoge Lower* with access provided via the proposed N4. This is the only location where direct access is being provided off the proposed N4.

  In addition to the main track two additional access tracks are provided off the main track to agricultural properties in *Cloghoge Lower*;
- An access track serving agricultural and domestic properties will be provided to the south-west of the proposed route in the townlands of *Cloghoge Upper* and *Cloghoge Lower* with access provided via the existing N4;

4.6 Junction Strategy and Treatment of Local Roads

4.6.1 General

> *The primary purpose of the national road network is to provide strategic transport links between the main centres of population and employment, including key international gateways such as the main ports and airports, and to provide access between all regions.*[31]

As a secondary function the network caters for local and short distance traffic. In general there are positive safety benefits in grade separating the national and local road networks. TD41-42/12 states:

> *...direct vehicular access onto national roads should be avoided as far as practicable.*

The *Proposed Road Development* has been designed in a manner which is consistent with the above principles. In this regard and for safety reasons it is considered that local traffic where possible should not be routed onto the national route. In order to accommodate this, attention has been had within the proposal to provide a separate and independent local road network providing reasonable access to the rural hinterland which will in turn preserve safety and capacity on the national road network.

In order to retain route capacity and safety on the national route the following principles were adopted in relation to direct access onto the N4:

[31] Spatial Planning and National Roads, Guidelines for Planning Authorities, January 2012, DoECLG.

- Roundabouts will be provided in locations where the cross section changes on the mainline tie-in points, this is broadly in cohesion with recommendations of NRA TD41-42/12 which outlines that:

  ...where there is a change in road type from a Motorway or Type 1 Dual Carriageway with full grade separation to a Type 2 or 3 Dual Carriageway with at-grade junctions, a roundabout should always be used at the first major junction in order to emphasise to drivers the changed character of the road. This has been found to reduce collisions.

  As the change in road type in the context of the *Proposed Road Development* is from a Standard Single Carriageway with at grade junctions to a Type 2 Dual Carriageway with Compact Grade Separated junctions, this principle is deemed appropriate to apply on a relative basis. The roundabouts will also provide a dual purpose of providing access to the surrounding towns/villages and hinterlands*;*

- Where additional junctions are considered on the Type 2 Dual Carriageway, these will be in the form of Compact Grade Separation, which, with the provision of suitable merging and diverging tapers provide slight safety benefits over roundabouts while also improving journey time along the route;
- Access tracks off the local road network will be provided to connect to areas where there has been severance of agricultural proprieties as a result of the *Proposed Road Development*;
- Side roads will be rationalised wherever possible so that the main side roads are taken over or under the proposed N4 and minor side roads (or side roads where there is a close alternative route) are closed.

4.6.2 Major Junctions

As already outlined, it is proposed that there will be three major junctions located on the proposed N4 which are described below:

4.6.2.1 Existing N4/N17 roundabout

The existing N4/N17 roundabout located in the townlands of *Collooney/Toberbride* provides a convenient junction for the commencement point of the *Proposed Road Development*. It allows for the various changes in cross section between the three separate legs of the national primary network (N4/N4/N17) while also accommodating the upgrade of an existing private road in the townland of *Toberbride* to be incorporated as a new local road serving the eastern parallel link road.

Provision for pedestrians and cyclists crossing the proposed Toberbride East-West Link road is already provided by refuge islands and drop kerbs which will be improved as part of the *Proposed Road Development*.

4.6.2.2 Compact Grade Separated Junction with L-1502-32 (Referred to as Drumfin/Cloonlurg Junction)

A Compact Grade Separated Junction (CGSJ) located between c. Ch. 6,490m and c. Ch. 6,730m will be provided with the L-1502-32. This provides convenient access for Ballymote traffic to the south and Riverstown traffic to the north-east of the *Proposed Road Development*.

4.6.2.3 Roundabout at Castlebaldwin Td. (Referred to as Castlebaldwin Junction)

This roundabout is located in the townland of *Castlebaldwin* at c. Ch. 13,630m. It provides for a change in cross section from a Type 2 Dual Carriageway down to a Standard Single Carriageway. It also re-links the severed L-1404-0 into the road network, providing a convenient access point to the village of Castlebaldwin to the west, the town of Ballymote to the north-west and for the rural traffic to the north-east in the townlands of *Drumderry, Sheerevagh, Annaghcor* and *Castlebaldwin* where clusters of residential properties are located. Provision for pedestrians and cyclists crossing the approach roads will be provided by incorporation of refuge islands and drop kerbs.

4.6.3 Treatment of Local Roads[32]

Between its two tie-in points with the existing N4, the *Proposed Road Development* intersects a total of 19 local roads including the existing N4 (at 2 locations) and 17 local roads. Due consideration to each road's

[32] Local Roads in this instance refers to those roads after construction of the *Proposed Road Development*.

importance, both to the individual and to the local communities were taken into account during the route selection and design process. During the design of the *Proposed Road Development* a preference was given to the grade separation of the local and national road networks in order to maintain existing community links.

Of the 18 local roads intersected by the proposed route (and in addition to localised widening to the L-7611-0/L-7612-0) the following outlines measures proposed:

- Little or no alteration[33] to the existing local road in 5 cases (L-76111-0, L-55015-0, L-5402-0, the existing N4 at *Ardloy Td.* and the L-1403-0 in the townland of *Annaghcor*);
- Little alteration[34] to the existing local road in 4 cases (L-5502-0, L-1502-32, L-54033-0 and L-5401-0);
- Alteration[35] to the existing local road in 4 cases (Existing N4 at *Doorly Td.*, L-55016-0, L1404-0 and the L-58015-0);
- Road Closure and alternative *via* alteration[36] to the existing local road in 5 cases (L-7611-0, L-7612-0, L-76121-0, L-3606-9, L-14019-0);
- Road Closure: There will be 1 no. road closure where the Link will not be re-established in the case of the L-54014-0; however, a nearby alternative is available via the L-5404-0, L-1403-0 and the L-1404-0.

Considering the foregoing there will be a requirement for Extinguishments of Public Rights of Way (on local roads) in the cases described in Table 4-4. The re-establishment of links will occur in all cases with the exception of the 54041-0 where a nearby alternative is available via the realigned L-1404-0 and the L-5404-0.

On these local roads a Compact Grade Separated Junction (CGSJ) is proposed at the L-1502-32 as outlined in 4.6.2.2 while a roundabout is proposed at the realigned L-1404-0 as outlined in 4.6.2.3.

The following table summarises the strategy adopted in relation to provision of junctions and the treatment of minor roads. Extinguishments of Rights of Way will be discussed further in section 4.9.1.3 of this Chapter.

Table 4-4: Junctions and treatment of minor roads

Road ID	Location[37]	Treatment	Comment
Toberbride east-west link	c. Ch. -190m	Link between the Eastern Parallel Link and the existing N4/N17 roundabout	New link through the use of an existing section of private road. Private Extinguishments of Right of Way (ROW) required.
Eastern parallel link	c. Ch. -190m to c. Ch. 2,830m.	Parallel and local road network collection link	New link through the use of a section of the existing N4 and a section of private road. Public and Private Extinguishments of Right of Way (ROW) required.
Western parallel link	c. Ch. 1,600m to c. Ch. 2,500m.	Parallel and local road network collection link	New Link.
No name (Toberbride Overbridge)	c. Ch. 280m (Mainline Ref.)	Link between the L-7611-0 and the Eastern Parallel Link.	New Link.
L-7611-0	c. Ch. 200m	Closure of junction on the existing N4.	Extinguish ROW – Road Closure – Section of the existing local road becomes redundant (constitutes the existing junction arrangement onto the existing N4). Provide alternative access arrangements.

[33] Little or no alteration means no significant change to the existing geometry.

[34] Little alteration means a change to the existing geometry but one which does not result in a change to local trips.

[35] Alteration means a change to the existing geometry which will require a localised change to existing trips.

[36] Road closure and alternative *via* alteration means a closure of direct access onto the National Primary route and the provision of alternative routes via additional design measures.

[37] Chainages where indicated are in reference to the mainline realignment.

Road ID	Location[37]	Treatment	Comment
` L-76111-0	c. Ch. 200m	Link to the L-7611-0	Extinguish ROW – Road Closure – Re-establish link.
L-7612-0	c. Ch. 1,000m	Closure of junction on the existing N4.	Extinguish ROW (in 2 no. locations) – Road Closure – Section of the existing local road becomes redundant (constitutes the existing junction arrangement onto the existing N4). Provide alternative access arrangements.
L-7611-0 to L-7612-0	*Toberbride/ Mullaghnabreena Td.*	Localised widening of the existing local roads.	Extinguish ROW – No Road Closure – Re-establish link.
L-76121-0	c. Ch. 980m	Closure of junction on the existing N4.	Extinguish ROW – Road Closure – Section of the existing local road becomes redundant (constitutes the existing junction arrangement onto the existing N4). Provide alternative access arrangements.
L-3606-9	c. Ch. 1,610m	Closure of junction on the existing N4.	Extinguish ROW – Road Closure – Section of the existing local road becomes redundant (constitutes the existing junction arrangement onto the existing N4). Provide alternative access arrangements.
L-14019-0	c. Ch. 2,080m	Closure of junction on the existing N4.	Extinguish ROW – Road Closure – Section of the existing local road becomes redundant (constitutes the existing junction arrangement onto the existing N4). Provide alternative access arrangements.
L-55015-0	c. Ch 3,370m	Underbridge: Local road passes under the proposed N4	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant. This road is a cul-de-sac, it is maintained in order to provide access to agricultural properties.
L-55016-0	c. Ch 4,060m	Overbridge: Local road passes over the proposed N4	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant.
L-5502-0	c. Ch 5,570m	Overbridge: Local road passes over the proposed N4	Extinguish ROW – Road Closure – Re-establish link.
L-1502-32	c. Ch 6,620m	Overbridge: Local road passes over the proposed N4	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant.
L-5402-0	c. Ch 8,630m	Underbridge: Local road passes under the proposed N4	Extinguish ROW – Road Closure – Re-establish link.
L-54033-0	c. Ch 9,300m	Underbridge: Local road passes under the proposed N4	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant. This road is a cul-de-sac, it is maintained in order to provide access to agricultural properties.
Existing N4	c. Ch. 10,230m	Underbridge: Local road passes under the proposed N4	Extinguish ROW – No Road Closure – Maintain existing link Requirement to manage considerable volumes of live traffic during construction.

Road ID	Location[37]	Treatment	Comment
L-5401-0	c. Ch 10,800m	Underbridge: Local road passes under the proposed N4	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant.
L-54041-0	c. Ch 12,330m	Road Closure	Extinguish ROW – Road Closure with a section of the existing local road being rendered redundant.
L-1404-0	c. Ch 13,530m	At Grade roundabout junction with proposed N4	Extinguish ROW (in 2 no. places) – Road Closure – Re-establish link.
L-1403-0	Junction with the L-1404-0	Re-link local road to L-1404-0	Extinguish ROW – Road Closure – Re-establish link with section of the existing local road being rendered redundant.
L-58015-0	Junction with the existing N4	Maintain existing access to the existing N4	Re-establish link

4.7 Structures

There are a total of 18 principal structures[38] provided for within the *Proposed Road Development* including:

- 4 no. road overbridges;
- 6 no. road underbridges;
- 2 no. clear span river bridges;
- 2 no. retaining walls (or reinforced earth structure) with a height in excess of 1.5m;
- 1 no. intermediate support ESB tower; and
- 3 no. noise barriers with a height greater than 3m.

In addition there will be a number of minor structures[39] provided for within the *Proposed Road Development* including:

- Culverts for drainage and environmental mitigation with a span of less than 3m;
- Noise mitigation barriers less than 3m in height;
- Cantilever signs at each Compact Grade Separated Junction;
- Retaining walls with a height of less than 1.5m

The following provides an overview of the *maximum design characteristics*[40] of the principal structures proposed as part of the *Proposed Road Development*.

4.7.1 Principal Structures

4.7.1.1 Road Bridges

4.7.1.1.1 *Overbridges*

Overbridges proposed will be 3 span structures provided with 5.3m headroom. They will maintain the Type 2 Dual Carriageway under the local road with an additional 4.5m lateral clearance from the edge of the nearside carriageway. Table 4-5 outlines the location of these structures with the maximum design criteria of the local road also outlined.

[38] *Principal Structures* for the purposes of this EIS shall include all those Category 1 and 2 structures as defined in NRA BD 02/09.

[39] *Minor Structures* for the purposes of this EIS shall include all those Category 0 structures as defined in NRA BD 02/09.

[40] Detailed structure design will be a matter for the contractor under the approval process outlined in NRA BD 02/09. For the purposes of this EIS *maximum design characteristics* are considered to include, cross section, headroom and number of spans.

Table 4-5: Location of Overbridges

Local road crossing over proposed N4	Chainage location (approx.)	Townland	Maximum Design Characteristic of Local Road
No name (Link between the L-7611-0 and the Eastern parallel link road).	Ch 280m	*Toberbride*	5.5m carriageway with 1.5m and 0.6m raised concrete verge.
L-55016-0	Ch 4,020m	*Knocknagroagh*	5.5m carriageway with 1.5m and 0.6m raised concrete verge.
L-5502-0	Ch 5,570m	*Drumfin*	5.5m carriageway with 1.5m and 0.6m raised concrete verge.
L-1502-32	Ch 6,600m	*Drumfin*	5.5m carriageway with 1.5m and 0.6m raised concrete verge.

4.7.1.1.2 *Underbridges*

Underbridges proposed will be simple structures, provided to maintain the local road link under the proposed N4 which will maintain its full cross section throughout. Table 4-6 outlines the location of these structures with the maximum design criteria of the local road also outlined.

Table 4-6: Location of Underbridges

Local road crossing under proposed N4	Chainage location (approx.)	Townland	Span Type	Maximum Design Characteristic of Local Road	Headroom provided
No name (Link between eastern and western parallel link roads)	Ch. 2,500m	*Doorly*	Single	5.5m carriageway with 1.5m and 0.6m raised concrete verge.	5.3m
L-55015-0	Ch. 3,380m	*Doorly*	Single	4m carriageway with 1.5m and 0.6m raised concrete verge.	4.5m
L-5402-0	Ch. 8,630m	*Carrownagark*	Single	5.5m carriageway with 1.5m and 0.6m raised concrete verge.	5.3m
L-54033-0	Ch. 9,310m	*Kingsbrook*	Single	4m carriageway with 1.5m and 0.6m raised concrete verge.	4.5m
Existing N4	Ch. 10,220m	*Ardloy*	Single	6m carriageway and 0.5m hard strip with 2.5m and 1m raised concrete verge.	5.3m
L-5401-0	Ch. 10,800m	*Tawnagh*	Single	5.5m carriageway with 1.5m and 0.6m raised concrete verge.	5.3m

4.7.1.2 River Bridges

There are 2 no. locations where the proposed route crosses streams/rivers which will require a clear span bridge for crossing. These structures will be of a simple form and similar to the road underbridges will maintain the proposed N4 cross section. They have been designed hydraulically based on a 1 in 100 year flood flow using HECRAS modelling software to ensure compliance with the requirements of the OPW approval process in relation to section 50 of the Arterial Drainage Act, 1945. Table 4-7 outlines the location of these structures together with the design characteristics calculated.

Table 4-7: River Bridges

River Name	Chainage location (approx.)	Townland	Span Type	Span	Soffit Level required
Lough Corran Outflow (Turnalaydan Stream)	Ch. 4,460m	*Drumfin*	Clear Span	20m	42.55m aOD
Drumfin River	Ch. 7,360m	*Carrowkeel/ Cloonlurg*	Clear Span	20m	52.13m aOD

4.7.1.3 ESB Tower

The 220kV Flagford to Srananagh overhead transmission line passes over the proposed route at c. Ch. 7,120m in the townland of *Cloonlurg*. In order to maintain the required 9m clearance an additional Intermediate tower is required adjacent to the proposed route. This will maintain the existing plan profile of the transmission line but will increase the vertical clearance over the proposed route as indicated in Fig. 4.6 of Volume 3. The tower provided will be consistent with other intermediate towers on the existing transmission line which have been developed by the ESB in order to reduce the visual impact of the line. In this regard the tower shall comply with paragraph 3.5.3.4 of the EIS for the Flagford-Srananagh 220kV Line EIS which states the following:

> *For 220kV single circuit designs the adoption of cold formed lattice structures was recommended. Cold-formed steel technology allows the production of towers with considerably reduced internal lattice bracing leading to a more open outline and reduced visual impact. These tower types have been adopted for this project.*
> *In addition the upper part of the suspension tower has been redesigned to eliminate a visually unattractive feature of previous designs, the high pointed shieldwire peaks. This was achieved by incorporating the shieldwire support points on the tower into a flat compact arrangement on the top beam of the tower. On angle towers, while not eliminated entirely, the shieldwire peaks are of much reduced relative magnitude and impact.*
> *In addition camouflage techniques which reduce visual impact and increase absorption of the line into the landscape were investigated. Towers with an optimum dull grey colour instead of the bright galvanising finish (which does weather to a dull grey over a period of years) and conductor with a dulled surface finish instead of bright aluminium outer strands can be used. It would be proposed that these be provided in specific areas as recommended by the landscape architect, generally locations where the impact of the line is deemed significant.*

4.7.1.4 Noise Barriers

The mitigation section of Chapter 8 (Noise and Vibration) specifies locations where Noise Barriers are required in order to ameliorate noise impacts to various properties. These barriers will be either of an earthen berm construction or be a proprietary barrier system. Each type will be solid, with no gaps at the base or between vertical joints and with a minimum surface mass of 10kg/m^2. All barriers shall achieve the performance specified in I.S. EN 1793 – 1:1998, I.S. EN 1793-2:1998, I.S. EN 1973-3:1998, I.S. 1794-1:2003 and I.S. EN 1794-2:2003. In three locations as described below the barrier height will be in excess of 3m.

Table 4-8: Noise Barriers greater than 3m in height

Chainage location (approx.)	Height (m)
Ch. 1,080m to 1,130m (Eastern Parallel Link)	3.5m
Ch. 4,060m to 4,200m (proposed N4)	4.0m
Ch. 12,410m to 12,610m (proposed N4)	4.0m

4.7.1.5 Retaining Walls/ Reinforced Earth Structures

Retaining walls (or reinforced earth structures) are proposed to limit the earthworks limits in the locations and for the reasons described below:

- In the townland of *Toberbride:* a retaining wall (or reinforced earth structure) ranging in height from circa 3.25m to 3.5m is proposed between circa Ch. 145m and circa Ch. 165m. This occurs on the outmost verge of the northbound lane of the Type 2 Dual Carriageway as depicted on Figure 4.1.1 of volume 3. The purpose of this structural feature is to maintain access arrangements for a residential property and to offset potential impacts which would otherwise arise as a result of rock breaking (or rock blasting);
- In the townland of *Ardcurley/Cloonamahan*: a retaining wall (or reinforced earth structure) ranging in height from circa 1.5m to circa 3m is proposed between circa Ch. 1,400m and circa Ch. 1,630m. This occurs on the outmost verge of the northbound lane of the Type 2 Dual Carriageway where it passes adjacent to the shores of Toberscanavan Lough as depicted on Figure 4.1.1 and 4.1.2 of volume 3. The purpose of this wall is to limit excavation in the vicinity of Toberscanavan Loughs, thereby reducing direct impacts on its sensitive habitats which are described in section 4.8.5.1.4 and Chapter 12 of this EIS.

4.7.2 Minor Structures

As outlined in paragraph 4.7, numerous minor structures will be required for the *Proposed Road Development*. These will generally be developed through the detailed design stage; however in order to provide a description of the whole *Proposed Road Development*, it is considered that they may include:

- c. 77 no. drainage culverts ranging in span from 0.9m to 3m;
- Noise barriers provided at 2 locations ranging in height from 1.5 to 2.0m (in addition to the higher noise barriers referred to in the preceding section);
- Cantilever Road signs provided at each approach to the CGSJ;
- Retaining walls less than 1.5m in height:
    - In the townland of *Ardcurley:* between the verges of the proposed Type 2 Dual Carriageway and the Eastern Parallel Link as depicted on Figure 4.1.1 of volume 3 which will accommodate varying verge levels;
    - In the townland of *Mullaghnabreena/Ardcurley:* on the outmost verge of the northbound lane of the Type 2 Dual Carriageway where it passes adjacent to the shores of Toberscanavan Lough as depicted on Figure 4.1.1 of volume 3;
    - Other localised walls to limit landtake on residential and business/enterprise properties;

4.8 Environmental Design Features

During the design and EIA process, certain criteria were applied to the *Proposed Road Development* in order to assess the Environmental Impacts. These included the initial design measures applied and additional features which have been incorporated into the design in order to avoid/reduce environmental impacts. The following paragraphs give a brief overview of additional design features which are considered to influence the EIA.

4.8.1 Pavement

Pavement design will be developed by the Contractor in accordance with the NRA DMRB and the NRA Specification for Roadwork's during the detailed design stage. For the purposes of Environmental Impact Assessment the design has considered the surface course materials to be as follows:

- Hot Rolled Asphalt on the:
    - Proposed N4 carriageways, hard shoulders and hard strips;
    - Roundabouts and their approaches; and
    - Compact Connector Roads which form part of CGSJs;
- Surface Dressing on:
    - Realigned local roads; and
    - Access Tracks;

4.8.2 Drainage Infrastructure

4.8.2.1 Outline

The area in which the *Proposed Road Development* is located lies within the catchments of the Unshin River cSAC/pNHA and Lough Arrow cSAC/SPA/pNHA. The majority of watercourses traversing the proposed route flow into the Unshin River Catchment with the exception of 1 no. to the south which flows into the Lough Arrow Catchment (the source of the Unshin River).

The drainage design[41] for the *Proposed Road Development* was progressed from two separate perspectives:

(1) Road runoff surface water drainage and treatment, including *inter-alia*:

   a. Identification of appropriate outfall locations;

   b. Determination of the most appropriate method of surface water conveyance (Pre Treatment and Source Control);

   c. Establishment and design of treatment facilities (Site Control);

(2) Separation of existing land drainage from the road drainage system of the *Proposed Road Development* including *inter-alia*;

   a. Identification of watercourse crossing requirements and design of same;

   b. Determination of a land drainage regime.

The design was carried out to a detailed standard using the MX Road Drainage design package and allows for an accurate establishment of the land take requirements for the *Proposed Road Development;* it also allows for an accurate prediction of the impacts (both positive and negative) which the *Proposed Road Development* will have on the receiving environment. Construction Stage requirements are considered in section 4.10.9 of this EIS.

The figurative output of the design process is provided in Fig. 4.7.1 to 4.7.8 contained within Volume 3 while additional information relating to outfall descriptions and analytical calculations is provided in Appendix 4.1 of Volume 4. The following paragraphs provide a summation of its main characteristics.

4.8.2.2 Road runoff surface water drainage and treatment;

Development of the road surface-water drainage system evolved through due consideration of the quality and quantity of water being discharged to the receiving environment, the sensitivity of the bedrock geology in the area and the biodiversity of the surrounding environment which is populated with numerous undesignated ecological wetland sites.

In this regard the principle of Sustainable Urban Drainage Systems (SUDS) has been applied as far as is reasonably practicable. This principle seeks to maximise the environmental benefits of the drainage system through quality and quantity control within a system which attempts to mimic the processes that occur in nature, additionally it is foreseen that the drainage design developed in this manner will blend in more harmoniously within the existing landscape considering the biodiversity values of the surrounding environment.

The design of the drainage system has considered SUDS in terms of the conveyance system and the quality/quantity treatment system adopted.

4.8.2.2.1 *Surface Water Conveyance; Pre-Treatment and Source Control*

The conveyance system of the *Proposed Road Development* has been developed throughout as Surface Water Channels. Over the edge drainage was generally avoided (with the exception of local roads and access tracks as described below) considering the sensitivity of the Hydrogeological environment which the *Proposed Road Development* occurs within and the localised flood plains which it intercepts.

Grassed Surface Water Channels in compliance with the UK Highways Agency HD 33/06 will be used in cut sections and on embankments of less than 1.5m in height. The system is shown figuratively in Fig 4.7.11 of

[41] The term *drainage design* shall be construed in accordance with the meaning of *design* in the context of the NRA PMG Phase 3.

Volume 3 and provides the SUDS components of *Pre Treatment* through the use of collector gullies and *Source Control* via the grassed channel itself.

Where Grassed Surface Water Channels are not permissible[42] (under the aforementioned UK HA HD33/06) Concrete Surface Water Channels are proposed.

The road drainage system has been developed in a manner so that as far as is reasonably practicable surface water emanating from a particular water body catchment area would be returned to that catchment following treatment (*Site Control)*.

The conveyance system of side roads will also where practicable adopt the system described above. However as already mentioned, there are instances where Kerb and Gully and over the edge drainage will be more appropriate. The conveyance system for access tracks will generally be an over the edge system discharging directly to the watercourse.

4.8.2.2.2 *Surface Water Treatment; Site Control*

At each surface water (Road runoff) outfall point along the route the following treatment measures have been proposed as part of the drainage design:

4.8.2.2.2.1 *Petrol Interceptors;*

Petrol and oil interceptors are proposed to be installed at outfalls from the mainline carriageway. These features are generally accepted as an effective means of controlling discharges of oil; particularly as such discharges primarily occur in first flush runoff when the receiving waters dilution levels can be low. They are also used for the containment of accidental spillages on the carriageway. Flows of up to 10% of peak flows are retained in a separation chamber for long enough to promote quiescent conditions, so that lighter than water pollutants such as oil and petrol can rise to the surface of the water. The pollutants are stored in a separator and the separated water discharges from the unit by gravity. If the flow rate rises above 10% of peak flows the excess is diverted by a bypass arrangement at the inlet and discharged without passing through the separation chamber. This ensures that peak flows will not cause 'wash out' of stored pollutants.

4.8.2.2.2.2 *Spill Containment measures;*

An allowance has been made at each outfall for spill containment devices in accordance with the NRA addendum to DMRB HD33/06 (January 2009). For the purposes of this stage of consent, these devices take the form of a pond with a minimum volume of 50m^3 and appropriate valves and penstocks to retain the spillage and provide a bypass arrangement around the spill containment pond.

4.8.2.2.2.3 *Constructed wetlands/attenuation facilities*

Constructed wetlands/attenuation pond facilities will provide for treatment volumes within a permanent pool in addition to attenuation controls for the 1 in 100 year storm providing a peak discharge rate equivalent to the existing Greenfield Runoff Rate. An outline of the location of these features is indicated in Table 4-9 and shown figuratively in Fig. 4.7.10 of Volume 3. Further calculations are provided in Appendix 4.1 of Volume 4.

Table 4-9: Constructed Wetland/attenuation Pond facilities

Approx. Chainage location (m)	Outfall No.	Townland
-190 (att. pond)	OF01	*Toberbride*
Ch 1,100m	OF02	*Ardcurley*
Ch 2,150m	OF03	*Ardcurley*
Ch 3,520m	OF04	*Doorly*
L55016-0	OF05	*Knocknagroagh*
Ch 4,250m	OF06	*Knocknagroagh*

[42] Not permissible on high embankments, which for the purposes of this EIS is considered to be Fill sections greater than 1.5m in height.

Approx. Chainage location (m)	Outfall No.	Townland
Ch 4,900m	OF07	*Drumfin*
Ch 6,500m	OF08	*Drumfin*
Ch 7,750m	OF09	*Carrownagark*
Ch 8,800m	OF10	*Kingsbrook*
Ch 9,400m	OF11	*Kingsbrook*
Ch. 10,050m	OF12	*Ardloy*
Ch. 10,650m	OF13	*Springfield*
Ch 12,450m	OF14	*Sheerevagh*
Ch 14,000m	OF15	*Cloghoge Upper*

Design Overview

The design of the Constructed Wetlands/Attenuation Ponds was advanced with reference to the Greater Dublin Strategic Drainage Study (undertaken by Dublin City Council). This considers that rainfall runoff from greenfield areas (whether agricultural land or virgin land) has very different characteristics to development runoff. These differences can be summarised under three main categories:

- Volume of runoff:
    - No runoff for small events;
    - Less runoff for large events.
- Rate of runoff:
    - Slower, later runoff for all events.
- Quality of runoff:
    - Cleaner runoff (BOD, sediment, pathogens, metals, hydrocarbons).

The objectives of the storage criteria utilised in the drainage design are to address these three aspects and to design the road runoff to mimic, as much as possible, the original greenfield behaviour. To do this, storage volumes are specifically and separately calculated to address each of these criteria. The means by which this is achieved is briefly explained below.

Volume of Stormwater Runoff – Small Rainfall Events

The volume of rainfall runoff is important at each end of the rainfall spectrum. Around 30 to 40 percent of rainfall events (probably in excess of 50 events a year in most areas) are sufficiently small that there is no measurable runoff taking place from Greenfield areas into receiving waters. By contrast, runoff from developments takes place for virtually every rainfall event. The difference between the two states means that streams become more “flashy” and groundwater recharge is often lower, thus reducing base flows in the streams between events.

For the purposes of the design phase these small rainfall events are considered in the sizing of the ponds, however, it may be a case that the appointed contractor would seek to investigate where feasible the use of infiltration Grassed Surface Water Channels where this is achievable.

Volume of Stormwater Runoff – Large Rainfall Events

The total volume of runoff from extreme rainfall events (depths of around 40mm or more when river flooding might occur) from a developed site is typically between 1 and 10 times the runoff volume from the same site in a Greenfield state. It is important to control this additional volume from the developed site as floodplains have finite storage volumes, and even if the runoff is attenuated over the period that Greenfield runoff occurs, by definition there must be greater depths of flooding if more water is discharged.

The criterion for Long Term Storage is a pragmatic approach to calculating an appropriate volume which should be retained and either discharged at sufficiently low flow rates (<2l/s/ha) to the receiving water, such that there is limited impact on exacerbating flooding downstream, or disposed of by infiltration. Theoretically, this form of storage needs only be mobilised at times of extreme rainfall. However in practice it is difficult to mobilise this storage only during extreme events. The basis of calculating the Long Term Storage volume is to use a 6-hour 100-year event and the soil type of the site.

Rate of Stormwater Runoff

Whatever the storm event, development runoff through traditional pipe networks, if allowed unchecked, will discharge into receiving waters at orders of magnitude greater than the undeveloped site. This causes flashy flow in the river that is likely to cause scour and erosion that may seriously affect the morphology and ecology of the stream. Attenuation storage is provided to limit the runoff from the site to minimise these effects. The design principle is to limit the runoff for events of equivalent frequency of occurrence to the same peak rate of runoff as that which would take place from Greenfield sites.

The 1 and 100 year Greenfield runoff rates are used for this purpose, with the 100-year event being used to define the maximum runoff rate from the site.

Quality of Stormwater Runoff

The quality of stormwater runoff is an issue for frequent small events. This is due to the flush of debris and sediment from the catchment surface in the first part of the event together with any sediment deposits in the pipe network. This is compounded by the fact that this highly concentrated initial flow may enter the receiving water that is still flowing at base flow conditions, thus providing a minimum level of dilution. For large events, or during periods of high river flow, this water quality impact is much reduced, so the key period of concern is the summer months of low river flows and the small events that take place on a regular basis.

The concept of Treatment Storage is to provide a body of water in which dilution and partial treatment (by physical, chemical and biological means) of this runoff can take place. This is effectively the volume of water that remains in ponds during the dry weather periods between rainfall events. The calculated amount of storage provided in the drainage design is the equivalent volume of runoff from a rainfall depth (adopted as 15mm).

Residence Times

The Constructed Wetlands are; as far as reasonably practicable designed for a residence time of circa 24 hours (for a design storm of 1 in 100 years) in accordance with the advice given in HA 103/06.

Sediment Fore bays/Containment Ponds shall be provided in the wetlands to allow initial settlement of heavy suspended solids and to allow for ease of maintenance.

The landscape planting of these areas is considered within Chapter 10 (Landscape and Visual) of this EIS and will include Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) for treatment purposes.

4.8.2.2.2.4 *Existing attenuation ponds to be utilised;*

The drainage design for the *Proposed Road Development* utilises two existing drainage infrastructure facilities. These include:

- Outfall No. 01: Two number attenuation lagoons constructed in 2006 adjacent to the existing N4/N17 roundabout in the townland of *Toberbride*:
    - These ponds were initially constructed to treat runoff from the adjacent Toberbride Business Park and have been determined to contain sufficient capacity to accept the road runoff from the *Proposed Road Development.*

      This has been established through a design carried out using MicroDrainage WinDes software package which indicates that based on a restriction on the outlet from the ponds to a Greenfield runoff rate of 8.9 l/s and a 100 year 60 minute storm there is adequate capacity for the ponds to treat the road runoff. However considering the 100 year 24 hour storm predicts the storm water level in the pond to be circa 200mm greater than the existing berm height; it is proposed that the perimeter berm be increased by circa 700mm to provide a 500mm freeboard in the event of such a storm.

- Outfall No. 12: An attenuation lagoon which was constructed as part of the recent improvement works on the existing N4 at Ardloy Td:
    - This particular pond will be supplemented by an additional adjacent pond and will be upgraded as part of the current proposal to satisfy the various design criteria set out in section 4.8.2.2.2.3

Both of these attenuation ponds are currently finished with an internal HDPE liner. The retrofitting of same will include the provision of a vegetated wetland surface in both locations.

4.8.2.2.3 *Considerations for Sealed Drainage*

Where risks are identified in relation to karstified bedrock or aquifer vulnerability, the aforementioned grassed surface water channels and ponds will be sealed. Such risks are outlined in Chapters 13 & 14 of this EIS and will be confirmed following the detailed Ground Investigation at detailed design stage. The design has considered such risks in relation to:

- Bedrock Geology: Type and nature of the bedrock geology with respect to its vulnerability to solution weathering, and the potential for the presence of karst features;
- Aquifer Classification: Type and nature or aquifer classification as determined by the Geological Survey of Ireland (GSI), to determine the importance of the receiving aquifer on a regional scale;
- Presence of Karst Features: Results from desktop studies of information available from the GSI, site visits, site investigation reports and geophysical test results; and
- Aquifer Vulnerability: The thickness and composition of overburden underlying the cuttings.

In general, bedrock for the majority of the site is classified by the GSI as a *Regionally Important Karstified (conduit) Aquifer (Rkc)* while aquifer vulnerability along much of the length of the *Proposed Road Development* is classified as Low (L). However, due to the karstified nature of the bedrock in the region, the bedrock aquifer vulnerability has been classified as High (H)/Extreme (E) in some areas. In these instances which are outlined in Table 4-10 the drainage infrastructure will be sealed.

Other localised areas may also be identified following the detailed Ground Investigation or during construction, these where they occur will also be sealed.

Table 4-10: Bedrock Aquifer Vulnerability Classification

Approx. Chainage	Description
Circa Ch. -190m to 200m	High (H)/Extreme (E
Circa Ch. 8,300m to 10,700m	High (H)/Extreme (E)
Circa Ch. 13,700m to 14,520m	High (H)/Extreme (E)

In addition to the foregoing; Constructed Wetland/Attenuation Facilities will be sealed where maintaining the permanent pool level is a concern, such locations will be verified following the detailed ground investigation contract.

4.8.2.2.4 *Separation of existing land drainage from the road drainage system;*

The objective of this element of the drainage design focussed on:

- The interception and removal of water flowing from lands adjoining the road;
- The separation of that intercepted surface water (from land) from the surface water generated by the road surface;
- The direction of that intercepted surface water (land) under the footprint of the *Proposed Road Development* at a suitable location which will insofar as is reasonably possible maintain the existing surface water catchment of the water body (existing rivers, streams, boundary ditches);

The main method of networking this drainage will be via boundary ditches (open drains) while structures in the form of culverts, or, in the case of larger streams/rivers, bridges will direct the surface water under the proposed road embankments.

4.8.2.2.4.1 *Boundary Ditches*

Boundary ditches (open drains) will be provided at the top of cut slopes and at the toe of embankments where the surrounding land slopes towards the realignment. The boundary ditches will prevent runoff from adjacent land flowing onto the proposed works, and the ponding of water at the toe of embankments. Any farm drains that are severed by the *Proposed Road Development* will either be diverted or discharged into a boundary ditch.

4.8.2.2.4.2 *Culverts and River Bridges*

Drainage Structures have been designed for a 1 in 100 storm return period including a 20% increase in flows for Climate Change. The parameters for hydraulically sizing the structures include the following specific criteria which satisfy OPW requirements for applications under Section 50 of the Arterial Drainage Act 1945:

- Bridge's or culverts are capable of passing a fluvial flood flow with a 1 % Annual Exceedance Probability or 1 in 100 year flow without significantly changing the hydraulic characteristics of the watercourse;
- Structures are capable of operating under the above design conditions while maintaining a freeboard of at least 300 mm;
- Where the land potentially affected does not include dwellings and infrastructure, culverts are capable of operating under the above design conditions while causing a hydraulic loss of no more than 300 mm (excluding the culvert gradient);
- Where the land potentially affected includes dwellings and infrastructure, it is demonstrated that those dwellings and/or infrastructure are not adversely affected by constructing the bridge or culvert;
- Culvert diameters, or height and width are not less than 900mm to facilitate maintenance access and reduce the likelihood of debris blockage.

Flood Flows for each of the crossing points have been established based on the principles set out in section 4.8.2.3 and have been checked and confirmed to be adequate in size in the Flood Risk Assessment (Appendix 4.2 contained within Volume 4 of this EIS). In addition to the clear span river bridges already described in section 4.7.1.2, Table 4-11 describes the maximum design characteristics of the additional structures on main watercourses (those marked on OSi mapping) crossed by the *Proposed Road Development*.

Table 4-11: Main Watercourse Crossings

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
Ch. 500m	Open Drain	Circular Culvert	1.05m dia.		N/A
Ch. 900m	Open Drain	Circular Culvert	1.8m dia.		N/A
Ch. 1,100m	Markree Demesne Stream	Box Culvert (2no. broken sections)	3m	2.0m	The culvert will be broken between the interface of the proposed N4 and the proposed Eastern Parallel Link. This will be in the form of a plan opening of 4.5m long x 3.5m wide. The invert will be depressed by 0.5m for fish passage.
Ch. 3,550m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.830m	N/A
Ch. 3,700m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.520m	N/A
Ch. 5,300m	Open Drain to	Box Culvert	2.13m	2.13m	N/A

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
	Lough Corran				
Ch. 5,620m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Box Culvert	1.52m	1.83m	N/A
Ch. 6,590m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Circular Culvert	1.35m dia.		N/A
Ch. 8,620m	Open Drain to Aghalenane Lough Outflow	Circular Culvert	0.9m dia.		N/A
Ch. 8,640m	Open Drain to Aghalenane Lough Outflow	Circular	1.2m dia.		N/A
Ch. 9,400m	Open Drain to Aghalenane Lough Outflow	Box Culvert	1.52m	1.52m	N/A
Ch. 9,650m	Open Drain to Aghalenane Lough	Box Culvert	1.05m dia.		N/A
Ch. 10,180m	Open Drain to Ardloy Lough	Box Culvert	1.52m	1.83m	N/A
Ch. 10,710m	Springfield Stream	Box Culvert	2.44m	2.13m	The invert will be depressed by 0.5m for fish passage.
	Springfield Stream	Box Culvert	2.74m	2.13m	The invert will be depressed by 0.5m for fish passage.
Ch. 10,850m	Open Drain to Springfield Stream	Circular Culvert	1.52m	1.52m	N/A
Ch. 11,320m	Open Drain to Springfield Stream	Circular Culvert	1.5m dia.		N/A
Ch. 12,250m	Lissycoyne Stream	Box Culvert	2.44m	1.830m	The invert will be depressed by 0.5m for fish passage.
Ch. 13,910m	Open Drain to Drumderry Stream	Box Culvert	1.83m	1.52m	The invert will be depressed by 0.5m for fish passage.
Ch. 14,230m	Tributary of Drumderry Stream	Bottomless Arch.	2.13m	2.13m	The invert will be depressed by 0.5m for fish passage.

All such structures crossing watercourses will incorporate the requirements of the NRA publication; *Guidelines for the Crossing of Watercourses during the Construction of Road Projects,* additionally, they will incorporate where appropriate mammal ledges as identified in the mitigation section of Chapter 12.

Consideration has been given during the design process to squaring structures (where possible) as they pass under the proposed route to minimise the length of structure required. The majority of such crossings are low volume streams or land drains which will be diverted in accordance with the general mitigation measures outlined in the Outline Erosion and Sediment Control Plan (appendix 4.5 of this EIS) and Chapters 12 & 14 of this EIS. More specific mitigation measures are proposed for the diversion of the Turnalaydan Stream as outlined in paragraph 4.8.3.

The development of the drainage design has been aided by consultation with the Inland Fisheries Ireland (IFI). This consultation process, in addition to consultations with the Office of Public Works will be maintained throughout the detailed design[43] stage.

The approval process under section 50 of the Arterial Drainage Act, 1945 for watercourse crossings will be applied for during Phase 5 of the NRA PMG. Such applications will incorporate the design criteria set out in this EIS.

4.8.2.3 Flood Flows

The following analytical factors and calculations have been applied in developing the drainage design. Any modifications made to the design during future phases of the NRA PMG shall be done in accordance with these principles unless an alternative method is scientifically demonstrable to be adequate.

Extreme Rainfall Return Periods

For the purposes of design, Extreme Rainfall Return Periods were provided by Met Eireann for the Collooney to Castlebaldwin *Proposed Road Development*.

Climate Change

The most common effect associated with climate change is that it will adversely impact both the frequency and severity of flooding. Generally, climate change theory suggests the occurrence of milder and wetter winters (with more intense rainfall events) while summers may become hotter and drier. Consequently, it will also lead to increased evaporation, decreased recharge and lower groundwater tables; all resulting in a decline of the reliable yield from water resource zones.

The design makes allowance for an increase of rainfall intensities of circa 20% for network drainage. A minimum allowance of 20% was also incorporated in the calculation of storage volumes for Constructed Wetlands/Attenuation Ponds and in the sizing of culverts.

Calculation of Greenfield Runoff

The DMRB HA 106/04 Part 1, Volume 4, Section 2 gives guidance in relation to limiting the frequency and severity of flooding caused by runoff from beyond the road boundary. It outlines the following empirical methods used in estimating the mean annual flood:

- ADAS (the Agricultural Development and Advisory Service) method for catchments areas <0.4km^2. It assumes a 75-year return period, which is then converted to a 100-year return period;
- IH 124 (Centre for Ecology and Hydrology) method for catchments areas >0.4km^2 but <25km^2.

The aforementioned methodology has been used for the majority of the route for the calculation of Greenfield Runoff. However a third methodology referenced from the Flood Studies Report has also been used where the storage effects of lakes are considered to influence Flood Flows. This methodology has been applied to the Markree Demesne Stream, the Turnalaydan stream and the Drumfin River.

ADAS Method:-

The ADAS method is primarily used for the sizing of field drainage pipes, which was based on TRRL report LR565 "The estimation of flood flows from natural catchments". The design flow (m^3/ s) with a 75-year return period is determined from the following equation:

$$QBAR = AREA\ (0.0443\ SAAR-11.19)\ SOIL^{2.0}\ \{(18.79T^{0.28}-1)/10T\}$$

Where

Area (in km^2) is the catchment plan area

SAAR (in mm) is the standard average annual rainfall for the particular location.

SOIL is the soil index

T is the time of concentration (in hrs) is given by $T = 0.1677W^{0.78}/Z^{0.39}$

[43] Detailed design means a design prepared during Phase 5 and 6 of the NRA Project Management Guidelines.

W is the maximum catchment width in metres

Z is the average height of the catchment divide in metres above the discharge level.

Modified Catchment Characteristic (MCCE) Or IH 124 Method:-

The IH 124 method was developed by The Centre for Ecology and Hydrology formerly the UK Institute of Hydrology. It is especially for use in small catchments <25 km2 from the 'Catchment Characteristics Equation' (CCE) used in the Flood Studies Report (FSR). The MCCE gives an estimate of the mean annual flood for a rural catchment QBAR, where:

$$QBAR = 0.00108\ AREA^{0.89} SAAR^{1.17} SOIL^{2.17}$$

The three parameters are defined in the FSR as follows:

AREA = Catchment Area (km^2)

SAAR = Average Annual Rainfall (mm), adopted as 1182mm

SOIL = FSR Standard percentage runoff parameter, dependent on five soils parameters

Mean annual flood (m^3/ s) calculated as described above can be converted to mean annual flood flows for other return periods by applying a factor (Qt) in accordance with the FSR. A growth factor of 0.87 is applied for a 1 in 100, 1.64 is applied for a 1 in 30 year return period and 1.96 is applied for a 1 in 100 year return period.

Flood Studies Report

The original 1975 FSR investigation involved flood frequency analysis of some 5500 record years from 430 British gauging Stations and 1700 record years from 112 Irish sites. The catchment areas varied from 0.05 to 9868km^2 and annual maximum flows from 0.06 to 997cumec. The FSR six-variable catchment characteristic regression equation for Ireland to estimate the mean annual maximum flood can be expressed as follows:

$$Q_{BAR} = 0.0172\ AREA^{0.94} F_S^{0.27} SOIL^{1.23} R_{SMD}^{1.03} S_{1085}^{0.16} (1+LAKE)^{-0.85}$$

The FSR six-variable catchment characteristic equation was also derived for SAAR replacing R_{SMD} :

$$Q_{BAR} = 0.00042\ AREA^{0.95} F_S^{0.22} SOIL^{1.18} SAAR^{1.05} S_{1085}^{0.19} (1+LAKE)^{-0.93}$$

- **AREA** is the catchment area (km^2);
- **STMFRQ** (stream frequency, Fs) is the number of stream junctions per km^2 on a 1:25,000 scale map. For Ireland this can be determined from a 1inch map and converted (using a formula given in the FSR) to an equivalent 1:25,000 (2.5 inch) number;
- **S1085** is the slope of the main channel between 10% and 85% of its length measured from the catchment outlet (m/km), (E85-E10)/(0.75 x MSL) where E is elevation along the channel and MSL is the main stream/ channel length;
- **SAAR** is long term mean annual rainfall amount in mm and 1:625,000 mapping of this parameter is available for Ireland based on meteorological records from 1941 to 1970;
- **R_{SMD}** is a measure of rainfall excess, in mm given by 1-day R5 rainfall reduced by a weighted mean of annual soil moisture deficit (SMD);
- **SOIL** is an index of how the soil may accept infiltration and is a measure of the Winter Rainfall Acceptance Potential (WRAP). It can be determined from FSR mappings at 1 : 625,000 scale for Ireland. The SOIL index is based on only five classifications (very high, high, moderate, low and very low WRAP) and the mapping scale and number of categories are regarded as providing a very coarse measure of catchment runoff potential. The Flood Estimation Handbook in the UK have replaced the SOIL index by a more extensively classified and calibrated variable called HOST (Hydrology Of Soil Types) provided at a grid resolution of 0.5km^2;
- **Lake** is an index defined as the fraction of catchment draining through lakes or reservoirs and the areas contributing to lakes whose surface area exceeds 1% of the contributing area is recorded.

The FSR equation has a standard factorial error of 1.47. The factorial error applies to the middle of the data set and consequently will be significantly higher at both ends of the data set.

The Q_{BAR} estimate is multiplied by a growth factor derived either from the national, regional or pooled growth curve to arrive at the T – year flood estimate.

For design purposes the Flood Studies Report methodology has been applied to the Markree Demesne Stream crossing, the Turnalaydan Stream crossing and the Drumfin Stream crossing.

4.8.2.3.1 *Road Runoff*

Road runoff has been calculated using the Rational Method and extreme rainfall data tables for various storm return periods obtained from Met Eireann and specific to the location of the *Proposed Road Development*.

Rational Formula:	Q	= C*i*A
Where	Q	= the peak discharge;
	C	= Coefficient of permeability taken as 0.95 for an asphaltic surface;
	i	= rainfall intensity (with an additional 20% increase for climate change);
	A	= catchment area, calculated from contour mapping of the preliminary design road surface.

Where groundwater is encountered in cut sections, road runoff will be kept separate from sub-surface flows being carried in narrow filter drains.

4.8.3 Lough Corran Outflow (or Turnalaydan Stream) Diversion

Due to the meandering nature of the Lough Corran Outflow (or the Turnalaydan Stream) as it passes under the alignment, consideration was given during the design process to realign the stream locally as it passes under the alignment. This was considering the fact that to span the existing river would require an additional span length to that outlined above (section 4.7.1.2) in order to clear the riparian zone of the river during construction. This diversion is assessed as a design measure in the EIS with a general schematic outlined in Figure 4.7.12 contained within Volume 3. Additional measures including habitat creation and improvement of the fisheries characteristics of the length of channel in general are set out in the mitigation section of the Flora, Fauna and Fisheries Chapter (Chapter 12). The channel shall be free of any erosion potential prior to its opening, this may include fully established vegetation or the use of sediment control mats which are biodegradable. The opening shall be carried out in a carefully controlled manner in accordance with the principles set out in the outline Erosion and Sediment Control Plan and with the mitigation measures set out in Chapters 12 and 14 of this EIS. The opening shall also be carried out under the supervision of the EAO and an IFI representative.

Should the contractor require to deviate from this proposal during the detailed design stage then the alternative structure across the existing stream shall be clear span with adequate clearance to avoid any in stream works or permanent structural features within 3m of the top of the river bank.

4.8.4 Geotechnical

4.8.4.1 Road embankment design in soft ground areas

4.8.4.1.1 *General*

Based on Preliminary Ground Investigation Contracts carried out for the *Proposed Road Development* and the subsequent preparation of a Preliminary Geotechnical Interpretive Report, it has been identified that there are areas along the route of the *Proposed Road Development* where soft ground conditions will be encountered which are unsuitable to support the weight of the road embankment. These areas are outlined in Table 4-12 and Fig. 13.4.1 to 13.4.8 of Volume 3 for indicative purposes. Although it will be a matter for the contractor to determine the appropriate construction techniques to deal with these ground conditions during the detailed design and construction stage, in order to ensure a full assessment of the environmental impacts the most potentially environmentally significant method of dealing with same has been assessed been that the soft material unsuitable for supporting the weight of the proposed route would be dug out and replaced with suitable fill material. This allows the engineering, environmental and monetary impacts of the *Proposed Road Development* to be determined and in particular to facilitate the Environmental Impact Assessment to be

completed on a reasonable basis reflecting general practice within the industry. Other possible methods of crossing such areas would be through the use of piling leaving the unsuitable material in place.

The volume of soft materials expected to be encountered within these soft ground areas are described in section 4.10.2.1 of this Chapter.

Table 4-12: Indicative locations of soft ground conditions anticipated to be encountered

Chainage location (indicative limits only)		Preliminary Ground Investigation/Preliminary Geotechnical Interpretive Report observations
From	To	
1,280m	1,600m	Potentially soft material underneath the existing road foundation. However, the design process assumes that this will be left in place.
2,120m	2,360m	Indicates a localised area of c. 2m deep at c. Ch. 2,300m Potentially soft material underneath the existing road. Excavation may be required for the south bound embankment in this area.
3,430m	3,730	Indicates a localised area of c. 2m deep at c. Ch. 3,510m
4,250m	4,770	Indicates a maximum depth of c. 5m between c. Ch. 4,590m and 4,690m
5,000m	5,760	Indicates a maximum depth of c. 4.1m at c. Ch. 5,400m
6,760m	7,690	Indicates a maximum depth of c. 4.5m at c. Ch. 7,250m
9,480m	9,500m	Indicates a localised area of a maximum of 1m deep underneath the south bound embankment.
9,590m	9,630m	Indicates a localised area of a maximum of 1m deep underneath the south bound embankment.
10,080m	10,270	Indicates a depth of c. 1m throughout
10,620m	10,900	Indicates a maximum depth of c. 6.3m between c. Ch. 10,290m and 10,790m
11,900m	12,420	Indicates a maximum depth of c. 3m at c. Ch. 12,280m
13,670m	13,980	Indicates a maximum depth of c. 4.5m at c. Ch. 13,920m
Eastern Parallel Link (c. Ch. 500m to 800m)		Indicates a depth a maximum depth of c. 2.5m throughout
Eastern Parallel Link (c. Ch. 2,220m to 2,480m)		Indicates a depth a maximum depth of c. 2m throughout
Sections of the L-55016-0 at Knocknagroagh		Indicates a depth of c. 1.5m throughout
Sections of the L-5502-0 at Drumfin		Indicates a maximum depth of c. 6m
Sections of the realigned L-1404-0 at Castlebaldwin and Cloghoge Upper		Indicates a depth of c. 1m throughout

4.8.5 Specific Design Mitigation Measures

During the course of the EIA and Design stages of the *Proposed Road Development* and through interaction with various stakeholders and the specialist sub-consultants carrying out various assessments, it became apparent that there was a need to consider specific mitigation measures in the design of the *Proposed Road Development*. The principles behind the consideration of these elements and the rational for providing additional design mitigations are described below.

4.8.5.1 Wetland Habitats;

As already outlined in 4.8.2.2.1, the drainage design has, where practicable, maintained the existing hydrological conditions. A more concerted effort has however been applied in the vicinity of the undesignated ecological sites identified as Lackagh Fen, Boathole Lough & Lough Corran and Ardloy & Aghalenane Loughs. This is in order to maintain the existing hydrological and hydro-geological regime feeding these sites which are valued as being of National, County and International importance respectively in Chapter 12 of this EIS. Sections 4.8.5.1.1, 4.8.5.1.2 and 4.8.5.1.3 outline measures considered in this regard.

An additional undesignated ecological site meriting specific consideration is Toberscanavan Loughs which is attributed the valuation of National importance in Chapter 12 of this EIS. Section 4.8.5.1.4 outlines measures considered for this particular site.

4.8.5.1.1 *Lackagh Fen*

The receiving environment of Lackagh Fen is described in Chapter 12 of this EIS as being:

> *Fen complex with Annex I Alkaline fen and transition mire with priority Annex I Tufa forming springs and high diversity marsh habitats.*

Considering the sensitivity of the site, a design mitigation proposal has been adopted which considers the drainage system, the geotechnical embankment design (through adjacent soft ground areas) and their associated integration as the *Proposed Road Development* passes through the surface and groundwater catchment areas contributing to the Fen habitat. The design mitigation measure is outlined in indicative plan (and descriptive) format in Fig. 4.8.1 of Volume 3 and has been developed to achieve the following characteristics:

- To preserve an existing seepage from a historical quarry rock face at c. Ch. 3,000m, which is considered may be providing some influence to the Fen;
- To limit road excavation as the route passes through the area mapped as Lackagh Fen to 2m (horizontally) generally from the toe of the embankment through the use of temporary supports (such as sheet piles) which will prevent any disturbance of peat outside the embankment construction zone. An LMA of 3m is provided for this purpose. The only exception to this will be between c. Ch. 3,435m and c. Ch. 3,540m where an LMA of c. 7m is required in order to re-link a section of drainage channel which lies partially within the Fen extents;
- To ensure the existing hydrological influences to the fen are maintained through linear drainage systems on the west side of the embankment;
- To prevent longitudinal drainage along the base of the embankment (through the use of hydraulic barriers constructed with lean mix concrete at the locations identified in Fig. 4.8.1 of Volume 3);

4.8.5.1.2 *Boathole Lough and Lough Corran*

The receiving environment of Boathole Lough and Lough Corran Wetland habitats is described in Chapter 12 of this EIS as being:

> *Mesotrophic lakes with reed swamp and cutover raised bog and transition mire habitats to the southeast.*

Considering the sensitivity of the site, a design mitigation proposal has been adopted which considers the drainage system, the geotechnical embankment design (through adjacent soft ground areas) and their associated integration as the *Proposed Road Development* passes through the surface and groundwater catchment areas contributing to the sensitive habitat. The design mitigation measure is outlined in indicative plan format in Fig. 4.8.2 (Volume 3). It has been developed to achieve the following characteristics:

- To limit road excavation as the route passes through the area mapped as Boathole Lough and Lough Corran to 2m (horizontally) generally from the toe of the embankment through the use of temporary supports (such as sheet piles) which will prevent any disturbance of peat outside the embankment construction zone. An LMA of 3m is provided for this purpose;
- To ensure the existing hydrological & hydro-geological influences to the Loughs are maintained through linear drainage systems;
- To prevent longitudinal drainage along the base of the embankment (through the use of hydraulic barriers constructed with lean mix concrete at the locations identified in Fig. 4.8.2 of Volume 3);

4.8.5.1.3 *Ardloy and Aghalenane Loughs*

The receiving environment of Ardloy and Aghalenane Loughs is described in Chapter 12 of this EIS as being:

> *Mesotrophic lakes complex with Annex I Alkaline fen and Transition mire habitats, priority Annex I Tufa forming springs and populations of Annex II Vertigo geyeri.*

Considering the sensitivity of the site, a design mitigation proposal has been adopted which considers the drainage system, the geotechnical embankment design (through adjacent soft ground areas) and their associated integration as the *Proposed Road Development* passes through the surface and groundwater catchment areas contributing to the sensitive habitat. The design mitigation measure is outlined in indicative plan format in Fig. 4.8.3 (Volume 3) with schematic cross sections also provided in Fig. 4.8.3. It has been developed to achieve the following characteristics:

- To limit road excavation as the route passes through the area mapped as Ardloy and Aghalenane Loughs (between c. Ch. 9,620 to c. Ch. 9,700) to 2m from the toe of the embankment through the use of temporary supports (such as sheet piles) to prevent any disturbance of localised shallow peat outside the embankment construction zone. An LMA of 3m is provided for this purpose.
- To ensure the existing hydrological & hydro-geological influences to the fen are maintained through linear drainage systems on the south side of the embankment accompanied by transverse embankment drainage measures between c. Ch. 9,680 and c. Ch. 10,010;
- To prevent longitudinal drainage along the base of the embankment (through the use of hydraulic barriers constructed with lean mix concrete at the locations identified in Fig. 4.8.3 of Volume 3);

4.8.5.1.4 *Toberscanavan Loughs*

The receiving environment of Toberscanavan Loughs is described in Chapter 12 of this EIS as being:

> *Wetland complex with Mesotrophic Lake, reed swamp, Annex I alkaline fen and priority Annex I alluvial woodland*

Considering the sensitivity of the site and the fact that an embankment height ranging from c. 0.8m to c. 2m is proposed as the route passes adjacent to the habitat; the Preliminary Geotechnical Interpretive Report for the *Proposed Road Development* considers that the aforementioned embankment if it is to be constructed on the existing road should be done so with lightweight fill to minimise the net loading and thus the settlement of the soft peat and organic material which is expected to lie under the layers of the existing road. A retaining wall or reinforced earth embankment is also proposed on the western side of the road, along the shores of Toberscanavan Lough to minimise the impact of any potential excavation/fill on the lake habitat. This design mitigation measure is indicated by the retaining wall/reinforced earth embankment depicted on the plan drawings such as that shown in Fig. 4.1.1 of volume 3 and has been developed to achieve the following characteristics:

- To limit road excavation and thus landtake on the site as the route passes through the area mapped as Toberscanavan Loughs (between c. Ch. 1,200 and c. Ch. 1,800);

In addition, as outlined in section 4.8.6.2.1 a fish passable weir will be provided on the Toberscanavan Lough outflow stream (Markree Demesne Stream) to maintain the low water level of the lake.

A general outline of the aforementioned weir detail is provided in Figure 4.9.1 (volume 3 of this EIS). The weir is designed to replicate the existing invert level (29.26m aOD) of the current upstream invert of the 1200mm diameter pipe culvert. This weir level shall be adjustable to a minimum elevation of 28.96m aOD, which is in cognisance of local opinion that the historical low water lake levels were lower preceding roadwork's carried out to the existing N4 in the 1980's. Any lowering of this weir plate level (29.26m aOD) shall only be done in stages which shall be agreed in advance with the local authority in consultation with the NPWS. The effect of these drops shall be assessed based on:

- an examination of continuous lake level water monitoring results (carried out over a minimum of two years);
- an examination of the effects on the riparian habitats based on the baseline habitat results;
- any associated resulting flood risk occurring downstream;

Only when it is assessed that effects are not considered to result in an increase in the impact significance assessed in Chapter 12 of this EIS (not significant at a local scale) should an additional drop be considered in consultation with the NPWS; by the same respect if the resulting impact is considered to be higher, then the weir level shall be returned to its previous position and fixed at that point. The same approach will apply to any subsequent drops of the weir plate. Any further modifications shall be subject to a separate consent procedure.

4.8.5.2 Landscape Infill Area;

The Landscape and Visual Impact Assessment Chapter of the EIS, has, as part of landscape mitigation screening, proposed that an area of severed agricultural land to the north-east of Castlebaldwin be graded to blend in with the existing and proposed public roads which bound it.

This landscape mitigation requires the low lying land to be raised to match the profile of the embankments of the existing and proposed public roads as outlined in plan format in figure 10.1.8 contained within volume 3 of this EIS. The area will then be top soiled and planted with woodland and shrub planting, wild flower meadow and parkland grass. Any existing land drainage systems within the area will be backfilled with Class 6[44] drainage material and diverted to the maintained watercourse (Drumderry Stream) to ensure any potential groundwater seepages are intercepted. This is with the exception of the Drumderry Stream which will be maintained via a diverted watercourse through the Landscape site. The section which will be diverted will be done so in accordance with the requirements set out in the outline Erosion and Sediment Control Plan, Chapters 12 & 14 of this EIS and under the supervision of IFI.

In accordance with the NRA SRW; the appropriate material to infill this site will be Class 4 Landscape Fill. The Spoil Management Report which is discussed in section 4.10.2.2 of this EIS considers that much of the glacial till element of the spoil material generated as a result of the *Proposed Road Development* would satisfy the geotechnical requirements of the Landscape Fill.

4.8.6 Flooding

The design of the *Proposed Road Development* had due regard to the OPW publication *The Planning System and Flood Risk Management: Guidelines for Planning Authorities, (2009)*.

This involved the undertaking of a Flood Risk Assessment on behalf of the Road Authority by Hydro Environmental Ltd. which is included as appendix 4.2 in volume 4 of this EIS and summarised below.

4.8.6.1 Identification of Flood Risk

The main watercourses that are crossed by the *Proposed Road Development* are Markree Demesne Stream (1 No. crossing), Turnalaydan Stream (1 No. crossing), Drumfin River (1 No. crossing), Springfield Stream (2 No. crossings), Lissycoyne Stream (2 No. crossings) and a tributary of Drumderry Stream (2 No. crossings). The three largest watercourse crossings are the Markree Demesne Stream, the Turnalaydan Stream and the Drumfin River having catchment areas of 6.2km^2, 16.1 km^2 and 21.5km^2 respectively. The remaining crossings have small catchment areas ranging from 1.24 to 1.6km^2. The Seasonal Mean Average Annual Rainfall (SAAR) for the study area is approximately 1230mm/annum and the winter rainfall acceptance potential (WRAP) classification for the study area soils is generally classified as moderate runoff catchments (SOIL Type 3) with Greenfield flood runoff rates of c. 6.5l/s per ha.

Many of the watercourses to be crossed were subject to OPW Arterial Drainage works in the past as part of the Owenmore Drainage Scheme. Large extents of the lands adjoining and crossed by the *Proposed Road Development* are designated as benefitting lands of the OPW drainage scheme. These lands would, in general, be expected to be low lying and prone to flooding and thus benefitting from the arterial drainage works.

4.8.6.2 Flood Risk Assessment

The Flood Risk Assessment involved:

- Site walkovers and assessments;
- Hydrometric and topographic surveys;
- Hydrological analysis to estimate the design flood flows (annual maximum flood, the 1 in 100 year and the 1 in 1000 year events);
- Development and application of hydraulic models of the main watercourse crossings to simulate the existing and proposed road scenarios;
- Flood risk assessment; and

[44] NRA SRW terminology.

- The production of flood risk maps in the vicinity of the road for the modelled watercourses.

All watercourses within the study area are ungauged and consequently the design flood flow hydrographs are estimated as currently recommended by Flood Study Report (FSR) catchment characteristic flood estimation methods. Standard Factorial Errors have been applied to flood flow estimations to yield the upper 66% confidence interval of the estimate and where deemed applicable are used to ensure that simulated flow hydrographs are suitably conservative in the assessment.

4.8.6.2.1 *Markree Demesne Stream Crossing*

The Markree Demesne Stream crossing involves the replacement of the existing 1200mm diameter pipe culvert under the N4 with a box culvert. Toberscanavan Lakes and associated flood plain area are located 225m upstream of the existing N4. In general, the water level in Toberscanavan Lough is controlled by the existing culvert and the study undertaken includes an impact assessment of the replacement culvert on both flood and normal/low flow conditions and water levels in the Lough.

The preconstruction hydraulic model simulations for Markree Demesne Stream determined that under design flood flows the 1200mm culvert is inlet controlled and acts as the choke on higher flood flow rates discharging downstream. The model simulations demonstrates that the choke effect of the existing 1200mm culvert combined with the upstream Toberscanavan lakes provide significant flood storage and attenuation reducing significantly the downstream peak flow rates.

The hydraulic model simulations for the post construction scenario determined that the proposed box culvert will reduce the upstream lake levels by 0.14m for mean annual flows and by 0.1m for the Q1000 design flood event. The resultant decrease in upstream storage leads to an increase in the flood flow peaks downstream of the N4 with a resultant rise in peak flood levels of between 0.04m and 0.24m. These increases can be mitigated by improving the downstream channel conveyance (i.e. clearance of dense vegetation). The impact on the existing low flow and mean lake levels at Toberscanavan will be mitigated by the construction of a low weir upstream of the proposed culvert as described in section 4.8.5.1.4 of this EIS. The proposed Constructed Wetland attenuation ponds encroach slightly into the 1 in 1000 year flood plain but have been shown not to impact on flood levels and flows. The proposed road level is 2m higher than the calculated Q1000 design flood level and therefore has a low flood risk.

4.8.6.2.2 *Turnalaydan Stream crossing*

The Turnalaydan Stream crossing involves the diversion of the river channel and the construction of a 20m clear span bridge. Properties adjacent to the existing N4 twin masonry arch bridge at *Lackagh/Knocknagroagh*, located 530m downstream, are subject to recurring flood risk and are identified as having a high to moderate flood risk with at least one property immediately upstream on the right bank flooding in the recent past. The lands upstream of Lackagh Bridge form part of a large flood plain which includes two lakes namely Lough Corran and Boathole Lough. The proposed road embankment crosses through approximately 300m of the river's floodplain at a location 520m upstream of the existing bridge structure on the N4 and c. 340m downstream of Lough Corran. The hydraulic model simulations for Turnalaydan Stream for the pre-construction scenario determined that the existing flood plain attenuates the peak Q100+FE design flood flow from 14.0m^3/sec to 12.73m^3/sec across the study reach. It is also proposed to construct a Constructed Wetlands attenuation pond adjacent to the proposed road alignment upstream of the existing river bridge. The proposed pond encroaches very slightly (<10m^2) on the Q1000+FE flood plain and was found to have negligible impact of flood levels.

The hydraulic model runs for the post construction scenario determined that constriction and reduction in flow conveyance due to the proposed bridge and road embankment will cause a minor afflux of 0.02m and 0.04m for the Q100+FE and Q1000+FE design flood events. The predicted impact downstream is neutral with no discernible change in flood flows and resultant flood levels. On the floodplain it is recommended that 3 no. large diameter pipe culverts (as outlined in figure 4.9.2 of volume 3) are installed at crossings of existing large open drains in order to main the existing local drainage regime and connectivity and reducing the impact of the road embankment in the flood plain.

The proposed road level at the crossing is 4.7m above the 1 in 1000 year flood level. The proposed road embankment encroaches on 13,100m^2 of the Q1000+FE flood plain with an associated estimated loss of storage of 4,295m^3 which is calculated to be equivalent to less than 4 minutes of the peak flood flow and thus has no perceptible impact on flow rate or flood level downstream. The construction of toe drains along the

road embankment in the flood plain will partially negate this loss of storage. No other compensatory storage measures are proposed.

4.8.6.2.3 *Drumfin River crossing*

The Drumfin River crossing involves the construction of a 20m clear span bridge. An existing N4 three arch bridge at *Drumfin/Behy Td.* is located 420m downstream of the proposed structure. The lands upstream of Behy Bridge form part of a large flood plain which is crossed by a network of open drains. The proposed road embankment crosses through approximately 610m of this floodplain. The hydraulic model simulations for Drumfin River for the pre-construction scenario determined that the existing flood plain attenuates the peak Q100+FE design flood flow from 20.3m^3/sec to 16.5m^3/sec across the study reach. It is also proposed to construct a constructed wetland/attenuation pond adjacent to the proposed road alignment upstream of the proposed bridge crossing. The proposed pond does not encroach into the Q1000+FE flood plain.

The hydraulic model simulations for Drumfin River for the post construction scenario determined that the proposed structure and embankment will cause a maximum upstream afflux of 0.14m at the peak of a 1 in 1000 year flood event and that this resulting water level rise will increase storage in the floodplain for a distance of approximately 1.4km upstream of the river crossing. The afflux is found to be due to contraction and reduction of flow conveyance across the flood plain. Increasing the span of the bridge crossing is shown to have minimal impact on flood levels. The resultant increase in upstream storage attenuates flows downstream of the floodplain proposed crossing by approximately 0.5m^3/sec and therefore marginally reduces flood risk downstream. It is recommended that 3 no. large diameter pipe culverts (as outlined in figure 4.9.3 of volume 3) are installed at crossing of existing large open drains in order to maintain the existing drainage regime and connectivity and reducing the impact of the road embankment in the flood plain.

The proposed road level at the crossing is 3.2m above the 1 in 1000year flood level. The proposed road embankment encroaches on 23,000m^2 of the Q1000+FE flood plain with an associated estimated loss of storage of 13,690m^3 which is calculated to be equivalent to 8.5 minutes of the peak flood flow. The construction of toe drains along the road embankment in the flood plain will partially negate this loss of storage. No other compensatory storage is proposed.

4.8.6.2.4 *Springfield Stream Crossing*

The Springfield Stream crossing involves the diversion of the existing stream channel and the construction of two box culverts to accommodate the construction of the main proposed N4 road embankment and an access track. The proposed crossings are located c. 340m downstream of the existing N4 Bridge at Ardloy in a minor and narrow flood plain area. An existing 900mm diameter land access culvert, located 280m downstream of the proposed crossings was shown to be overtopped during design flood events; however, the associated afflux does not extend upstream to the proposed road. Springfield Stream drains to the swallow hole complex at *Tawnagh Td.* located approximately 0.5km downstream of the proposed road.

The proposed road embankment at the Springfield Stream culverts passes through an area where flood flows were shown to be conveyed in bank and therefore has negligible impact on flood plain storage. The hydraulic model for Springfield Stream confirms that the road will have negligible impact on flood storage. It is proposed to construct a Constructed Wetlands attenuation pond adjacent to the proposed road alignment downstream of the proposed bridge crossing. The proposed pond does not encroach into the Q1000+FE flood plain.

The proposed road level at the crossing is 11m above the 1 in 1000year flood level. The proposed road embankment encroaches on 1,500m^2 of the Q1000 flood plain with an associated estimated loss of storage of 154m^3 which is calculated to be equivalent to 1.5 minutes of the peak flood flow. No compensatory storage is proposed.

4.8.6.2.5 *Lissycoyne Stream Crossing*

The Lissycoyne Stream crossing involves the diversion of the stream channel and the construction of two box culverts to accommodate the construction of a land access and the main proposed N4 road embankment. The proposed crossings are located immediately downstream of a L54041-0 known locally as the Bog Road in an area designated as benefitting lands. The river models demonstrated that the local road would be overtopped during flood events.

Post construction model runs determined that the proposed structures cause a small afflux of 6cm for the Q1000 design flood which extends to the local road but does not impact flood levels further upstream. The

replacement of the local road culvert would reduce flood storage upstream and therefore would cause an increase in peak flows downstream which would be expected to cause negligible increase in flood risk. The proposed Constructed Wetland attenuation pond is located well out of the Lissycoyne Stream flood plain. It is proposed that 1 no. 900mm diameter culvert (as outlined in figure 4.9.4 of volume 3) is placed at c. Ch. 12,000m to maintain the existing local drainage regime, connectivity and reduce the impact.

The proposed road level at the crossing is 3.8m above the 1 in 1000 year flood level. The proposed road embankment encroaches on 1,400m^2 of the Q1000 flood plain with an associated estimated loss of storage of 116m^3 which is calculated to be equivalent to be less than 1 minute peak flood flow. No compensatory storage is proposed.

4.8.6.2.6 *Tributary of Drumderry Stream Crossing*

The crossing of the tributary of the Drumderry Stream involves the replacement of an existing N4 culvert and the provision of a culvert within an access track. The lands downstream of the N4 are designated as benefitting lands and are drained by a network of open drains. The hydraulic models for the existing scenario confirmed that the existing 900mm pipe culvert and upstream channel are undersized and the existing N4 road would be expected to be overtopped during a 1 in 1000 year flood event.

The proposed replacement culvert will reduce upstream flood risk upstream of the N4 considerably. There will be a minor increase in flood risk between the replacement N4 culvert and the proposed downstream culvert due to encroachment of the access track road embankment into the flood plain. The proposed road level at the crossing is 2.2m above the 1 in 1000 year flood level.

4.8.6.2.7 *Minor Culvert Crossings*

The proposed minor culvert crossings have been assessed using hydraulic calculations based on Manning's equation. Following the assessment it is concluded that all pipe sizes proposed are suitably sized to convey the design flood flows with minimal afflux.

4.8.6.3 Specific Flood Risk Assessment Mitigation Requirements

The following provides an overview the mitigation requirements defined as part of the Flood Risk Assessment to reduce flood risk. These measures are thus incorporated into the design of the *Proposed Road Development.*

Table 4-13: Specific Flood Risk Assessment mitigation requirements

Study Area	Location (approx. Ch.)	Description
Markree Demesne Stream	5m upstream of the culvert proposed at c. Ch. 1,100m.	Provision of a V notch weir to maintain the low water levels as described in section 4.8.5.1.4 of this EIS.
	At selected locations carried out within the limits of the landtake downstream of the culvert outlet.	Clearance of dense vegetation carried out in accordance with the measures described in Chapter 12 of this EIS.
Turnalaydan Stream	Ch. 4,350m; Ch. 4,400m; Ch. 4,550m;	Provision of c. 1.5m diameter pipe culverts within the floodplain at crossings of existing large open drains in order to maintain the existing drainage regime and connectivity and reducing the impact of the road embankment in the flood plain
Drumfin River	Ch. 7,200m; Ch. 7,460m; Ch. 7,550m;	Provision of c. 1.5m diameter pipe culverts within the floodplain at crossings of existing large open drains in order to maintain the existing drainage regime and connectivity and reducing the impact of the road embankment in the flood plain
Springfield Stream	Ch. 10,700m to Ch. 10,820m;	Existing channel where diverted will have a minimum width (bed level) of 3m and profiled to include a low flow channel
Lissycoyne Stream	Ch. 12,000m;	Provision of c. 0.9m diameter pipe culvert within the floodplain at crossings of existing

Study Area	Location (approx. Ch.)	Description
		large open drains in order to maintain the existing drainage regime and connectivity and reducing the impact of the road embankment in the flood plain

4.8.7 Lighting

It is proposed to provide lighting at all junction locations in order to assist road users at night to comprehend the new layout and to avoid driver confusion. The reasons for providing lighting are: -

- To clearly define and introduce the new road type to road users;
- To highlight areas where mixed traffic is likely to be present in order to improve road safety and reduce the potential for conflict at night;
- To improve driver comfort and reduce fatigue;

It is proposed to provide lighting to traffic route standard at the following locations:

- Toberbride (East) Junction: On each of the approaches;
- Cloonamahan Junction (North): On each of the approaches;
- Doorly Junction: On each of the approaches;
- Drumfin/Cloonlurg Junction (CGSJ): On each of the mainline approaches and for the full length of each of the Compact Connector Roads;
- Castlebaldwin Junction (roundabout): On each of the mainline approaches and for the full length of the L1404-0 connection to the existing N4, additionally on the L1404-0 approach from the north-east.

4.8.7.1 Lighting Design

The lighting installation shall be designed in accordance with ISEN 13201-2: 2003 Road Lighting Part 2: Performance Requirements and BS 5489-1: 2003 Code of practice for the Design of Road Lighting, Part 1: Lighting of Roads and Public Amenity Areas. The installation of lighting columns is to comply with the requirements of Series 1300 and 1400 of the *'Specification for Road Works'* as published by the NRA.

The design of lighting columns shall include the following:

- Lighting columns in the design shall be of slim galvanised steel construction with tubular outreach brackets to support the lanterns;
- The mounting height of the lanterns will be dictated by the overall road width and the Lighting Class applicable to the various category of road. In any case, columns will have a mounting height no higher than 12 metres;
- The lanterns will be fully cut off "Flat Glass" lanterns with Electronic control gear and SON lamps (or LED) as WRTL "Arc" or similarly approved. They will be installed with Zero tilt to minimise glare and light spill;
- As far as practically possible, lighting will be directed away from residential properties;
- All cabling associated with lighting will be located underground.

4.8.7.2 Environmental Impacts due to lighting

Impacts on the environment include the following:

- Visual impacts by day and by night.
- Sourcing of raw materials for the manufacturing of lighting components. These include steel, zinc, plastics, copper, electrical and electronic switching and control components.
- Manufacturing and transport of lighting components, such as columns and brackets, cables, distribution pillars, ducts, lanterns, lamps, ballasts, ignitors, photocells, fuses, and switches.

- Disposal of used and damaged components over the life of the installation.
- Ongoing consumption of electrical energy.

4.8.7.2.1 *Impact by Night*

Because much of the *Proposed Road Development* runs through largely undeveloped rural areas, special measures are recommended to minimise the impact of the lighting installation on the night-time environment. The lanterns will be fully cut-off flat glass type, which eliminate light emission above the horizontal, and effectively limit light spillage beyond the road boundary.

4.8.7.2.2 *Manufacturing and Materials*

A small market, such as Ireland, can have little effect on sourcing of raw materials and manufacturing methods. The environmental effect of these activities is minimised by efficient lighting and electrical design to ensure minimal waste of resources.

4.8.7.2.3 *Disposal*

Proper disposal of used and damaged equipment is a function of maintenance procedures. The body responsible for long term management of the road shall ensure that proper procedures are adhered to.

4.8.7.2.4 *Energy*

The necessary consumption of electrical energy is minimised by efficient design and the use of a highly efficient system such as high pressure sodium discharge lanterns. Electricity consumed is off-peak generated, which allows for the efficient use of generating plant.

4.8.8 Route Signage and Road Markings

4.8.8.1 Introduction

Clear and unambiguous signage is essential for the safe and efficient operation of the road network. Signage includes signs on posts and carriageway markings. Traffic Signs are divided into three group's namely regulatory signs, information signs and warning signs.

4.8.8.1.1 *Regulatory Signs*

Regulatory traffic signs indicate the existence of road regulations or implement such regulations or both. Regulatory signs may be either mandatory or prohibitory.

4.8.8.1.2 *Information Signs*

Information signs give road users information about routes and facilities of interest. The colour of information signs depends on the route classification. In the case of the *Proposed Road development*:

- Signs indicating a national route have white lettering with yellow route number and white border on a green background;
- Signs on routes other than national routes have black lettering, symbols and border on a white background.

Facilities of interest to tourists are shown with white lettering, symbols and border on a brown background.

4.8.8.1.3 *Warning Signs*

Warning signs give notification of a hazard ahead and are diamond shaped. The hazard is indicated by a black symbol on a yellow background.

4.8.8.2 Design of Signage

Traffic signage, including regulatory, warning and directional signs, are to be implemented following consultations with the NRA in compliance with the relevant standards, specifications and guidelines of the

NRA, Department of Transport, Tourism and Sport, and the Department of the Environment, Community and Local Government, including:

- The proposed junctions on the *Proposed Road Development* will require a network of signage to convey the necessary information to the driver and to improve the safety of the road and junction arrangement. This signage will include advance directional signage at 2km, 1km and 500m distance prior to the junction, as well as the junction off sign and route confirmation sign following the junction. These signs will be in conjunction with any regulatory signage required which will be addressed during the detailed design stage;
- New information signs will also be required to direct traffic approaching from the existing N4 to the *Proposed Road Development*. There will also be a requirement to remove, relocate or amend existing signage on the local surrounding network;
- Signage for facilities/tourist locations may also be required, and must be in accordance with NRA policy documents and standards.

The proposed road signage will be examined in more detail during the detailed design stage. All of the proposed signs will be accommodated within the landtake of the *Proposed Road Development* or alternatively within existing road corridors controlled by the Local Authority.

4.8.9 Pedestrian and Cyclist Provision

The provision of safe and adequate facilities for non-motorised road users (NMU's) is an important aspect of any new road scheme. In recognition of this, the *Proposed Road Development* considers specific measures for NMU's including the following and mitigation measures set out in Chapter 6 of this EIS:

- To encourage the use of the existing route via signage provision;
- Provision of a 3m wide cycle track (two way) adjacent to the south bound carriageway on the Eastern Parallel Link which connects the existing N4 to the Toberbride (East) Junction;
- Provision of traffic islands and associated footpaths at entry/exits from the Castlebaldwin Junctions;
- Provision of traffic islands and associated footpaths at entry/exits from the Drumfin/Cloonlurg Junction (CGSJ) of both the north and south bound Compact Connector Roads where they meet the L1502-32;
- Provision of footpaths on all road, over and underbridge structures;
- A section of the L-1404-0 which is part of the Beara Breifne Way (a historical trail which follows the line of the march of O'Sullivan Beara in 1602) is severed by the *Proposed Road Development* at circa Ch. 13,530m. The design in considering this trail proposes a 2m wide walking track to re-link pedestrians (over the shortest length possible) via an uncontrolled pedestrian crossing back into the historical trail. An outline of this design measure is provided in Fig. 4.10 contained within volume 3 of this EIS.

4.8.10 Utilities and Services

In addition to the impact on the 220kV Flagford to Srananagh overhead transmission line (as outlined in paragraph 4.7.1.3), the construction of the *Proposed Road Development* will generally result in some limited impact on existing utilities.

Those companies and organisations whose plant may be affected have been consulted during the development of the project. These include:

- Electricity Supply Board (ESB);
- Electricity Supply Board International (ESBI);
- Sligo County Council (Water & Sanitary Services);
- Bord Gais;
- Carrownagark Group Water Scheme;
- ESB Telecoms;
- Eircom (Telecommunications); and

- Communications including:-
  - UPC;
  - Vodafone Ireland Ltd.;
  - Telefonica O2 Ireland Ltd;
  - Meteor Mobile Communications;
  - Hutchison 3G Ireland Ltd.;
  - BT Ireland;

The disruption of utilities along the route has the following implications for the design and construction of the project:

- It will be necessary to re-route sections of existing services, with connections back to the existing apparatus at the terminal points of these services;
- Provision shall be made for proposed additional services and extensions to existing networks, in particular at bridge crossings;
- For existing services, it may be necessary to maintain these services as far as possible during construction. This may entail temporary service diversions and/ or staging of works during the construction phase;
- At detailed design stage, all existing services will be confirmed on site and the various utility companies and local authorities shall be consulted to confirm any additional and amended service infrastructure.

4.9 Other Statutory Considerations

4.9.1 Compulsory Purchase Order Considerations

The *Proposed Road Development* by its nature will require a Compulsory Purchase Order (CPO) for an area of c. 181.5 Ha of land (including roadbed) comprising in the main agricultural lands with 15 residential properties also included. All lands included are considered necessary for the construction of the *Proposed Road Development*.

A CPO for the purchase of land for the purposes of road construction, other than a motorway, is effected by Local Authorities (being the Roads Authority) under section 76 of (and the Third Schedule to) the Housing Act 1966 as extended by Section 10 of the Local Government (No. 2) Act 1960 (as substituted by Section 86 of the Housing Act 1966) and amended and extended by section 6 (and the second schedule) of the Roads Act 1993 and the Planning and Development Acts 2000-2013, the Housing Acts 1966 to 2009, the Local Government Acts 1925 to 2012 and the Roads Act 1993 to 2007, which is published in accordance with article 4 (a) of the Third Schedule to the Housing Act 1966.

The following parameters have been used to identify the land required for the construction and operation of the *Proposed Road Development*:

- Proposed road footprint;
- Proposed footprints of constructed wetland attenuation facilities;
- Areas required for other drainage elements including outfalls, culverts, ditches, petrol interceptors and spill containment measures;
- Proposed access tracks;
- Areas for landscaping, noise reduction and ecological compensation;
- Areas for construction;
- Maintenance strip;
- Acquisition of severed land plots; and
- Areas required for spoil repositories/borrow pits;
- Areas required for temporary sediment controls which are described in the Outline Erosion and Sediment Control Plan contained within Volume 4 of this EIS and described in 4.10.9 of this chapter.

4.9.1.1 Accommodation Works

Accommodations works are carried out to mitigate adverse effects of the *Proposed Road Development* on individual land and property owners. These works will be carried out as part of the main roadwork's contract and generally consist of providing items such as gateways, walls and fences, cattle pens, replacement services and such like. Further information is given in Chapters 7 and 11 of this EIS which describes the impact on Non-Agricultural and Agricultural properties.

4.9.1.2 Access tracks:

4.9.1.2.1 *Agricultural & Domestic*

The land ownership mosaic together with recorded views of affected landowners has been used to establish access requirements and to evaluate side road and mainline realignments. The suggestions received have been evaluated and where practicable incorporated into the *Proposed Road Development* to mitigate impacts.

The access tracks proposed as already outlined in 4.5.1.3 will:

- Ensure landowners have access to the Local Road Network in the area;
- Ensure efficient access between multiple land parcels owned by any one owner is achieved;
- Eliminate all direct accesses onto Type 2 Dual Carriageway sections of road;

Tracks will be provided, built mainly parallel to the realignment, which will access the local road network.

4.9.1.2.2 *Service Tracks*

Access to drainage treatment locations as already outlined in 4.5.1.3 will where viable be incorporated with agricultural access tracks. Where additional sections of track are required for this purpose they will be constructed to the same standard as the agricultural tracks.

4.9.1.3 Extinguishments of Rights of Way

There are a number of both public and private rights of way, which shall be extinguished as a result of the *Proposed Road Development;* these are indicated on Figure 11.1.1 to 11.1.8 of volume 3.

The public rights of way on local roads, which shall generally be within the lands to be acquired and which require extinguishment have been described in Table 4-4. In addition there will be extinguishments required to the national primary route at its tie in points in between the townlands of:

- *Collooney/Toberbride* and *Doorly*; and
- *Cloghoge Upper and Cloghoge Lower.*

The extinguishments are further described in Part 1 of the Third Schedule to the Compulsory Purchase Order described in section 4.9.1 and are generally required for the following reasons:

- Construction of the proposed route, side roads and access tracks;
- Closure of existing junctions onto the proposed route;
- Widening of existing local roads;
- Construction of structures associated with the *Proposed Road Development*;

Private rights of way are also being extinguished as a result of the *Proposed Road Development*. These are rights of way noted on landowners Land Registry Folios or where landowners have stated that one exists to their knowledge. Where a private right of way is extinguished an alternative access either exists or a new access is being provided as part of the *Proposed Road Development*. It is possible that further private rights of way which are not known about may exist across land being compulsorily acquired which will also be extinguished. The following are the known private rights of way to be extinguished:

- On a section of private road which provides access to development lands (business and enterprise in the townland of *Toberbride*;
- On a section of private road which provides access to development lands (business and enterprise in the townland of *Toberbride*;

- On a section of private road which provides access to residential property in the townland of *Toberbride*;
- On a section of private road which provides access to residential property in the townland of *Toberbride*;
- On a section of private road which provides access to residential and agricultural property in the townlands of *Collooney/Toberbride;*
- On a section of private road which provides access to residential and agricultural property in the townland of *Ardcurley*;
- On a section of private road which provides access to Markree Demesne and agricultural property in the townland of *Ardcurley*;
- On a section of public road which provides access to agricultural property in the townland of *Doorly*;
- On a section of private road which provides access to residential and agricultural property in the townland of *Doorly*;

4.9.2 Effects on European Sites

4.9.2.1 General

The *Proposed Road Development* has taken account of Section 57 of the Planning and Development (Amendment) Act, 2010, which inserted Part XAB into the Planning and Development Act, 2000. This relates to the context of Appropriate Assessment and is with regard to Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora - '*The Habitats Directive'* which was originally transposed into Irish law by the '*European Community (Natural Habitats) Regulations 1997*' (S.I. No. 94/1997). The most recent transposition of this legislation is the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011). The Birds Directive (2009/147/EC) whose transposition into Irish legislation is now contained in the 2011 Regulations seeks to protect birds of special importance by the designation of Special Protection Areas (SPAs), whereas the Habitats Directive does the same for habitats and other species groups within Special Areas of Conservation (SACs), which are currently designated as candidate Special Areas of Conservation (cSAC) in Ireland. Under current legislation, both SPA and cSAC sites are designated as 'European Sites' in Ireland; irrespective of the status of their formal inclusion at a Community level. It is the responsibility of each member state to designate SPAs and SACs, both of which will form part of Natura 2000, a network of protected areas throughout the European Union. Article 6, paragraphs 3 and 4 of the EC Habitats Directive (1992) state that:

> 6(3) *'Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.'*
>
> 6(4) *'If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted*
>
> *Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.*

In addition the European Court of Justice in Case C-127/02 (the "Waddenzee Ruling") has made a relevant ruling in relation to Appropriate Assessment:

> *"Any plan or project not directly connected with or necessary to the management of the site is to be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives if it cannot be excluded, on the basis of objective information, that it will have a significant effect on that site, either individually or in combination with other plans or projects" and that the plan or project may only be authorised "where no reasonable scientific doubt remains as to the absence of such effects".*

4.9.2.2 Natura Impact Statement

The Appropriate Assessment Screening Report for the *Proposed Road Development* was submitted to An Bord Pleanála by Sligo County Council for review. Following this a direction was issued by An Bord Pleanála (ref: 21.JN0002; 11th July, 2012) requesting that a Natura Impact Statement be prepared for the *Proposed Road Development*, having regard to the potential for significant effects on European Sites. This was with regard to:

(a) The nature and scale of the *Proposed Road Development*;
(b) The route of the *Proposed Road Development* through an area with a hydrological and hydro-geological relationship with the Unshin River candidate Special Area of Conservation, the Lough Arrow candidate Special Area of Conservation and the Lough Arrow Special Protection Area,
(c) The submissions made to the board.

The Natura Impact Statement has been undertaken by Ecofact Environmental Ltd. and is included as appendix 12.1 within volume 4 of this EIS. This statement concludes *inter-alia* that:

> *Effective measures to mitigate potential impacts have been provided by design and avoidance. Design stage mitigation measures, with specific reference to operational stage water quality protection, have been included in the project proposal. The detailed drainage design for the* Proposed Road Development *is presented in the EIS in Chapter 4 (Description of the Proposed Road Development) and expanded upon in Chapter 14 of the EIS (Hydrological and Hydrogeological Impact Assessment). The scope of these mitigations with reference to the potential for adverse effects on the qualifying interests of the Natura 2000 sites within the study area have been discussed in the mitigation section of this report. Details of mitigation proposals for the protection of water quality and aquatic conservation interests during the construction stage are set out in the Erosion and Sediment Control Plan, which is included in the EIS reporting (Appendix 4.5)* [Referred to in section 4.10.9 of this Chapter of the EIS][45] *and which will effectively limit any potential water quality impacts to the local context, thus avoiding the potential for downstream water quality impacts within the designated Natura 2000 sites. The incorporation of these measures into the* Proposed Road Development *design and their subsequent implementation on site will ensure that there will be no significant effects, either individually or in combination with other plans or projects affecting the conservation interests or conservation objectives of the Unshin River cSAC or the Lough Arrow cSAC and SPA complex, i.e. the integrity of these Natura 2000 sites. It is therefore concluded that the Proposed Road Development will not, beyond reasonable scientific doubt, adversely affect the integrity of any European Site (Natura 2000 site) whether directly, indirectly or cumulatively.*

4.10 Construction of the *Proposed Road Development*

4.10.1 Programme & Contract

Subject to satisfactory completion of the statutory procedures and to the availability of finance, it is anticipated that construction work will commence in 2015.

It is expected that the *Public Works Contract for the Provision of Civil Engineering Works Designed by the Contractor (PW-CF4)* issued by the Department of Finance will be the form of Contract to be used for the *Proposed Road Development*. The use of this type of Contract is based on a clear definition of requirements and a comprehensive output specification which effectively transfers a significant portion of risks to the Contractor. It also however encourages the contractor to utilise innovative designs and construction techniques which will improve the quality of the end product. No change of designs or construction techniques

[45] Insertion for the purposes of this chapter of the EIS.

which would result in any significant increase in environmental impacts beyond those predicted and assessed herein would be permitted on foot of the development consent if granted on foot of this application. This method does allow however for potential further reduction of impacts by virtue of improvements in such designs or techniques.

The construction period is anticipated to last approximately 2 years. Normal hours of work will be Monday to Saturday 07:00 to 19:00 hours unless specific restrictions are placed on certain activities within certain chapters of the EIS. Certain operations may however be carried out outside of these hours with the permission of the contracting authority.

Where restrictions are placed on the Contractor due to seasonal constraints, as for example in the case of felling of trees, consideration will be given to advance works being undertaken where appropriate.

4.10.2 Earthworks Materials

4.10.2.1 Earthworks Balances

The design stage of the *Proposed Road Development* has identified that earthworks balancing (cut:fill) when applied exclusively to the material won and generated in the course of the various design elements would lead to a significant deficit of fill material and a significant surplus of spoil material generated. This is mainly as a consequence of:

- The fill design requirements for:
    - Underbridges, overbridges, and watercourse culvert crossings;
- The undulating topography;
- The environmental need to avoid cutting into the groundwater table (and saturated bedrock) in sensitive locations;
- The characteristics of the drumlin deposits which the *Proposed Road Development* intercepts, insofar as the preliminary Ground Investigation results indicate that the material excavated from the upper surfaces of road cuts generally appears to be unsuitable for road construction purposes;
- The interception of areas of soft ground along the route which will require to be excavated from underneath proposed road embankments and replaced with suitable fill material;

The spoil[46] material estimated to be generated (following its appropriate use in road construction and landscape areas) as a result of the aforementioned characteristics consists of Subsoil[47] (c. 177,000m^3), Peat (c. 307,000m^3) and Organic Clays (c. 223,000m^3). The fill requirements (including filling of soft spots) are estimated to be c. 1,240,000m^3

4.10.2.2 Spoil Management

4.10.2.2.1 *Outline of approach*

Considering initially the spoil material generated, a Spoil Management Report was prepared by the design team. The principle purpose of this report was to establish a method which would allow the requirements of section 50(3) (a) and (c) of the Roads Act, 1993 (as amended) to be met; which relates to the information which is to be contained in an Environmental Impact Statement as already discussed in Chapter 1 of this EIS.

The report which is contained as appendix 4.3 of volume 4 adopted a screening approach whereby a series of predetermined stages allowed for a broad initial investigation to be refined gradually with the objective of eventually establishing the most appropriate approach and techniques to deal with this material.

The approach was initiated with the development of a broad Range of Options which were considered suitable in principal to accept this spoil material. This concluded that the most viable option to deal with this material

[46] Spoil Material is a shorthand definition used for the purposes of this EIS for material which is excavated during the construction works. The term has been selected on the basis that it is essentially neutral and free from any of the connotations associated with the word "waste".

[47] Which is unsuitable for road construction purposes.

appeared to be spoil repositories which were contained within the severed agricultural lands required for CPO, or, other lands which were contiguous to the *Proposed Road Development*. The suitable options established were based on initial characteristics including *inter-alia* landform, site topography, working characteristics etc. The various options included:

- Option 1: Spoil Repositories within those lands required for land severance reasons;
- Option 2: Ecological & Landscape Improvement Works on lands which are remote from but in proximity to those plots required for land severance reasons, including:
    - Existing conifer plantations of low ecological value;
    - Restoration of existing Cutover Bogs;
- Option 3: Spoil Repositories/ Borrow Pits;
    - Locations within those lands required for land severance reasons
    - Configuration Type 1[48] directly adjacent to those lands required for land severance reasons;
    - Configuration Type 2 directly adjacent to those lands required for land severance reasons[48];
- Option 4: Land infilling of low lying/low value agricultural lands which are directly adjacent to those lands required for land severance reasons

Upon examination of these options and following an assessment process, the optimum sites were considered to be those landscape infill sites contained within Option 1 and the Spoil Repositories/Borrow Pits contained within Option 3. There were a number of reasons for this including:

(1) They are within or directly adjacent to the *Proposed Road Development*;
(2) The material is stored predominately below ground level, therefore:
    a. There is no risk of impacting on flood plains;
    b. There is no risk of a material slide;
(3) Considering the depth of material which they can accept, they have a much smaller land area requirement when compared with the other options;

Additionally and equally as important; in terms of the Spoil Repositories/Borrow Pits the report examined the need for such infrastructure in terms of material resource requirements. This revealed, based on cost comparisons which included fuel consumption considerations, that there was a very justifiable need for borrow pits to be included within the limits of the *Proposed Road Development* and as such the limits of the CPO were extended to include their provision thus providing what is effectively a maximum envelope on the nature of this *Proposed Road Development*, its impacts and mitigation. The intention is that the contractor can later select from within that envelope. This is done, notwithstanding the fact, that it will be the contractor's prerogative to determine onsite dimensions based on the detailed ground investigation and using the principles of adaptive management during the detailed design and construction stage respectively.

4.10.2.2.2 *Site Characteristics*

Following approval by the NRA to include the aforementioned sites within the limits of *the Proposed Road Development*, i.e. within the CPO, the report examined in greater detail the:

- Pit locations including the material which could be won from each particular site; and
- The configurations of the Spoil Repositories/Borrow Pits;

This process resulted in the selection of sites listed in Table 4-14 whose locations are described in figurative terms in Fig. 4.11.1 to 4.11.10 contained within Volume 3 of this EIS.

Table 4-14: Spoil Repositories

Repository	Number	Location
Landscape Infill	SR-LI-01	Circa. Ch. 5,100m - 5,530m, RHS
	SR-LI-02	Circa. Ch. 5,600m - 5,700m, LHS
	SR-LI-03	Circa. Ch. 6,600m - 6,700m, LHS

[48] Description of configuration provided in section 4.10.2.2.2.2.

Repository	Number	Location
	SR-LI-04	Circa. Ch. 6,720m - 6,870m, LHS
Spoil Repository/Borrow Pit (Type 1)	SR/BP-Type 01-No. 01	Circa. Ch. 10,300m - 10,520m, LHS
	SR/BP-Type 01-No. 02	Circa. Ch. 10,840m - 11,000m, LHS
	SR/BP-Type 01-No. 03	Circa. Ch. 11,400m - 11,780m, RHS
	SR/BP-Type 01-No. 04	Circa. Ch. 12,690m - 12,900m, RHS
Spoil Repository/Borrow Pit (Type 2)	SR/BP-Type 02-No. 01	Circa. Ch. 5,430 - 5,500m, RHS
	SR/BP-Type 02-No. 02	Circa. Ch. 5,480 - 5,740m, RHS
	SR/BP-Type 02-No. 03	Circa. Ch. 11,560m - 11,700m, LHS

4.10.2.2.2.1 *Landscape Infill Sites*

The sites listed under Landscape Infill in Table 4-14 are suitable sites which have been identified within lands required for land severance reasons. In general these lands are sites:

- Which are flat or basin shaped;
- Which lend themselves to grading down and blending in of road construction embankments;

These lands are to be filled to a depth (determined by the characteristics of each specific site) with the 'unsuitable' soil, subsoil material and where appropriate peat material. The perimeter edge of the graded lands shall be no greater that 1V:4H, sloping down to existing ground levels, onto road construction embankments or onto containment berms which shall have side slopes of 1V;4H.

4.10.2.2.2.2 *Spoil Repository/Borrow Pits*

The Spoil Management Report sets out two separate schematic configurations for the spoil repository/borrow pits, it also establishes performance requirements which mainly relate to the final landform or landscape perspective which the pits will provide. The following is an outline of some of the conditions which have been devised in the configuration of each of the separate pits which were developed in consideration of a number of factors including *inter-alia* landscape & visual impacts, ecological and geotechnical stability. They were sited so that they would allow re-grading back into the existing topographical landscape.

In this regard Type 1 Spoil Repositories/Borrow Pits were selected for backfilling predominately with glacial till material excavated during the course of the construction works and considered unsuitable for the construction of road embankments while Type 2 Spoil Repositories/Borrow Pits were selected for backfilling predominately with peat and alluvial or organic clays.

Although there are some prescriptive design assumptions made, these should be construed as a demonstration of how the pits could be developed, it will ultimately be the appointed contractor's responsibility in accordance with the contract documents to ensure that the performance objectives are met.

The following describes the particular configurations; the associated figures are provided in Figures 4.11.1 to 4.11.12 of volume 3.

Spoil Repository/Borrow Pit Type 1 Configuration

Outline

(1) The lands will be made available for return to the appropriate landowner following completion of the landscape establishment period;
(2) The topographical slope following a period of 24 months from the final reinstatement will resemble as close as possible its pre excavation slopes. During this 24 month period and following grass seeding, the appointed contractor shall manage the land as part of the landscape maintenance works for the *Proposed Road Development*. To demonstrate compliance with this, the contractor will be required to develop a method statement for backfilling the pit and a monitoring programme which shall outline the rate of settlement;

(3) The topsoil quality and depth at the site shall be surveyed pre-excavation and returned to a similar state following the repository stage;
(4) The permeability (measured by K value) of the upper 1m of the repository shall match as far as is reasonably practicable its pre-excavation value;
(5) Following the period of 24 months outlined above, the performance objective will be that the agricultural value of the field will as far as is reasonably practical resemble its pre-excavation state;

Material Extraction

The material extraction process shall generally be by machine excavation in accordance with the following general principles:

(1) Prior to excavation, the contractor shall have the material required to reinstate the pit identified both in terms of quantity and source.

(2) The upper surface of the drumlin which is determined by the contractor to be unsuitable for use in the embankments, environmental bunds or the constructed wetland attenuation facilities shall be set aside for eventual restoration as part of the repository stage;

(3) The suitable material won from the pit shall in the first instance be used in the adjacent fill areas of the *Proposed Road Development*, where haulage is required further afield this shall be done principally within the confines of the CPO boundary on tracks which will be the responsibility of the contractor to provide;

(4) Should rock be encountered during the extraction stage, the same controls as those outlined for the Type 2 Spoil Repository/Borrow Pits shall apply;

(5) Water quality management within the development of the pit shall be in accordance with the criteria set out in the outline Erosion and Sediment Control Plan;

Spoil Repository Stage

(1) The material to be deposited shall be from the glacial till subsoil material generated in the first instance from the adjacent road cut which is considered to be unsuitable for the purposes of road embankment construction. Provision may be made for alluvial clay (max 10%) to be mixed into the bottom 3m of this pit provided it can be proven that this will not compromise the final landform;

(2) A land drain shall be completed 2m from the roadside edge of the containment bund prior to final reinstatement of the pit. Controls as outlined in the outline Erosion and Sediment Control Plan shall be incorporated into these drains prior to their discharge to the adjacent watercourse;

Fencing and return of lands to the Landowner

(1) A temporary boundary fence shall be constructed around the perimeter of the pit which shall remain in place until the following conditions have been met:

a. The grass sward has fully re-established itself;

b. At least 24 months following reinstatement, or, in any event until the settlement monitoring indicates that the material within the pit has fully consolidated itself. Should this result in any noticeable deviations in the surface of the pit, then an additional spread of topsoil shall be applied and seeded appropriately;

Spoil Repository/Borrow Pit Type 2 Configuration

Outline

(1) It is generally acknowledged that deposition of peat and organic clays to depths of 15m to 20m will ultimately result in consolidation over time. However, it is considered that if the materials are appropriately mixed (or placed) then this settlement can be substantially reduced.
To adequately address the risk of settlement, it is considered that a slope of 1V:4H be provided into the pit (within the repository level) to a depth of 3m. Additionally it is recommended that the peat surface be mounded at 1-2 degrees towards the centre of the pit to compensate for settlement. At a point 5 years after reinstatement of the surface peat layer, the site shall be re-examined by the Local Authority to determine if additional landscaping is required;

(2) The final performance objective (following the above mentioned period of 5 years) of the repository shall be that:
   a. The site will have regenerated (or be at that stage showing positive signs of regenerating) into a peatland habitat;
   b. It will be safely adequate to allow light agricultural livestock access across the site;
   c. It will be safely adequate to access the site with light agricultural machinery;

(3) Provision is made in the landtake requirements for an environmental bund where this is deemed necessary.

Material Extraction

(1) A 2.1m high fence shall be constructed around the perimeter of the site prior to extraction commencement;

(2) Prior to excavation, the contractor shall have the material required to reinstate the pit identified both in terms of quantity and source;

(3) The topsoil layer or peat Acrotelm layer of the pit shall be stripped prior to excavation and set aside for the eventual reinstatement of the surface of the pit;

(4) The upper surface of the pit which is determined by the contractor to be unsuitable for use in the embankments, environmental bunds or the constructed wetland attenuation facilities shall be set aside for eventual restoration as part of the repository stage (to the base of the pit or used as a capping layer);

(5) The locations for use of the suitable material (predominately granular) won from the pit shall be determined by the contractor, however, in accordance with the Outline Erosion and Sediment Control Plan, it will be a requirement that excavations underneath the road embankment will be backfilled as that excavation advances, therefore, as far as is deemed practicable by the contractor the extraction of suitable material and the excavation of unsuitable material from underneath the proposed embankments shall be carried out in sequence. In addition to the requirement of the Outline Erosion and Sediment Control Plan this will ensure a controlled approach to the extraction/repository process;

(6) Specific limits in terms of Noise & Vibration, Air Quality, Hydrology and Hydrogeology will apply in during the extraction process of the pits. These relate to such things as vibration limits from blasting, dust emissions and interception of karstic flows and are expanded upon in the various chapters of the EIS Volume 2;

(7) In advance of any blasting or rock breaking being carried out in the pits, a pre condition survey shall be carried out on all structural properties within a 500m radius of the pits. An additional survey shall be carried out within 6 weeks of the final extraction at the site;

(8) Haulage of the material arising from the pits shall be done principally within the confines of the CPO boundary on tracks which will be the responsibility of the contractor to provide;

(9) Water Quality management within the development of the pit shall be in accordance with the criteria set out in the Outline Erosion and Sediment Control Plan. Water discharged into the surface water system must be within the limits set out in the second schedule to the European Communities (Quality of Salmonid Waters) Regulations, 1988, measured at the point of discharge to the nearest watercourse. If groundwater inflows are encountered which are greater than this, then recharging this groundwater to the ground outside the borrow pit via recharge wells or pits could be carried out. If such groundwater recharging was not possible and if it was then impossible to keep discharges to the surface water system within acceptable limits then the cell in question shall be closed at that point for commencement of the repository stage;

Spoil Repository Stage

(1) For the purposes of the EIS, the following is considered for reinstatement:

   a. Pit invert to 3m from Ground Level: peat & organic clays (50:50) with possibly some subsoil material;

b. 1m - 3m below Ground level: Class 4 Fill[49]. This layer is intended to act as a consolidation and safety layer prior to the restoration of the peat surface;

c. 0m - 1m below Ground Level: peat from the Acrotelm layer elsewhere on site with a vegetation mulch on the surface as per the outline erosion and sediment control plan;

d. Surface: Grass seed mix in accordance with the requirements of Chapters 10 and 12 of the EIS;

(2) In accordance with the requirements of the outline Erosion and Sediment Control Plan, a sedimentation pond shall be provided on site for sediment control during the re-establishment period discussed below;

(3) Outline Erosion and Sediment Control shall include the provision of the above pond and shall contain additional measures as outlined in the Outline Erosion and Sediment Control Plan;

(4) Settlement monitoring shall be carried out following the repository stage at bi-annual intervals for a period of 5 years;

(5) The 2.1m Perimeter Fencing shall remain in place for a period of at least 5 years after which point and following examination of the settlement monitoring results a decision shall be taken if the fence may be removed and replaced with a 1.2m high timber post and rail fence. Ecological Land Management shall be considered at that time, the Local Authority shall determine the most appropriate method of this which might include a long term agricultural lease or selling on the plot;

4.10.2.2.3 *Alternatives and Spoil Material Remaining*

The Spoil Management Report through analytical calculations outlines that if the sites which have been included wholly within the confines of the *Proposed Road Development* transpire to maximise the extents described in the report, there may remain potential that a surplus balance of circa 72,000 m^3 of peat and circa 7,000m^3 of organic clay material could remain. It may be a case that the vertical limits of the borrow pits described are maximised further by the contractor during the detailed design/construction phase of the project thus reducing these quantities. Notwithstanding this, in recognition of the aforementioned balance and the assumptions contained within the report (which are reflective of the stage of design and consent), other considerations are provided including alternative construction techniques and the potential application of the Waste Hierarchy.

As a measure of absoluteness, section 10 of the Spoil Management Report examines the most likely sites outside the CPO which the contractor might consider if an offsite approach was required for any particular reason. The utilisation of the sites which includes conifer plantations (4 no.) and low lying agricultural lands (2 no.) is considered in each of the relevant impact assessment chapters of the EIS in a Macro sense in terms of *Indirect* and *Cumulative* Impacts.

4.10.3 Construction & Demolition Waste Management Plan

An *Outline* Construction and Demolition Waste Management Plan has been prepared for the *Proposed Road Development* and is included as Appendix 4.4 of Volume 4. This plan initiates the Construction and Demolition Waste Management process and an obligation as part of the contract documents for the project will be placed on the Contractor to develop, maintain and operate a more detailed Construction and Demolition Waste Management Plan.

The Outline plan addresses the following aspects of the project:

- Analysis of the waste arising/material surpluses;
- Waste handling and methods identified for the prevention, reuse and recycling of wastes;
- Material handling procedures;
- Roles including training and responsibilities for C&D waste; and
- Waste Auditing protocols;

[49] Terminology as per the NRA Specification for Roadworks.

4.10.4 Construction Compounds

Construction compounds will include stores, offices and plant storage. The location of the compounds will be a matter for the contractor. In general these would be located where open ground with good road access is available in close proximity to the major construction works. Some of the compounds may be permanent for the duration of the contract while others would be mobile and remain for the duration of a particular construction activity. Following construction these areas will be cleared and reinstated.

The Outline Erosion and Sediment Control Plan included as appendix 4.5 of this EIS (Volume 4) outlines the following controls which are to be implemented in the siting of such compounds:

- Construction compounds shall be located on dry land and set back from lakes, river and stream channels, ecological sensitive areas (internationally and nationally important habitats, wet areas such as wetland habitats, marshes and fens, etc.) and away from potential floodplain areas;
- Construction compounds shall not be located in European Sites or within 50m of the boundary of same;
- Construction compounds shall not be located within other designated environmental sites or other ecologically sensitive sites;
- The storage of fuels, other hydrocarbons, and other chemicals within the construction compounds will not be permitted within 50m of a sensitive watercourse or lake and 10m from other watercourses;
- Compounds shall not be located within 75m of an inhabited dwelling house.

4.10.5 Temporary Access and Construction Traffic

Construction traffic will be generated by movement of material, equipment and supply vehicles. A small amount of traffic will be generated by site personnel.

Primary access to the site for all construction vehicles will be provided from the existing N4 at *Doorly*, *Ardloy* and *Castlebaldwin.* The route is a National Primary Route and, generally, of sufficient width and condition to accommodate construction traffic without causing adverse effects to nearby property or delays for road users. It is anticipated that construction traffic will also use a haul road along the road corridor itself, for access. The use by construction traffic of local roads L55015-0, L55016-0, L5502-0, L1502-32, L5402-0, L54033-0 and the L5401-0 will be limited to activities associated with construction of the bridges.

Vehicle movements will be required for the movement of material on haul roads within the site boundary. At the peak construction times this may result in approximately 200 traffic movements a day (approximately 30 movements an hour).

In order to minimise disruption, a traffic management plan for the construction period will be developed. Construction vehicles will be restricted to the construction corridor where possible and will only use local roads when as outlined above.

The Contractor will be responsible for daily inspection and maintenance of roads to ensure that they are free of construction debris, dust and mud.

4.10.6 Temporary Road Diversions

The locations where local roads require temporary diversions during construction of the realignment are listed below. These diversions will in most cases be accommodated within the land-take required for construction of the *Proposed Road Development.* However, there are localised instances where the diversion may be via alternative routes on the local road network. All diversion routes will be properly sign posted.

In all additional cases to those described below, local road access shall be maintained throughout the construction process via localised treatment measures within the landtake required for the *Proposed Road Development.*

Table 4-15: Temporary Road Diversions

Location	Temporary Diversion Required
c. Ch -190m (Mainline	Temporary localised diversion required through the works area including consideration of

Location	Temporary Diversion Required
Ref.) to c. Ch. 2,953m (Eastern Parallel Link Ref.)	the various local roads (public and private) and accesses adjoining this section of the national primary route. This will be a Traffic Management measure. There will be no detours outside the CPO line permitted unless unforeseen conditions dictate. In such circumstance such diversions shall only be carried out with the permission of the Local Authority.
L-7611-0/L-7612-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-7611-0 and the L7612-0.
L-55015-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-55015-0.
L-55016-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-55016-0.
L-5502-0	During the construction period detours may be required to facilitate structure, alignment construction and the operation of the adjacent spoil repositories/borrow pits. Detours shall be via the existing local road network.
L-1502-32	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-1502-32.
L-5402-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-5402-0.
L-54033-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-54033-0.
L-5401-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-5401-0.
L-1403-0/L-1404-0	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L-1403-0/L-1404-0.
Ch. 14,000 – 14,522m	This will be a Traffic Management measure. There will be no detours outside the CPO line permitted unless unforeseen conditions dictate. In such circumstance such diversions shall only be carried out with the permission of the Local Authority.

4.10.7 Employment

Employment requirements will vary throughout the construction period. During the construction stage local facilities and materials will be used. It is estimated that the *Proposed Road Development* could generate local employment opportunities for construction workers, professional staff and administration support. Requirements for local accommodation will depend on the sourcing of staff by the contractor.

4.10.8 Construction Works

The following outlines the likely stages of the construction works, general impacts and mitigation measures that will be employed during this stage.

4.10.8.1 Pre-Construction Works

Archaeological surveys and testing will be undertaken prior to the main works starting in order to resolve archaeological issues. Following resolution of the archaeology, site clearance will require the use of large machinery and vehicles. Areas of land will be required along the length of the route for construction compounds and temporary access routes. Advance works will include diversion of services where required and vegetation clearance.

4.10.8.2 Main Earthworks Activities

4.10.8.2.1 *Creation of Highway Formation, Structures and Drainage*

Materials brought to site will include concrete structural elements, concrete, materials for the road pavement, cement, hard-core/gravel, pipes, chemicals and oils. The construction of the roads and associated structures

including bridges and river crossings will involve earth movements, crossing services, site drainage and run off, dewatering operations, working near or within watercourses, working on flood plains and laying the road pavement.

4.10.8.2.2 *Fencing and Landscaping*

Temporary fencing will be erected as required to delineate boundaries and to minimize disturbance to adjoining land. The majority of the major earthworks required for landscaping will be undertaken during the main construction phase. Landscaping works will be included as part of the main construction contract.

4.10.8.2.3 *Protection of Topsoil*

The contractor will be required to prepare and implement a Topsoil Management Plan as part of the contract Environmental Operating Plan. This will address issues of stripping, handling, storage and re-spreading to ensure that impacts on soil condition and ecology are minimised and the completed scheme maximises the environmental benefit of the soils reuse.

4.10.8.2.4 *Blasting*

Blasting may be required in cuts where rock is encountered and in the Spoil Repositories/Borrow Pit sites as described in section 4.10.2.2.2.2. Blasting shall be carried out in accordance with the mitigation measures outlined in Chapter 8 (Noise and Vibration) in addition to a pre condition survey carried out on all structural properties within a 500m radius of such locations. An additional survey shall be carried out within 6 weeks of the final extraction of material from the site.

4.10.8.3 Assessment of Effects, Mitigation Proposals and the Environmental Operating Plan

Details of the predicted impacts and mitigation associated with the construction of the *Proposed Road Development* are included within the relevant chapters. The environmental measures detailed within the EIS will be implemented as an integral part of the *Proposed Road Development*. An Environmental Operating Plan will be prepared by the appointed contractor in accordance with NRA Guidelines for *the Creation, Implementation and Maintenance of an Environmental Operating Plan*. This plan will outline procedures for the delivery of environmental mitigation measures and for addressing general day-to-day environmental issues that can arise during the construction phase of the *Proposed Road Development*. It will also include statutory obligations, recommendations and guidelines of statutory environmental bodies and agencies and current best practice related to environmental protection during construction.

Construction effects are generally of short-term duration and are localised in nature. In considering the possible methods of mitigation it is necessary to balance the severity of the impact with its duration. For example, it may be better to cause greater disruption over a shorter period than less disruption over an extended period. Disturbance arising from construction may result from various activities including preparatory works, diversion of services, noise and vibration from plant, excavation and fill operations, spoil disposal, stockpiling and handling, construction traffic, severance of roads and accesses and the duration and timing of construction.

Disruption due to construction can be mitigated to a certain extent by imposing working restraints within the contract documentation. Mitigation will include:

- Adopting good working practices;
- Adequate site supervision;
- Development of working methods to protect areas of importance;
- Programming to minimise environmental disturbance (e.g. working hours, avoiding ecologically sensitive periods);
- Pollution control measures as considered in the Outline Erosion and Sediment Control Plan described in section 4.10.9 of this Chapter;
- Access to agricultural holdings and property will be maintained where possible;
- Local liaison and involvement of regulatory bodies;

- Appropriate traffic management and signing (including restricting heavy construction traffic to approved routes and access points);
- Restriction of working hours and types of plant and machinery used;
- Supervision and control of deliveries and storage;
- Covering loads and stockpiles;
- Damping down during dry weather conditions.

Method statements and environmental measures detailed in the Environmental Operating Plan (EOP) will be subject to regular audit by the Environmental Assurance Officer (as described in section 4.10.10) throughout the construction period.

4.10.9 Construction Stage Water Quality Considerations

4.10.9.1 Overview

An Outline Erosion and Sediment Control Plan (contained within appendix 4.5 in volume 4 of this EIS) has been prepared as a method of water quality mitigation to offset potential Construction Stage pollution impacts from the *Proposed Road Development* to adjacent watercourses including the Unshin River cSAC/NHA and Lough Arrow cSAC/pNHA/SPA and their respective tributaries/inflow streams.

The Plan is intended to inform the Construction Stage Erosion and Sediment Control Plan which, in turn, will form an integral part of the Environmental Operating Plan for the *Proposed Road Development*. In particular, the mitigation, control, monitoring and emergency measures for the *Proposed Road Development* in relation to Erosion and Sediment Control are described in this document. The Plan is also used to:

- Inform the Hydrological & Hydro-geological and in turn the Flora, Fauna & Fisheries Impact Assessments; and
- Ensure sufficient lands have been included within the CPO to treat sediment runoff during the Construction Stage for the *Proposed Road Development*;

The main body of the report (appendix 4.5 of volume 4) is guided by the technical guidance document, *Control of water pollution from linear road projects*, published by CIRIA (C648). Additionally plans prepared by other design offices for similar projects were reviewed and considered.

4.10.9.2 Principles of Erosion and Sediment Control

The principles of erosion and sediment control during the construction stage of a Roads Project as outlined in CIRIA C648 include.

(1) Erosion control (preventing runoff) which is much more effective than sediment control in preventing water pollution. Erosion control is less susceptible to failure from high rainfall, requires less maintenance and is also less costly;
(2) Plan erosion and sediment control at the design stage, as far as practicable, so that requirements can be built into the design and land requirement for the project and to inform the details of the Construction Stage Erosion and Sediment Control Plan;
(3) Minimise erosion and potential for soiled water to be generated by minimising runoff;
(4) Install drainage and runoff controls before starting site clearance and earthworks;
(5) Minimise the area of exposed ground;
(6) Prevent runoff entering the site from adjacent ground, as this creates additional polluted water;
(7) Provide appropriate control and containment measures on site;
(8) Monitor and maintain erosion and sediment controls throughout the construction period of the project;
(9) Establish vegetation as soon as practical on all areas where soil has been exposed.

This Outline Erosion and Sediment Control Plan initiates these principles for eventual incorporation and expansion in the Construction Stage Erosion and Sediment Control Plan.

4.10.9.3 Contents of the Plan

The plan (appendix 4.5 of volume 4) contains the following information:

(1) An identification of existing land use, surface water features, low-lying areas and natural drainage ways;
(2) An outline of the main construction activities likely to be relevant in relation to erosion and sediment generation;
(3) An outline of the relevant S-P-R linkage which may cause potential for sediment pollution. S-P-R for this purpose can be described as:
    a. (S) Source: The construction activities which are likely to generate sediment runoff;
    b. (P) Pathway: The potential pathways for the above mentioned pollution to reach sensitive areas;
    c. (R) Receptor: Areas which are considered sensitive in terms of sediment laden runoff;
(4) An outline of available site information which allows for an appreciable understanding for the sediment runoff which is likely to be generated and particular risks which may be encountered in specific areas;
(5) An outline of the controls determined at the current plan stage for incorporation and expansion within the detailed Erosion and Sediment Control Plan;
(6) An overview of Monitoring and Audit Requirements; and
(7) Emergency Procedures.

4.10.10 Monitoring of Environmental Commitments

The environmental commitments outlined in this EIS will as already discussed (section 4.10.8.3 of this Chapter) be included within the EOP to be developed by the Contractor. The Local Authority will appoint an Environmental Assurance Officer who shall be responsible for *inter-alia*:

(1) Ensuring that the measures included in the EOP consider the full gamut of environmental commitments contained within this EIS;

(2) Ensuring that the method statements and environmental measures detailed in the EOP are implemented on site via regular auditing procedures;

(3) Ensuring that the controls described in the Erosion and Sediment Control Plan are adequately adhered to;

(4) Ensuring that the approach and objectives of the Spoil Management Plan are adequately adhered to;

(5) The auditing of Waste Management practices carried out under the Construction and Demolition Waste Management Plan.

In addition, the Environmental Assurance Officer shall audit any design changes made during the detailed design phase to ensure that the effects of such changes do not have any additional significant effects.

The Environmental Assurance Officer will be delegated powers under the contract sufficient for any appropriate instructions to be issued.

4.11 Operation and Maintenance

During a period of 24 months after construction, remedial and maintenance works will be undertaken as required. During the period of establishment, landscaping maintenance will be carried out.

Routine maintenance on National Primary Roads is normally undertaken by the Local Authority. In general, routine maintenance comprises grass cutting, road sweeping, gully emptying, street light maintenance and landscape maintenance. A separate maintenance procedure will be adopted to maintain the central barrier within the Dual Carriageway road sections.

4.12 Relevant Figures and Appendices

4.12.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 4.1 (Key 1: 4.1.1-4.1.8):	*Proposed Road Development Location Map*: Design Overview, Plan Mainline; Key Sheets;
Fig. 4.1.1 – 4.1.8:	Design Overview; Plan Mainline;
Fig. 4.2 (Key 2: 4.2.1-4.2.8)	*Proposed Road Development Location Map*: Design Overview; Mainline Geometrics; Key Sheets;
Fig. 4.2.1 – 4.2.8:	Design Overview; Geometrics Mainline;
Fig. 4.3 (Key 3: 4.3.1-4.3.20):	*Proposed Road Development Location Map*: Design Overview; Geometrics Side Roads; Key Sheets;
Fig. 4.3.1 – 4.3.20:	Design Overview; Geometrics Side Roads;
Fig. 4.4.1 – 4.4.2:	Design Overview; Typical Cross Sections;
Fig. 4.5:	Traffic Model Information; Overview
Fig. 4.5.1:	Traffic Model Information;
Fig. 4.6:	Design Overview; 220kV Line Diversion;
Fig. 4.7 (Key 4: 4.7.1-4.7.8):	*Proposed Road Development Location Map*: Design Overview; Drainage; Key Sheets;
Fig. 4.7.1 – 4.7.8:	Design Overview; Drainage System;
Fig. 4.7.9:	Design Overview; Drainage System; Location of Constructed Wetland/Attenuation Pond;
Fig. 4.7.10:	Design Overview; Drainage System; Schematic detail of Constructed Wetland/Attenuation Pond;
Fig. 4.7.11:	Design Overview; Drainage System; Schematic detail of Grassed Surface Water Channel;
Fig. 4.7.12:	Turnalaydan Stream Channel Diversion;
Fig. 4.8 (Key 5: 4.8.1-4.8.3):	*Proposed Road Development Location Map*: Design Overview; Specific Design Mitigation; Key Sheets;
Fig. 4.8.1:	Specific Design Mitigation; Lackagh Fen;
Fig. 4.8.2:	Specific Design Mitigation; Boathole Lough and Lough Corran;
Fig. 4.8.3:	Specific Design Mitigation; Ardloy and Aghalenane Loughs;
Fig. 4.9 (Key 6: 4.9.1-4.9.4):	*Proposed Road Development Location Map*: Flood Risk Mitigation; Key Sheets;
Fig. 4.9.1:	Flood Risk Mitigation (Toberscanavan Loughs/Markree Demesne Stream);
Fig. 4.9.2:	Flood Risk Mitigation (Turnalaydan Stream);
Fig. 4.9.3:	Flood Risk Mitigation: (Drumfin River);
Fig. 4.9.4:	Flood Risk Mitigation (Lissycoyne Stream);
Fig. 4.10:	Uncontrolled Pedestrian Crossing;
Fig. 4.11 (Key 7: 4.11.1-4.11.8):	*Proposed Road Development Location Map*: Spoil Management Sites; Key Sheets;
Fig. 4.11.1-4.11.8:	Spoil Management;
Fig. 4.11.9:	Spoil Management; Plan Layout: SR/BP Type 2, No.'s 1 and 2;
Fig. 4.11.10:	Spoil Management; Plan Layout: SR/BP Type 2, No. 3;
Fig. 4.11.11:	Spoil Management; Typical Cross Sections: Type 1 SR/BP;
Fig. 4.11.12:	Spoil Management; Typical Cross Sections: Type 2 SR/BP;

Other relevant figures include:

Fig. 13.4:	Geotechnical Overview; Key Sheets;
Fig. 13.4.1-13.4.8:	Geotechnical Overview.
Fig. 11.1:	Agriculture and Material Assets; Key Sheets;
Fig. 11.1.1-11.1.8:	Agriculture and Material Assets.

4.12.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 4.1.:	Operation Stage Drainage Information;
Appendix 4.2:	Flood Risk Assessment;
Appendix 4.3:	Environmental Assessment Report: Spoil Management Report;
Appendix 4.4:	Outline Construction and Demolition Waste Management Plan;
Appendix 4.5:	Outline Erosion and Sediment Control Plan;

Part 2 – Impact Assessment

This section of the Environmental Impact Statement (EIS) assesses the likely environmental impacts and the measures envisaged to reduce and where possible remedy significant adverse impacts of the *Proposed Road Development*.

Throughout the EIS process mitigation by avoidance has been adopted where possible and changes have been made to the proposed design to reduce or eliminate adverse impacts. In areas where this has not been possible mitigation measures have been suggested to reduce or eliminate the impacts.

All proposed mitigation works indicated in this EIS or shown on Drawings in Volume 3 of this EIS, are based on the design stage of the *Proposed Road Development* and may be revised during detailed design in the next phase. The design and the environmental mitigation measures will be further progressed and refined during the detailed design of the *Proposed Road Development*. This will include any mitigation measure contained in such approval as may be granted by An Bord Pleanála.

The detailed design will seek to develop the design in a manner such that there is no material change in terms of significant adverse impacts on the environment. Opportunities may be identified to further reduce the significance of adverse impact and, in some cases, improve the residual effect/impact.

Where re-alignment of a section of the *Proposed Road Development* has been suggested as a measure for mitigating a particular impact, this re-alignment has been considered in terms of engineering design and the impact of the proposed re-alignment on other aspects of the environment.

5 Impact Assessment - Introduction

5.1 General

The potential environmental impacts associated with this *Proposed Road Development* are presented in Chapters 6-15 inclusive under the headings Human Environment, Natural Environment and Material Assets.

5.2 Relevance of Construction Contract

As already outlined in section 4.10.1 of this EIS it is expected that the *Public Works Contract for the Provision of Civil Engineering Works Designed by the Contractor (PW-CF4)* issued by the Department of Finance will be the form of Contract to be used for the *Proposed Road Development*. It is expected that the use of this type of contract will allow the contractor to utilise innovative designs and construction techniques which will improve the quality of the end product. In accordance with the NRA PMG, the contract documents for the *Proposed Road Development* will include the following statement:

> *The detailed design will seek to develop the design report proposals in a manner such as there is no material change in terms of significant adverse effects on the environment. Opportunities may be identified to further reduce the significance of adverse environmental effects, and in some cases, improve the residual effect of the impact.*

5.3 Scope of EIS

This EIS has been prepared having regard to the following:

- Legislation as set out in Section 1.2 and 1.3 of this EIS;
- The EPA Advice *Notes on Current Practice (in the preparation of Environmental Impact Statements)*;
- The NRA *Project Management Guidelines*;
- The NRA *Environmental Impact Assessment of National Road Schemes – A Practical Guide*;
- Consultation with statutory and non-statutory bodies, as well as local interest groups throughout the Route Selection Stages;
- Other Environmental Impact Statements for *Proposed Road Developments* of a similar size and nature; and
- Additional references as outlined to the rear of each Chapter of this EIS.

5.4 Impact Assessment

5.4.1 EIS Chapters

The Impact Assessment Chapters of the EIS have generally been prepared in order to satisfy the requirements required by the various pieces of legislation set out in Chapter 1.

Section 50(3) of the Roads Act, 1993, (as amended) states the following:

An environmental impact statement shall, in addition to and by way of explanation or amplification of the specified information referred to in subsection (2), contain further information on the following matters:

(b) a description of the aspects of the environment likely to be significantly affected by the proposed road development, including in particular

- *human beings, fauna and flora,*
- *soil, water, air, climatic factors and the landscape,*
- material assets, including the architectural and archaeological heritage, and the cultural heritage,
- *the inter-relationship between the above factors;*

The relevant Chapters consider these factors as outlined in Table 5-1.

Table 5-1: Section 50(3)(b) of the Roads Act, 1993 (as amended); Factors to be considered.

Factor considered	Relevant Chapter
Human Beings	The human environment can be described as the existence, activities and well-being of people, usually considering people as groups or populations. It therefore includes issues in relation to economic activity, social considerations (e.g. development patterns and types of activity), land use (including severance and amenities) and health and safety (e.g. human health and nuisance). This EIS assesses the impact of the *Proposed Road Development* on human beings within the sections on Socio-Economic Impact, Non-Agricultural property, Noise & Vibration, Air Quality, Landscape & Visual and Agricultural Land.
Fauna and Flora	The impact on Fauna and Flora is addressed in the chapters on Flora, Fauna & Fisheries and Hydrology & Hydrogeology.
Soil	The impact on Soil is addressed in the chapter on Soils and Geology.
Water	The impact on Water is addressed in the chapter on Hydrology & Hydrogeology and the Chapter on Flora, Fauna & Fisheries.
Air	The impact on Air is addressed in the chapter on Air Quality and Climate.
Climatic Factors	Reference has been had to Climatic Factors in the Chapter on Air Quality and Climate
Landscape	The impact on Landscape is addressed in the chapter on Landscape & Visual Impact Assessment.
Material assets, including the architectural and archaeological heritage, and the cultural heritage,	Material assets include natural resources (e.g. air, water, geology and soils), economic resources (e.g. towns, settlements, roads, utilities, land ownership, transport infrastructure) and cultural resources (e.g. archaeology, architecture, settlements, monuments, features and historic sites, folklore and tradition). Impacts on natural resources are considered within Chapters on Soils & Geology, Hydrology & Hydrogeology and Flora, Fauna and Fisheries. Impacts on economic resources are considered in the chapters on Socio-economic, Non – Agricultural property and Agricultural property. Impacts on cultural resources are considered under the Chapter on Architectural, Archaeological and Cultural Heritage.
the inter-relationship between the above factors	In addition to the assessment of impacts on individual topics, the inter-relationship between these factors was also taken into account as part of the EIS. Where a potential exists for interaction between two or more environmental topics, the relevant specialists have taken the potential interactions into account when making their assessment and where possible complementary mitigation measures have been proposed. An overview of this is outlined in section 5.6 of this Chapter.

The relevant Chapters seek to further satisfy the requirements of Section 50(3) (c and d) of the Roads Act, 1993 (as amended) by way of provision of information on the items as outlined:

(c) a description of the likely significant effects (including direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the Proposed Road Development on the environment resulting from—

- *the existence of the Proposed Road Development,*
- *the use of natural resources,*
- *the emission of pollutants, the creation of nuisances and the elimination of waste, and a description of the forecasting methods used to assess the effects on the environment;*

(d) an indication of any difficulties (technical deficiencies or lack of know-how) encountered by the road authority concerned in compiling the required information;

5.4.2 EIS Structure: Impact Assessment

The Impact Assessment is structured within three sections as outlined below:

5.4.2.1 Section A – Human Environment

This section of the Environmental Impact Statement deals with the potential impacts of the *Proposed Road Development* on human beings.

These impacts are:

- **Socio-Economic/Community Impact** – the direct and indirect impacts of the *Proposed Road Development* on the population living or working in the vicinity of the proposed development;
- **Non-Agricultural Property** – the impact of the *Proposed Road Development* on non-agricultural property;
- **Noise and Vibration Impacts** – the impact of noise and vibration during construction and operation of the *Proposed Road Development*;
- **Air Quality and Climate Change** – the impacts of air quality and climate change (also relevant to section B) during construction and operation of the *Proposed Road Development*;
- **Landscape and Visual impacts** – the impact of the *Proposed Road Development* on the aesthetic aspect of the landscape and the visual obstruction and intrusion; and
- **Agriculture** – the impact of the *Proposed Road Development* on agricultural property**.**

5.4.2.2 Section B – Natural Environment

This section of the Environmental Impact Statement deals with the potential impacts of the *Proposed Road Development* on the Natural Environment. The effects have been grouped as follows:

- Impacts on **Flora, Fauna and Fisheries**;
- Impacts on **Soils and Geology;**
- Impacts on **Hydrology and Hydrogeology**;

5.4.2.3 Section C – Material Assets

This section of the Environmental impact Statement examines the impacts of the *Proposed Road Development* on Material Assets including:

- Impacts on **Architectural, Archaeological and Cultural Heritage**

5.4.3 Objectives of the Environmental Impact Assessment

In general, the objectives of the EIA can be summarised as follows:

- To establish the existing environmental conditions of the site and surrounding area, which may be potentially affected by the *Proposed Road Development*;
- To identify the potential effects, both positive and negative, that may arise from the construction and operation of the *Proposed Road Development*, taking account of the size and location, the sensitivity of the local environment, the concerns of interested parties and the requirements of statutory consultees;
- To predict and evaluate the extent and significance of the potential effects; and
- To identify and evaluate measures that can be employed to mitigate adverse effects.

The EIS addresses the direct, indirect, secondary, cumulative, short, medium, long-term, permanent, temporary, positive and negative effects as well as the interactions. The effects have been examined for the construction and operation stages of the project to define the full effects of the *Proposed Road Development*.

5.4.3.1 Scenarios

A number of different scenarios have been examined when determining likely significant impacts:

- The *'Do Nothing'* or *'Do Minimum'* scenario compares the quality of the existing receiving environment with that of the likely environment should the *Proposed Road Development* not be built;

- The *'Do Something'* scenario compares the quality of the existing receiving environment with that of the likely environment should the *Proposed Road Development* be built.

5.4.3.2 Effects

5.4.3.2.1 *Methodology*

To evaluate identified effects, those contributing to the EIS were asked to use the same terminology and approach to the identification of significant effects where possible. For those topics where the adoption of the preferred approach was not possible, the method by which significant effects have been identified is set out near to the start of relevant chapters. The likely significant impacts are thus described where possible using the four-tier system presented in the EPA advice notes, by reference to:

- Quality of impact;
  - Positive, Neutral, Negative;
- Significance of impact;
  - Imperceptible, Slight, Moderate, Significant, Profound;
- Duration of impact;
  - Short-term, Medium-term, Long-term, Permanent, Temporary;
- Types of Impact;
  - Cumulative, 'Do-Nothing Impact, Indeterminable, Irreversible, Residual, Synergistic, 'Worst Case'

Where appropriate, mitigation measures have been proposed to reduce any significant adverse impacts. The EIS presents the residual impacts of the *Proposed Road Development* after the proposed mitigation measures as identified in each Chapter have taken effect as planned.

5.4.4 Structure of individual Impact Assessment Chapters

Sub consultants have structured the relevant Chapters of the EIS based on the EPA (2002) *Guidelines on Information to be Contained in an Environmental Impact Statement*. Where there is deviation from this structure, it is outlined at the beginning of the relevant Chapter; in general however the following structure has been adopted for Impact Assessment Chapters:

- **Introduction:**
  - Overview of the specialist area and aims of study;
- **Methodology:**
  - Relevant legislation, site visits, any assumptions made;
- **Description of Existing Environment**:
  - Existing environmental character of the proposed site and surrounding area, including assessment of context, character, significance and sensitivity. This section will particularly focus on providing a thorough baseline assessment of the existing environment.
- **Description of Likely Impacts** :
  - Assessment of likely Impacts as follows:
    - Assessment of the *'do nothing'* or *'do minimum'* impact providing an overview of how current trends would impact on the environment if the *Proposed Road Development* is not built;
    - Description of impacts from construction and operation of the *Proposed Road Development* and their consequences for the environment;
    - Consideration of impact interactions and cumulative impacts;
    - Assessment of the worst-case scenario.
- **Mitigation Measures**:
  - Description of proposed mitigation measures to avoid, reduce or remedy impacts;
- **Residual Impacts**:
  - Description of any expected residual impacts after mitigation;
- In some instances such as in the case of Flora, Fauna and Fisheries, a **Summary** is provided which outlines the main findings.

A summary of the environmental commitments, i.e. the mitigation measures to be undertaken is then outlined in Chapter 16 of this EIS.

5.4.5 Consideration of Design Features

The *Proposed Road Development* is as described in Chapter 4 of this EIS and as such this is the proposal under assessment for the *Description of Likely Impacts.* The only exception to this is the Drainage Design where a more discrete approach is adopted for the reasons explained in 5.4.5.1.

5.4.5.1 Drainage Design

The drainage design is an obvious physical design element of the *Proposed Road Development* and is described appropriately in Chapter 4 of this EIS. It provides benefits to the receiving environment in terms of water quality control and biodiversity (particularly in relation to the Constructed Wetlands) and is considered an integral component of the *Proposed Road Development.* However, notwithstanding this, it was decided during the EIA process for transparency reasons to separate the physical characteristics of the system (its footprint and landform) from the water quality benefits which it will provide. This allows the Hydrological and Hydro-Geological Impact Assessment Chapter (Chapter 14) to demonstrate its importance in terms of limiting impacts on the receiving environment, while also allowing other Impact Assessments within the EIS the opportunity to assess the likely impacts (positive and negative) of its physical characteristics on the receiving environment.

5.5 Naming Conventions

In terms of referencing/labelling physical elements of the existing environment the following approach should be noted.

5.5.1 River, Stream and Lake/Lough names;

The standard approach in labelling watercourses crossed by (or in the vicinity of) the *Proposed Road Development* was to initially reference OSi mapping. However, in the case of the current site it has been established that names used on some of these features are ambiguous in some cases, e.g.:

- a section of the Unshin River between its source (Lough Arrow) and its junction with the Douglas River is labelled the Arrow or Unshin;
- a tributary of the Unshin River which intersects with the *Proposed Road Development* at c. Ch. 4,440m is labelled the Arrow or Unshin River.

Considering these anomalies and the fact that numerous smaller watercourses intercepted by the *Proposed Road Development* are not named on the OSi mapping, reference was given to the EPA Envision website, local naming conventions and various stream characteristics in devising a list of watercourse names. The following table indicates the main water bodies intercepted by or in the immediate vicinity of the *Proposed Road Development* and the reference of the naming convention used in this EIS.

Table 5-2: Water bodies in vicinity of the Proposed Road Development

Waterbody Name	Name on OSi mapping	Final Reference point
Unnamed drain in *Mullaghnabreena Td.*	None	Watercourse Characteristics, i.e. the name *'unnamed drain in Mullaghnabreena'* is used.
Toberscanavan Loughs	Toberscanavan Loughs	OSi
Markree Demesne Stream (or Toberscanavan Loughs outflow)	None	EPA Envision and the fact that the river is an outflow from Toberscanavan Loughs.
Unshin River	Unshin River	OSi
Turnalaydan Stream (or Lough Corran outflow)	None	EPA Envision and the fact that the river is an outflow from Lough Corran.
Lough Corran	Lough Corran	OSi
Boathole Lough	Boathole Lough	OSi
Drumfin River	Arrow or Unshin	EPA Envision. River is a tributary of the Unshin so OSi name is considered inappropriate.

Waterbody Name	Name on OSi mapping	Final Reference point
Tributary of Drumfin River	None	Watercourse Characteristics: i.e. stream is a tributary of the Drumfin River.
Cuileencroobagh Lough	Cuileencroobagh Lough	OSi
Aghalenane Lough	Aghalenane Lough	OSi
Turlough and Swallow Hole Complex	Swallow Hole	Local terminology is added to the OSi naming convention to distinguish the location.
Springfield Stream	None	EPA Envision.
Lissycoyne Stream	None	EPA Envision.
Drumderry Stream	None	EPA Envision.
Tributary of Drumderry Stream	None	EPA Envision. (NOTE: The IFI have been calling this stream locally the Brickeen Stream, this is in conflict with EPA Envision who name a stream further south as the Brickeen)
Lough Arrow	Lough Arrow	OSi

5.5.2 Townland names

References to townland names are based on current OSi mapping information. Townland names intercepted by the *Proposed Road Development* are outlined in italics (e.g. *Toberbride*) in Part 1 of the EIS in order to draw attention to same.

5.5.3 Property Numbers

For consistency and as far as was practicable, properties potentially in the vicinity of the *Proposed Road Development* were given a number in advance of the impact assessment. This allows for continuity in determining impacts on properties, particularly in the case of impact assessments on Noise and Vibration, Air Quality and Landscape and Visual.

5.6 Interactions

In addition to the assessment of impacts on individual topics, the inter-relationship between each chapter was also taken into account as part of the EIS. This was facilitated through:

- Ongoing interaction between the design team and specialist sub consultants;
- Discussions at workshops and EIA progress meetings; and
- Direct consultation between the various sub consultants, e.g. Landscape and Visual consultant corresponding with the Flora, Fauna and Fisheries consultant regarding landscape planting to compliment ecological mitigation requirements, etc.

Where a potential exists for interaction between two or more environmental topics, the relevant specialists have taken the potential interactions into account when making their assessment and where possible complementary mitigation measures have been proposed. Table 5-3 gives an indication of the initial identification process in determining where there may have been a potential for an interrelationship to occur.

Table 5-3: Impact Interaction identification

	Socio-Economic	Non- Agricultural Property	Air Quality and Climate	Noise and Vibration	Landscape and Visual	Agriculture Property	Flora, Fauna and Fisheries	Soils & Geology	Hydrology & Hydro-geology	Archaeology, Architecture and Cultural Heritage
Socio-Economic		•	•	•	•	•				•
Non Agricultural Property	•		•	•	•	•			•	
Air Quality and Climate	•	•				•	•	•		
Noise and Vibration	•	•			•	•	•	•		•
Landscape and Visual	•	•		•			•			•
Agriculture Property	•	•	•	•			•		•	
Flora, Fauna & Fisheries			•	•	•				•	
Soils & Geology			•	•					•	
Hydrology and Hydrogeology		•	•			•	•	•		
Archaeology, Architecture and Cultural Heritage	•				•					

The following is a broad overview of the more significant inter-relationships which were identified and considered during the EIA process.

Table 5-4: Impact Interaction overview

Inter-Relationship		Brief summary of interaction
Chapter	Chapter	
Socio Economic	Non-Agricultural Property	Potential impacts to human beings as a result of impacts to residential properties directly affected.
Socio Economic	Air Quality and Climate Change	Potential impacts to human beings in terms of exposure to dust, particulates and other emissions during the construction and operational phases. May affect amenity values.
Socio Economic	Noise and Vibration	Potential impacts to human beings in terms of noise nuisance during the construction and operational phases. Abatement measures to reduce the impact of noise on nearby residents during the construction and operational phases of this project may is in some cases required. May affect amenity values.
Socio Economic	Landscape and Visual	Potential visual impacts may affect amenity values. Landscape mitigation measures is required in order to offset same.
Socio Economic	Agricultural Property	Social impact in terms of direct impacts on farming activities.
Socio Economic	Archaeology, Architecture and Cultural Heritage	Amenity impacts regarding accessibility to Cultural Heritage sites.

Inter-Relationship		Brief summary of interaction
Chapter	Chapter	
Non-Agricultural Property	Air Quality and Climate Change	Potential impacts to properties in terms of exposure to dust, particulates and other emissions during the construction and operational phases.
Non-Agricultural Property	Noise and Vibration	Potential impacts to properties in terms of noise nuisance during the construction and operational phases.
Non-Agricultural Property	Landscape and Visual	Potential visual impacts to human beings. Landscape mitigation measures is required in order to offset same.
Non-Agricultural Property	Agricultural Property	Impacts where residential property is connected with an agricultural property.
Non-Agricultural Property	Hydrology and Hydrogeology	Potential impacts to properties in terms of pollution to ground and surface water.
Air Quality and Climate	Agricultural Property	Potential impacts to properties in terms of exposure to dust, particulates and other emissions during the construction and operational phases.
Air Quality and Climate	Flora, Fauna and Fisheries	Potential impacts to ecological sites in terms of exposure to dust, particulates and other emissions during the construction and operational phases.
Noise and Vibration	Landscape and Visual	The Landscape and Visual impact which may accrue as a result of provision of noise mitigation.
Noise and Vibration	Agricultural Property	Potential impacts to properties in terms of noise nuisance during the construction and operational phases.
Noise and Vibration	Flora, Fauna and Fisheries	Potential impacts to ecological sites in terms of exposure to dust, particulates and other emissions during the construction and operational phases.
Landscape and Visual	Flora, Fauna and Fisheries	Interaction required in terms of provision of mitigation to complement Flora, Fauna and Fisheries Chapter, e.g. connectivity and use of appropriate planting species.
Landscape and Visual	Archaeology, Architecture and Cultural Heritage	Potential for visual impacts to Archaeology, Architecture and Cultural Heritage sites in particular national monuments.
Agricultural Property	Hydrology and Hydrogeology	Potential impacts to properties in terms of pollution to ground and surface water.
Flora, Fauna and Fisheries	Hydrology and Hydrogeology	Potential impacts and mitigation requirements to maintain the existing hydrological and hydro-geological regime to rivers, lakes and groundwater dependent ecosystems.
Soils and Geology	Noise & Vibration	Potential impacts as a result of excavation of bedrock.
Soils and Geology	Air Quality	Potential impacts as a result of excavation of bedrock.
Soils and Geology	Hydrology and Hydrogeology	Potential impacts as a result of interception of groundwater flows as a result of removal of geological materials;

Section A; Human Environment

This section of the Environmental Impact Statement deals with the potential impacts of the *Proposed Road Development* on human beings.

These impacts are:

- **Socio-Economic/Community Impact** – the direct and indirect impacts of the development on the population living or working in the vicinity of the proposed development;
- **Non-Agricultural Property –** the impact of the *Proposed Road Development* on non-agricultural property which represents residential properties along the route;
- **Noise and Vibration Impacts –** the impact of noise and vibration during construction and operation of the road;
- **Air Quality and Climate Change**– the impacts of air quality and climate change (also relevant to section B) during construction and operation of the road;
- **Landscape and Visual impacts** – the impact of the development on the aesthetic aspect of the landscape and the visual obstruction and intrusion;
- **Agricultural Property -** the impact of the *Proposed Road Development* on agricultural property**;**

6 Socio Economic

6.1 Introduction

This chapter presents an assessment of the socio-economic - or community - impact of the proposed re-alignment of c. 14.71 kilometres of the N4 between Collooney Td. /Toberbride Td. south of Collooney and Cloghoge Lower Td. south of Castlebaldwin Td. in County Sligo. The socio-economic study has been prepared by Optimize.

The objective of the socio-economic study is to identify, describe and assess the impact of the *Proposed Road Development* on the social and economic functioning of the local community and the region. The assessment was undertaken in line with the *Advice Notes on Current Practice (in the preparation of an Environmental Impact Statements)* (EPA, 2003), the *EPA Guidelines on the Information to be contained in Environmental Impact Statements* (EPA, 2002) and the *NRA publication Environmental Impact Assessment of National Road Schemes - A Practical Guide* (NRA, 2008). In addition, reference is made to the guidelines provided on Community Effects in Part 8, Section 3 of the UK Department of Transport Publication Design Manual for Roads and Bridges Volume 11 (DMRB et. al. 1993, updated 2009).

The chapter assesses the impact of the proposed road on journey time and journey patterns, as well as the impacts on community severance, journey and general amenity, and the regional and local economy. The chapter is structured as follows. Firstly, the methodology by which potential impacts are assessed is introduced. Secondly, the current - or "receiving" - environment is described. These sections are followed by a description of the predicted impacts of the proposed road. Impacts within the existing corridor and along the new route are discussed together as the proposed re-alignment passes through a rural area and runs parallel to the existing N4. The impacts are considered from the perspective of a Do-something Scenario (with development) in the Opening Year of 2017 and the Design Year of 2032 compared with a Do-Nothing Scenario (without development). The anticipated impacts, their significance, proposed mitigation and residual significance (post mitigation) are summarised in appendix 6.1 (Volume 4 of this EIS). To conclude the chapter, a discussion of mitigation measures is provided followed by an assessment of the residual impacts.

6.2 Methodology

6.2.1 Appraisal method used for the assessment of impacts

6.2.1.1 Information and Data sources

The socio-economic study requires that an understanding of the existing community is built up through background research, site visits, and discussions with local people and community representatives. Specifically, in this case, data was collected by means of: -

- Primary data sources (e.g. demographic data from the Central Statistics Office);
- Design drawings of the proposed route and associated junctions provided by the design team;
- Current and projected traffic estimates produced by the Traffic Model for the *Proposed Road Development*;
- A review of secondary sources such as the National Development Plan 2007-2013, the National Spatial Strategy 2002-2020, the Sligo County Development Plan (CDP) 2011-2017, the Collooney Mini-Plan (part of the CDP), and the Regional Planning Guidelines for the Border Region 2010-2022;
- Local consultation with residents, business people, shopkeepers, schools, interest groups, community organizations, development groups, partnerships and Bus Éireann;
- Observation of local settlement and travel patterns and identification of community facilities.

The desk and field research was first undertaken in 2005, but updated in November 2009, November 2011, November 2012 and August 2013.

6.2.1.2 Impact Assessment

The assessment of the impacts of the proposed road, Do-Something Scenario, is compared with that of the Do-Minimum Scenario. It is important to understand that Do-Minimum does not exclude other confirmed or

Proposed Road Developments going ahead and impacts of the development itself will be incremental to these. A comparison is made for

(1) the Opening Year of 2017, and
(2) the Design Year of 2032

Impacts can be either negative or positive. Their significance is assigned as Imperceptible, Slight, Moderate, Major and Profound. Significance depends among other considerations on the nature of the environment affected, the duration of an impact, the probability of its occurrence and the impact on vulnerable or sensitive groups. In addition, the magnitude of an impact will be a function of:

(a) the scale of the impact itself,
(b) the numbers of people likely to be affected.

Magnitude is assessed as high, medium or low with the rationale for this assessment given in the text.

The socio-economic study generally addresses impacts at a community level rather than for individuals or identifiable properties. In the Impacts Table included in appendix 6.1 (Volume 4 of this EIS), impacts are presented as they would affect the worst hit subset of the population. This classification is clarified in relation to the approximate absolute numbers affected.

Impacts have been broadly categorised in this report under the following four headings:

- Journey characteristics: an assessment of the impact of the proposed route on journey time and travel patterns;
- Community severance: an assessment of the impact of the proposed route with regard to any severance of a community from community facilities, particularly schools, recreational facilities or community services, with an emphasis being given to facilities used by older people or other vulnerable groups;
- Amenity: An assessment of the impact on journey amenity (i.e. relative pleasantness of a journey) and on other aspects affecting general amenity or human well-being;
- Economic impacts: an evaluation of the proposed road in the context of economic prospects and employment needs and in relation to residential development and projections in the local area.

6.2.1.2.1 *Journey Characteristics*

New roads have an inevitable effect on local journey duration, journey time reliability and journey patterns for vehicle journeys, journeys by public transport, bicycle and for pedestrians. Each is discussed in turn in this chapter.

Assessment of journey times and patterns is inevitably dependent on precisely where an individual journey originates and ends, when it is undertaken (e.g. within or outside peak hours), and by whom it is undertaken, e.g. vulnerable groups. Impacts have been assessed in accordance with the significance criteria outlined in *Table 6-1*, with positive impacts resulting from a decrease, and negative impacts resulting from an increase, in journey length or duration.

Table 6-1: Criteria used in the assessment of changes in journey length or duration

Impact level	Significance criteria
Imperceptible	No appreciable change to present journeys, i.e. <10% change in typical journey length or duration.
Slight	Some inconvenience, but present journey patterns likely to be maintained, i.e. 10%-30% change in typical journey length or duration.
Moderate	Journeys becomes longer and some groups may be dissuaded from making trips, i.e. 30%-60% change in typical journey length or duration
Significant	Considerable inconvenience. Many people will be deterred from making trips, i.e. 60%-100% change in typical journey length or duration
Profound	More than 100% increase/decrease in journey length or duration sufficient to cause marked change in behaviour of a sizeable proportion of population.

Journey length refers to the distance required to be travelled for a particular journey, whilst duration is the time taken to make the journey. Average walking speed for pedestrians is taken to be 5km/hour. Average cycle speed is assumed to be between 15-20km/hour.

6.2.1.2.2 *Community Severance*

Severance is a typical impact of a road development and occurs whenever access to community facilities is impeded by the physical barrier of the road itself (e.g. traffic load or perimeter fencing), loss of direct connectivity or a significant lengthening of journey time. Severance can be defined as both relief from existing severance or as new or increased severance.

6.2.1.2.2.1 *Relief from severance*

Relief from severance is a positive impact. The UK DMRB (2009) provides a quantitative guide to the reduction in traffic volumes providing relief from severance in areas with daily traffic flows of more than 8,000 vehicles. However, this advice is not easily applied to rural roads in Ireland where traffic volumes may be less, but speeds are often higher than those occurring in urban areas. In addition, the absence of a roadside pavement from many rural roads limits the locations at which pedestrian crossings can occur. Severance can also apply to vehicle crossings of major roads or other roads where sightlines are restricted, with the effect that trips could be deterred particularly for older drivers (see also Journey Amenity). For these reasons, a greater level of traffic reduction may be required to achieve the same level of relief from severance. Consequently, the DMRB has been used as a basis for interpreting relief from severance.

Table 6-2: Criteria used in the assessment of relief from Severance

Impact level	Significance criteria
Imperceptible	<10% reduction in daily traffic levels (AADT)
Slight	10-30% reduction in traffic levels (AADT)
Moderate	31-60% reduction in traffic levels (AADT)
Major	61-80% reduction in traffic levels (AADT)
Profound	More than 80% reduction in traffic levels (AADT)

Note: See comments above for applicability

The definition of severance is not precise. It depends also on the level of use of facilities, duration of the day over which traffic conditions are experienced, and the sensitivity of the population affected. Similarly, the introduction of crossing facilities could reduce severance despite increased traffic levels.

These factors have been taken into account in providing the above definitions of impact significance. For instance, sensitive groups are identified specifically where they comprise a higher proportion of pedestrian journeys or where specific amenities are associated with these groups. Such facilities would include schools, surgeries, hospitals, churches, post offices and shops.

6.2.1.2.2.2 *New severance*

New or increased severance is a negative impact that occurs where either a new road, or increased traffic on an existing road, forms a barrier between people and community facilities. Here again, the DMRB provides definitions. These guidelines have been adapted to reflect the five significance categories used in the report.

Table 6-3: Criteria used in the assessment of new/increased Severance

Impact level	Significance criteria
Imperceptible	Journey patterns maintained
Slight	Present journey patterns likely to be maintained, albeit

Impact level	Significance criteria
	with some hindrance to movement.
Moderate	Some residents, particularly children and elderly people, are likely to encounter some severance, perhaps due to a need to access pedestrian crossings.
Major	Most residents are likely to encounter severance which, in some cases, will cause them to make less frequent use of particular community facilities.
Profound	People are likely to be deterred from making more important trips to an extent sufficient to induce a re-organisation of their habits.

It is also worth adding that where physical severance is above a particular threshold or introduces anxiety in relation to safety, an element of psychological severance can occur that deters people from making casual journeys. Social severance can follow from the restriction of people's accessibility or because communities become identified by their containment within certain road boundaries. In this chapter reference is also made to neighbourhood severance in that, while there may be no community facilities, a road may induce severance in the interaction between neighbouring households. The consequences of these impacts are difficult to measure, but are likely to be appreciated most especially by older citizens and others who are at risk of social isolation.

6.2.1.2.3 *Amenity*

The amenity or pleasantness of a journey is described in the DMRB as being concerned with:

- changes in the degree and duration of people's exposure to traffic, i.e. fear/safety, noise, dirt and air quality; and
- the impact of the road itself – primarily any visual intrusion associated with the development and its structures.

Aspects such as the level of traffic on a road, the proximity of footpaths/cycle-paths, or the nature of any crossings/junctions to be negotiated are of particular importance when assessing amenity, as are the number and types of people affected. In addition, extended journey times where these involve lengthy queuing for drivers will also have an effect on journey amenity as will hazardous crossings or manoeuvres. Changes in the amenity of a journey can also affect journey patterns which are dealt with under the heading of Journey Length and Characteristics. In the absence of official guidance by which to gauge the significance of these impacts, an explanation of the reason for allocating a particular significance level is included in the text.

Furthermore, environmental impacts affecting the pleasantness of journeys, such as pollution, noise and landscape impacts, also affect general amenity or the well-being of people living in the vicinity. So too can direct impacts on particular community facilities and recreational sites. Typically, these impacts are specifically addressed in under the headings of Noise or Visual, but they have a community dimension too in that well-being is affected with impacts on tourism also being possible.

6.2.1.2.4 *Economic Impacts*

Economic and employment impacts will occur at both regional and local levels and can be either positive or negative. These impacts are difficult to quantify, at least in the case of road development. Much road development is proposed with the intention of enhancing the business environment, particularly in relation to reducing journey time and improving journey time reliability for commercial goods or for travel and commuting by employees. However, there can also be negative impacts in relation to loss of passing trade to businesses such as newsagents, grocery stores, service stations, guest houses, etc.

'Slight' impacts are broadly defined as those to which a small effect on the business environment can be attributed to the development. 'Moderate' economic impacts are defined as those to which a somewhat greater effect on the business environment can be identified. 'Major impacts would be such as to substantially affect business performance or to influence the location decisions of new business. In that businesses require employees, there are implications for employment and for settlement patterns and residential development.

6.3 Existing Environment

6.3.1 Context

6.3.1.1 Regional Context

The N4 is one of the State's key national primary routes linking the Midlands and the East of the country with the North-west, including County Sligo, North County Leitrim and County Donegal. The road is described in the National Spatial Strategy as a National Transport Corridor connecting the Gateway City of Sligo and as being fundamental to the development potential of the Western Region.

In recent years, various investments have been made to upgrade the N4 and to enhance the connectivity of the North-west Region. These have included:

- The upgrading between 2001 and 2004 of sections of the N4 between Carrick-on-Shannon and Boyle,
- The opening in 1999 of the N4 Curlews Bypass around the edge of the Curlew Mountains between Boyle and Castlebaldwin,
- The opening of a dual carriageway in 1998 between the N17 (part of the Atlantic Corridor as described in Transport 21) at Collooney and the southern boundary of Sligo town.
- The extension of the above in 2005 as a dual carriageway inner relief road through Sligo town as far as Hughes Bridge over the River Garvogue.

In addition, the N15 connecting Sligo to Donegal has been upgraded between Bundoran and Donegal town. A bypass of Longford connecting the N4 and N5 was completed in 2012.

These improvements would leave the N4 between Castlebaldwin and Collooney as the only lengthy section of the N4/N15 National Transport Corridor between Longford town and Sligo that has not undergone significant improvement in recent years. This part of the N4 remains a clearly inferior section of road characterised by narrow stretches, sharp bends and blind summits. National, Regional and local traffic uses the same road space and there are few safe opportunities for overtaking. Vehicle tail backs often accumulate behind slow moving vehicles and the combination of the physical features of the existing road and driver frustration presents a significant road safety hazard.

At a local level too the N4 forms the only north-south link in a 15 kilometre-wide corridor between the R295 from Boyle through Ballymote and the R284 between Drumsna (south of Carrick-on-Shannon) and Sligo. Some regional traffic does use the latter secondary road in preference to the N4.

6.3.2 Demographic Profile

Both the existing road and the proposed new alignment pass through a lightly populated rural area. No large towns are directly affected, although Ballymote, Collooney and Ballysadare fall just outside the study area and Sligo town is only twelve kilometres to the north. The largest community in the road corridor is Castlebaldwin, although the core of this settlement is represented by only around 20 properties. Riverstown is a larger community situated three kilometres east of the existing road. Along the route there are small concentrations of houses at Drumfin and Lackagh, although there is much scattered housing along the length of the route and in the surrounding countryside. In recent years there has been considerable new development to the east of the existing N4 corridor, for example in and around Riverstown and in surrounding townlands such as Coolbock. By comparison, there has been relatively little new development west of the existing N4, excepting some single house construction along the local road between Castlebaldwin and Ballymote (L1404-0). In part, this is because much of the land here is low lying and wet. Most land within the corridor is given over to poor quality grazing.

Analysis of the demographic profile is based on data from the 1996, 2002, 2006 and 2011 Census of Population as published by the Central Statistics Office (CSO). The population of County Sligo rose by 7.4% to 65,393 persons by 2011 while that of Sligo town and its environs had risen by less than 1% to 19,452. However, by comparison, there was a significant increase in the population of surrounding communities in part due to tax allowances available under the former Rural Renewal Scheme on new development in these locations. The population of Collooney rose by a considerable 53% between 2006 and 2011 with large increases also recorded for Ballysadare, Ballymote and Strandhill (see *Table 6-4*). These incentives applied to the Upper Shannon Region, but were not available in Sligo Borough. Since this time, national economic conditions have led to a consolidation in the population and the replacement of net in-migration to Ireland by out-migration.

Within the road corridor area, the population of Riverstown has increased in recent years due to the appeal of its traditional village core and the surrounding attractive countryside where many fine views can be found. Of the Electoral Divisions (EDs) in the study area, the Collooney ED recorded another substantial increase in population. Significant increases have also been recorded by Drumfin after a former period of relative stability of population change. Overall, though, the area retains a light population density.

Table 6-4: Urban population change

Year and % change	Collooney	Ballysadare	Ballymote	Strandhill	Sligo & Environs
2011	1369	1344	1539	1596	19452
2006	892	971	1229	1413	19402
2002	619	853	981	1002	19735
1996	573	612	994	764	18509
% change 2006-2011	53.5%	38.4%	25.2%	13.0%	0.03%
% change 2002-2006	44.1%	13.8%	25.3%	41.0%	-2.0%
% change 1996-2002	8.0%	39.4%	-1.3%	31.2%	5.7%

Table 6-5: Local Population – Electoral Divisions

Year and % change	Collooney	Lisconny	Drumfin	Riverstown	Lakeview (Castlebaldwin)	Temple-vanny	Bricklieve	State (millions)
2011	2543	422	414	732	474	245	238	4,581
2006	1745	401	339	638	391	240	234	4.240.
2002	1255	367	338	562	366	221	216	3.917
1996	1107	383	300	553	331	217	214	3.626
% change 2006-2011	45.7%	5.2%	22.1%	14.7%	21.2%	2.1%	1.7%	8.1%
% change 2002-2006	39.8%	9.3%	0.3%	13.5%	8.5%	8.6%	8.3%	8.2%
% change 1996-2002	13.4%	-4.2%	12.7%	1.6%	10.6%	1.8%	1.0%	8.0%

Table 6-6: Housing Stock

Year and % change	Collooney	Lisconny	Drumfin	Riverstown	Lakeview (Castlebaldwin)	Templevanny	Bricklieve	State ('000s)
2011	1458	147	182	326	222	91	89	1,995

6.3.3 Community Facilities

There are a limited number of community facilities in the area. The main centre in this respect is Riverstown which possesses two churches, a community centre and Folk Park, a post office, a Garda station, a national school (Ardkeeran), a crèche, a motor workshop, pub and shops. Outside of Riverstown there are national schools at Coolbock, Doobeg (Knockmina) and Castlebaldwin (Cloghoge) and a post-primary school at Coola north of Riverstown off the R284. The school at Castlebaldwin is located two hundred metres west of the N4, although some children are brought to school by car or school bus from east of the N4. On the main road in Castlebaldwin there is a small grocery shop, a motor workshop, a pub (which provides lunches/dinners for

drivers on the N4) and a prominent service station along with an associated grocery store. In recent years a Supermacs restaurant has been added to this enterprise. However, the car dealership and tyre shop has now closed. The village also possesses a small furniture plant and a well-known restaurant. There is a chapel at Sheerevagh east of Castlebaldwin and another church at Doobeg on the road between Drumfin and Ballymote, three kilometres west of the N4.

In the north of the study area, a HSE centre for learning disability now occupies the former Passionist Monastery at Cloonamahan one kilometre west of the N4 with an entrance off the existing road. Just to the north there is a temporal facility for the Traveller Community beside Toberscanavan Lough. Approaching Collooney, Toberbride Business Park is connected to the Toberbride roundabout from the east. The site includes an indoor children's play centre and a gym

Collooney is the main town serving the study area and has a typical range of shops and community facilities. A variety of car and furniture show rooms and warehouses have been constructed in recent years in the vicinity of the N4 north of the Collooney/Toberbride junction with the N17. The nearby Markree Castle, east of the N4, is a well established hotel and restaurant, popular for weddings and offers both horse riding and angling on the River Unshin which runs through the demesne. Sligo, to the north, is the main retail and social destination for people living in the study area and also contains the county offices, a major hospital and an Institute of Technology. A sizeable proportion of local people also commute from the study area to Sligo for work or college.

In terms of amenity and tourism, the N4 provides an attractive vista for journeys north of the county border from the Curlew Mountains. From here the landscape opens out with views across Lough Arrow to Slieve Dargan north-east of Collooney. This vista provides the first impression of County Sligo for visitors arriving on the road. Attractive views are maintained throughout the study area.

Of specific locations, the main destinations include the beach at Strandhill. In addition, there is walking to be had on the southern side of Lough Gill and on the Sligo Way which runs below Slieve Dargan and into Collooney. The Folk Park at Riverstown hosts regular cultural events and a popular annual fair. There are stables at Toberbride near Collooney. The Beara-Breifne Way Historical Trail cuts through Castlebaldwin, Carrowkeel and the Bricklieve Mountains before heading down the eastern edge of the Curlew Mountains towards Boyle and Lough Key and forms part of the newly designated 500km Beara-Breifne Way and this could encourage more use of the trail in Castlebaldwin.

Lough Key is a major amenity destination for day trips all year around and for summer camping. The lough itself, Lough Gill, Lough Arrow, Lough Toberscanavan and Lough Bo are also popular with anglers. Lough Arrow and Lough Bo are accessible from Castlebaldwin. Lough Arrow can be accessed at various points including from a slipway just off the N4 four kilometres to the south of Castlebaldwin. Lough Bo is located seven kilometres to the east via local roads. Clay pigeon shooting is also available here.

The region is rich in archaeological remains. These include the Carrowkeel Megalithic Cemetery (National Monument). The complex is accessible from Castlebaldwin and receives modest numbers of visitors every week. There are tentative plans for visitor facilities. To the east of Castlebaldwin there is a cairn near Heapstown that is believed to be associated with Carrowkeel. The ruins of Ballindoon Abbey are located nearby on the east bank of Lough Arrow. Ruins of fortified houses are visible from the road just south of Castlebaldwin (National Monument) and at Behy Bridge.

Accommodation in the immediate area is limited to a small number of bed and breakfasts or guest houses, but there is also a well-known hotel and restaurant, the Cromleach Lodge Hotel, at Carrickglass on the eastern edge of Lough Arrow together with a nearby independent hostel. The Cleavry Mill Restaurant is located in Castlebaldwin.

6.3.4 Current traffic conditions and severance

The N4 in the study area carries a significant volume of traffic. Journey times can vary due to the mixture of national, regional and local traffic, their differing speeds and a lack of safe overtaking opportunities. These factors combined with the narrow width of much of the road means that journey times would be sensitive to changes in traffic volumes.

Amongst the local population there is a high car dependency as indicated below in Table 6-7. Indeed, comparison with Table 6-8 for 2006 shows that this reliance on motor vehicle transport has increased in the last six years. In part this change will have been due to new residents, a high proportion of whom are working

outside of the immediate area. However, the figures do reveal a sizable reduction in bus use. Table 6-9 shows that a high proportion of people have two cars, although many people in Collooney, Riverstown and Lakeview are restricted to one car. Car sharing, and the proximity of local workplaces and community facilities (e.g. schools), help to explain the relatively lower proportion of households in these three communities with no private transport or just one car. However, a sizeable number of people have no access to private transport despite the rural location, although the proportional figure has fallen in recent years probably as a result of the effect of new residents on the average (e.g. in Collooney to 11% from 16%).

As regards alternative modes of transport, the nearest railway station is at Ballymote. There is a bus service in the form of the national Bus Eireann Expressway service on the N4 and regular connections between Collooney and Sligo. Bus Eireann services run between Boyle and Collooney at least four times daily with three services allowing passengers to alight at Castlebaldwin or Drumfin. There is a twice weekly service (No. 471) between Sligo stopping at Riverstown and Castlebaldwin on Thursday and Fridays. Local school services use sections of the N4 running between Castlebaldwin and Riverstown serving local schools and the secondary school in Ballymote. A local community organisation, the Community of Lough Arrow Social Project (CLASP) provides a community transport service for isolated households and elderly people. The service provides a connection with various destinations including Sligo on Thursdays.

Table 6-10 indicates that the journey time category into which the highest proportion of local people fall is that of ¼ to ½ an hour which would often be characterised by journeys to south and central Sligo town or to Boyle.

Table 6-7: Travel mode for journeys to work, school and college (percent of stated total) 2011

DED	Walk	Bicycle	Bus	Motor vehicle	Other
Collooney	6.4%	negligible.	5.5%	84.1%	3.0%
Lisconny	3.5%	negligible.	10.3%	78.6%	6.2%
Drumfin	2.5%	0	13.2%	77.4%	6.8%
Riverstown	7.7%	negligible.	5.1%	82.4%	4.2%
Lakeview	8.8%	0	11.8%	72.4%	7.6%
Templevanny	2.8%	0	16.0%	61.8%	19.4%
Bricklieve	3.5%	1.4%	21.3%	66.7%	7.0%

Source: Central Statistics Office

Table 6-8: Travel mode for journeys to work, school and college (percent of stated total) 2006

DED	Walk	Bicycle	Bus	Motor vehicle	Other
Collooney	8.9%	0.1%	10.5%	69.8%	10.7%
Lisconny	4.3%	0	14.0%	69.4%	12.3%
Drumfin	2.5%	0	18.9%	60.5%	18.1%
Riverstown	9.5%	0.5%	12.1%	61.9%	16.1%
Lakeview	5.8%	0	12.3%	64.0%	18.1%
Templevanny	0.1%	0	12.6%	65.7%	21.0%
Bricklieve	1.2%	0	20.4%	59.3%	18.6%

Source: Central Statistics Office

Table 6-9: Number of private vehicles per household

DED	none	one	two	> two
Collooney	10.8%	43.1%	39.0%	7.1%
Lisconny	5.8%	32.5%	48.3%	13.3%
Drumfin	7.5%	31.7%	51.0%	9.7%
Riverstown	13.8%	39.3%	36.7%	10.2%
Lakeview	10.7%	33.3%	45.8%	10.2%
Templevanny	9.9%	44.0%	41.8%	4.4%
Bricklieve	12.5%	42.0%	37.5%	1.1%

Source: Central Statistics Office

Table 6-10: Journey times to work, school and college (percent where stated)

DED	< ¼ hour	¼ - ½ hour	½ - ¾ hour	¾ - 1 hour	1 - 1½ hours	> 1½ hours
Collooney	41.9%	42.7%	9.7%	1.6%	2.3%	1.8%
Lisconny	37.4%	47.8%	11.7%	neg.	2.1%	negligible
Drumfin	26.7%	46.4%	17.6%	1.7%	3.8%	3.8%
Riverstown	38.5%	37.7%	19.4%	1.1%	2.5%	negligible
Lakeview	29.4%	38.3%	19.0%	8.5%	2.4%	2.4%
Templevanny	29.1%	29.1%	29.9%	4.8%	2.2%	5.2%
Bricklieve	31.0%	24.3%	25.4%	6.0%	2.2%	1.5%

Source: Central Statistics Office

Heavy traffic, combined with hazardous crossings from side roads, is a cause of poor journey amenity on the N4. The perceived hazard applies to all drivers, but particularly to older drivers and to school children or others alighting from buses. For example, local road L1401-0 from Drumfin to Riverstown carries a reasonably high amount of traffic (approx 1600 AADT) and its junction with the N4 is preceded by on-road warnings. Nevertheless, the junction has been the site of various accidents.

Journey amenity is poor for both national and regional traffic. The N4 passes through pleasant countryside, particularly around Tawnagh, but there is presently little opportunity for drivers to appreciate the surroundings due to the narrowness of the road, high traffic speeds and the volume of traffic. Safe overtaking opportunities are very limited and add to driver anxiety. Between Doorly and Drumderry (just north of Castlebaldwin) there is no hard shoulder and the road is only wide enough for one line of vehicles travelling in each direction. Drivers who choose to overtake may have no alternative but to attempt to squeeze back into the existing line of vehicles. However, the formerly sharp bend between Ardloy and Ardloy Bridge has been avoided by a recent realignment and widening of the road at this point.

Accident data available from the Road Safety Authority for 2005 to 2011 for the relevant length of the N4 lists two fatal accidents in 2008, one fatal accident in 2009, one fatal accident in 2010 and two serious accidents plus twenty three reported minor accidents since 2005. Earlier data recorded by Sligo County Council on the basis of accident report forms supplied by An Garda Síochána shows a similar pattern for the years 1996-2004. Fuller details are provided in Section 1.5.5 of this EIS. Fatal accidents have also occurred more recently. Causal data is not available in all cases, but at least four of these accidents involved overtaking and four involved right hand turns. The level of accidents is of concern locally and an action group has been set up to highlight safety concerns. Rest facilities are currently confined to an undeveloped view point of Lough Arrow and a viewpoint above Lough Key (both to the south). Neither of these has facilities such as toilets or refreshments.

Cycle journeys are subject to poor amenity given the close proximity of traffic. Sections of the road are so narrow that vehicles may have to slow to a few kilometres per hour behind cyclists until an opportunity to pass

safely arises. As a result of the very poor journey amenity, the road is avoided by cycling clubs and local cycle journeys are few (refer, for example, to *Table 6-7*). Pedestrian traffic, with the exception of that to or from bus stops, is virtually non-existent along most sections.

Inevitably, the heavy traffic is a cause of community severance, for instance in Castlebaldwin where an impact occurs despite traffic calming and a pavement footpath along the western side of the road. Only one house is currently located on the east side of the N4, but there is a small nucleus of properties just one kilometre to the east around Sheerevagh. Children tend not to cross the road unaccompanied, but parents do drive across the N4 to bring their children to the local school.

Elsewhere along the N4 between Cloonamahan /Ardcurley and Cloghoge Lower, the small number of community facilities within the corridor of the existing N4 means that severance is restricted mainly to crossings of the road and to interaction between individual householders living along the road. Nevertheless, the narrowness of the road exerts significant social severance and tangible community severance for individual properties fronting the road. There are a sizeable number of properties along the N4 in the study area (over 50 with a further 20 or more set back from the road) with small concentrations at Lackagh, Drumfin, Carrownagark and Tawnagh. Severance is imposed on pedestrian crossings of the road, but also between properties on the same side of the road. In addition, there are hazards for vehicle crossings of the road from side roads, for example at Doorly, Drumfin, Carrowkeel (Behy) and Carrownagark.

6.3.5 Economic functions

The N4 itself is a vital communication and economic link between the East and North-west of the country, including some of the more peripheral counties of the state. The main economic activity in the immediate study area is farming, namely beef cattle, suckle production and some intensive dairy. Much of the land is of marginal quality and is poorly drained, but there are good fertile soils to the east of the road corridor. Riverstown is a local economic centre, but the main centres are Boyle to the south, Collooney to the north and Sligo. Within the corridor there are various small enterprises, including the aforementioned service station, car dealers and convenience restaurant, as well as a more formal restaurant, a bed and breakfast, a tractor part and repair garage, a motor repair garage, an art gallery and a furniture company. The Toberbride Business Park includes a windows business, a headstones company, an indoor children's play centre and a gym. Several commercial units are currently unoccupied. Of these, the service station/car dealer/restaurant, art gallery and B&B are highly dependent on passing trade or familiarity due to the road.

6.4 Description of Likely Impacts

6.4.1 Introduction

The proposed re-alignment of the N4 represents one of a number of improvements of the N4 between Dublin and Sligo. The new alignment will replace an existing narrow section of road which includes a number of hazardous bends and blind summits. Overtaking is unadvisable along much of the existing road. The *Proposed Road Development* will involve the provision of a Type 2 Dual Carriageway between the townlands of Collooney/Toberbride and Castlebaldwin along with a Standard Single Carriageway that will tie into the existing national primary network south of Castlebaldwin. The existing N4/N17 roundabout will provide the commencement point for the *Proposed Road Development* at Collooney/Toberbride with a second roundabout in the townland of Castlebaldwin to facilitate the change in cross section. A junction at the *Proposed Road Development* mid-point will provide a connection with the L1502-32 Ballymote road.

As a consequence of the *Proposed Road Development* both safety and traffic flow will be improved. From its northern terminus, the *Proposed Road Development* will involve a realignment of the N4 that will run parallel and to the west of the existing N4 until just north of Ardloy. At this point, the new alignment would cross the existing road, but continue to run parallel to existing road to the east as far as the tie-in with the existing N4 just south of Castlebaldwin.

The road passes through a largely rural area. Through traffic, including HGVs, will be diverted from the existing N4 allowing this road to carry slower moving local traffic. There will be significant positive impacts in relation to reduced road hazard and traffic flow as well as a positive impact on general amenity and relief from neighbourhood severance for properties along the existing road. On the negative side, there will be some adverse impacts on passing trade for some existing businesses.

6.4.2 Construction

Information relating to construction activities is provided in section 4.10 of Chapter 4 (of this EIS) which expands upon items such as:

- Programme & Contract;
- Earthworks materials, volumes and management considerations;
- Construction & Demolition Waste Management Plan;
- Construction Compounds;
- Temporary Access and Construction Traffic;
- Temporary Road Diversions;
- Employment;
- Construction Works;
- Construction Stage Water Quality Considerations; and
- Monitoring of Environmental Commitments.

Site access for construction traffic will be provided from the existing N4 at Doorly, Ardloy and Castlebaldwin. Use of local roads will be restricted to necessary activities at these locations, for instance the construction of bridges. The impact of construction traffic on residential properties in the study area is restricted by the fact that few properties are located beside the route of *Proposed Road Development*. Impacts on general amenity due to noise, visual or light may occur in the vicinity of overbridge construction, but are specifically dealt with in the relevant chapters of the assessment. Slight impacts on journey amenity are likely where short diversions are necessary, for example at the cul-de-sac at Knocknagroagh along which there are several private residences. To minimise disruption, a traffic management plan will be prepared. Access arrangements and mitigation measures on individual Non-Agricultural Properties are provided in Chapter 7 of this EIS.

6.4.3 Journey Patterns

Under a Medium Growth scenario in the design year the traffic model predicts increases in AADT for the mid-section of the *Proposed Road Development* of 3.8% in the Opening Year of 2017 compared with the existing N4 under a Do-Minimum scenario or 3.3% in the Design Year of 2032. Compared with the Do-Something Scenario [50] traffic on the northern section of the existing N4 will be reduced by 80% under the Medium Growth Do-Something Scenario in the Design Year compared with the Do-Minimum scenario and on the southern section of the road below Carrownagark by over 97% compared with the Do-Minimum.

Current journey times are of the order of c. 11-12 minutes in either direction (see Chapter 4 of this EIS). The proposed re-alignment would have the effect of reducing journey times and improving journey time reliability on the N4. The impact would extend to regional journeys in that current journey times are often extended by the combination of local and through traffic and by a lack of safe overtaking opportunities. These benefits to journey patterns will increase over time once the economy recovers and should the long-term trend to increased traffic volumes resume. On the basis of current traffic volumes, the *Proposed Road Development* will result in a *slight positive* impact for regional journey times in the Opening Year. This positive impact will increase over time relative to a Do-Nothing Scenario and represents a cumulative impact in combination with road improvements elsewhere on the N4. There will be a *slight positive* impact on journey time reliability too particularly for shorter trips between, for example, Sligo and Boyle.

6.4.3.1 Local journeys

The northern end of the *Proposed Road Development* connects directly with the horizontal line of the existing road between Cloonamahan and Toberbride. Local traffic using the existing N4 to the south will connect with a parallel road (Eastern Parallel Link) which would connect with the eastern entrance of the existing N4/N17 roundabout at Collooney/Toberbride. This road will also collect traffic from the scattered community of Lisconny. In addition, an underpass at Doorly will provide access to the parallel road for the HSE facility and a farm on the west side of the *Proposed Road Development*. This underpass will also provide access to the local roads at Cloonamahan and Carrigeensallagh (via the Western Parallel Link). Traffic heading north from these roads will have the option of heading west to join the N17 or of diverting south to connect with the Eastern Parallel Link via the underpass (a slight negative impact for around six properties for journeys towards Sligo)

[50] Comparing Link No. 24 (*Proposed Road Development*) and No 23 (existing N4) as given in the Traffic Modeling Report.

At the southern end of the *Proposed Road Development* northbound traffic will be able to directly join the new alignment via the tie-in with the existing N4. Traffic from the existing N4, or local traffic from Castlebaldwin and Bellarush, will be able to join the new alignment via a short connecting road and roundabout junction in the townland of Castlebaldwin (c. Ch 13,630m). The existing local road (L1404-0) will be severed, but provided with a connection to the new alignment and to Castlebaldwin at the roundabout junction via a short realignment involving no significant change in journey patterns.

Elsewhere, there will be only one opportunity to join the new alignment at the proposed Compact Grade Separated Junction with the L1502-32. Traffic from Ballymote will also be able to avail of this junction, although most journeys north from Ballymote are likely to continue on the R293 unless originating from rural locations to the east on the L1502-32. The *Proposed Road Development* is predicted to lead to a small increase in traffic of 20% to 2,100 AADT on this road (L1502-32) under the Medium Growth scenario in the design year of 2032 due to the convenience of the proposed junction. There will be a corresponding reduction of nearly 36.4% on the L1404-0 from Castlebaldwin to Ballymote.

Drivers arriving at Drumfin crossroads from the direction of Riverstown will have the option of heading 800 metres south to join the L1502-32 and the new alignment or continuing north on the existing N4 to the new Toberbride (East) Junction which will in turn connect to the existing N4/N17 roundabout (and vice-versa for journeys in the reverse direction). In the former case, the total diversion of 1,600 metres for northbound journeys represents, at worst, a *slight negative* impact for journeys from Riverstown to Collooney or Sligo. Northbound journeys originating in the scattered community of Branchfield to the west will have the same option or of using the existing local road to Cloonamahan (the L3606-9 via the L5501-0). The latter is likely to be the usual choice.

Other local roads cross the new alignment using over or underpasses. Consequently, much local traffic will continue to use the existing N4 with the essential difference that traffic levels on the road will be significantly less due to the transference of national or regional through traffic to the new alignment. For most local traffic this will involve a *slight positive* impact on local journey time.

Should regional bus services continue to use the existing road, journey time savings in comparison with current journeys will be *imperceptible* while there will be a *slight positive* impact on journey time reliability. There are no additional significant journey time impacts in relation to pedestrian or bicycle journeys. Rather, impacts relate more to journey amenity (see below).

6.4.4 Community Severance

There are no community facilities directly along the length of the existing N4 between the northern and southern tie-ins with the exception of the facilities in Castlebaldwin. There are schools and other facilities located a short distance from the N4 as noted above, including facilities in Riverstown and the school at nearby Cool bock. Traffic will be able to continue to access these facilities using the existing road or via overbridges forming part of the *Proposed Road Development*. Knockmina National School at Knockmoynagh is located a short distance from the L1502-32. St. Joseph's Church is located on the same local road but on the opposite side of the crossroad junction with the L1502-32. The small volume of additional traffic on the L1502-32 will not be of such magnitude as to have a significant severance impact on these facilities or on any cycle journeys that are made to the school from north of the crossroads here. For the same reason, there will not be any significant severance affecting use of the small New Kilmorgan Cemetery which is located beside the L1502-32 to the east of the above crossroads, although occasional funerals could involve delays for traffic accessing the proposed junction from the direction of Ballymote.

There are scattered single dwellings throughout the study area, but most individual properties are located on the existing N4 or to the east of the new alignment north of Ardloy. The *Proposed Road Development* presents no new severance impact on dwellings within the corridor, but the improvement in safety for pedestrians and cyclists due to the transference of most traffic from the N4 will lead to moderate positive relief from neighbourhood severance, i.e. interaction between individual households.

The L55016-0, a cul-de-sac in the vicinity of Lackagh, will be severed at approximately Ch.4060m, but be replaced with a new alignment and overbridge just to the north without a significant severance impact. The L54033-0 which serves some individual houses beside Aghalenane Lough will be realigned without significant impact.

The L54041-0 north of Castlebaldwin will be severed, but alternative access to the existing N4 is available via the L5404-0 to Castlebaldwin. This road connects with the L1404-0 which will also be severed, but provided with a link road to the Castlebaldwin Junction. The L1404-0 is followed by the Historical Trail and is also used by small numbers of pedestrian and cyclists to access community facilities in Castlebaldwin and possibly the chapel at Sheerevagh. A *slight negative* impact will arise without mitigation.

Bus Eireann currently has no plans to alter services due to the presence of a new alignment. However, there are no nucleated communities within the corridor of the existing road with the exception of Castlebaldwin. As such, there could be a temptation to allow some regional services to benefit from the new alignment. Were this to occur, negative severance issues could arise in relation to access to important community facilities, for instance in Boyle or Sligo.

6.4.5 Journey Amenity and General Amenity

6.4.5.1 Journey amenity

There will be *major positive* journey amenity impacts for all users of the new road alignment due to safer overtaking opportunities afforded by the new alignment particularly as most of the *Proposed Road Development* will involve a dual-carriageway design. Users of both the new alignment and the existing N4 will be able to drive at a speed with which they are comfortable without accumulating tail backs or feeling obliged to travel at higher speeds. A positive impact will also apply to local traffic remaining on the existing N4. The transfer of traffic to the *Proposed Road Development* will permit a reduction in speed limits on the existing N4 and allow for safer overtaking, exits and crossings. The impact is of *major positive* significance, but is moderated in some locations due to residual traffic and the continued existence of junctions with local access roads. Specifically, the impacts is reduced to *moderate positive* north of the existing N4's junction with the L5502-0/L1401-0 (Riverstown Road) from which additional vehicles join the N4. A particular positive journey amenity impact of high magnitude applies to the L5502-0/L1401-0 which forms the main access for Riverstown and which has been the location of accidents in the past. Similarly, a positive impact results from the reduced hazard associated with crossings or right hand turns onto the existing N4 from the L1302-0 at Doorly townland where sightlines are rather restricted. A *major positive* impact, albeit of low magnitude, applies to a minor access road from Carrowkeel (south of Behy Bridge) which joins the road just below a blind summit. A *moderate positive* impact also applies to the local road from Tawnagh at Ardloy Bridge, although the volume of traffic on this road is light. As noted under the section on severance, the benefits of the transference of through traffic from these local junctions will apply especially to older drivers or others who could have an elevated sense of anxiety when crossing or turning off the existing N4. In addition, there is a significant positive impact for at least two school buses that cross the existing N4 at the Drumfin crossroads.

At the Drumfin crossroads, northbound road users from Riverstown will have the choice of continuing north to Toberbride or a connection with the *Proposed Road Development* via a detour south to the proposed junction with the L1502-32. It is likely that a proportion of this traffic will continue to use the existing N4 to the north as an alternative to travelling 800 metres south along the existing N4 to join the L1502-32 and the junction. In doing so, motorists will experience a net *moderate positive* impact as above due to the transference of through traffic from the busy crossroads.

For cyclists, the perceived and real hazard associated with journeys on the existing N4 will be significantly reduced, providing a *major positive* impact for this user group. Although the magnitude of this impact will be modest in the Opening Year given the low volume of cycle traffic, it is likely to rise over time as the improved journey amenity stimulates more cycle traffic including for local journeys and amenity. Signage can be used to direct cyclists to use the existing road in accordance with NRA design standards. In addition, the proposed Eastern Parallel Link from the existing N4 and L1302-0 at Lisconny to the Toberbride junction will further enhance the predicted positive impact. A *slight negative* journey amenity impact will apply to the L1502-32 junction for Ballymote prior to mitigation, although the magnitude of the impact is low due to the very low level of cycle traffic.

As noted earlier, there is currently virtually no pedestrian activity along or across the existing N4 due to the proximity of fast moving traffic and HGVs. The transference of traffic to the new alignment will encourage more pedestrian journeys. Pedestrian crossings of the existing N4 by bus passengers, including school children, will be considerably safer, providing a *moderate positive* impact.

Landscape impacts are addressed in Chapter 10 of the EIS. There is potential for the existing N4 to the north of the southern tie-in at Castlebaldwin to contribute to the journey experience of tourists and cyclists given the attractiveness of the countryside through which the road passes. Reed-fringed lakes and castle ruins are visible along the route and tourist centres such as Riverstown and Carrowkeel are located nearby. The *Proposed Road Development* will pass beside the small Aghalenane Lough at Ardloy, but traffic on the existing N4 at the location will be much reduced as it will at Loughymeenaghan from which the *Proposed Road Development* is more distant.

There will be a *slight positive* journey amenity impact on the Castlebaldwin to Ballymote local road (L1404-0) due to the 36% reduction in traffic on this road which is characterised by numerous bends. Positive journey amenity impacts arise for all users of the R295 between Ballymote and Boyle as the *Proposed Road Development* will provide an alternative to the existing road which is vulnerable to winter weather where it crosses the Curlew Mountains.

6.4.5.2 General amenity

The reduction in traffic volumes predicted for the existing N4 due to the transference of most traffic to the new alignment will lead to a significant improvement in the amenity of people living alongside the road. This positive impact will follow from reductions in the environmental intrusion of nearby traffic including reduced noise and vibration as well as the interaction with relief from neighbourhood severance. Several properties located within 100m of the new alignment could, however, incur additional environmental impacts. Such impacts could apply at locations such as Doorly, Knocknagroagh, Carrownagark, Aghalenane, Ardloy and Sheerevagh. For the specifics and significance of these impacts refer to the Noise and Vibration Impact Assessment Chapter.

A dual amenity impact arises for the Beara-Breifne Historical Trail which runs through Castlebaldwin. The L1404-0 will be bisected by the *Proposed Road Development* with directions to an uncontrolled pedestrian crossing on the north side of the new junction. In itself, this represents a *moderate negative* impact of low magnitude. However, only farm traffic will remain on the L1404-0 and crossings of the existing N4 will be safer noting the existing traffic calming. On balance, therefore, the impact is *slight negative*, but can be further reduced with mitigation. A circular walking opportunity will arise between the Historical Trail and the L-1404-0 (east and west of the *Proposed Road Development*), albeit with a short stretch being on the local road.

Elsewhere there could be positive impacts for small lakes beside the existing N4 such as Loughymeenaghan Lough where there is occasional angling. However, there will be an adverse impact on amenity use of wetlands and woodlands including those used by the Teeling and District Gun Club. The area west of the existing N4 is one of the club's principal destinations.

6.4.5.3 Tourism

The N4 is one of the major routes used by tourists to access the North-west. The *Proposed Road Development* will continue to provide attractive views and these can be enhanced by the mitigation listed in the Landscape and Visual Impact Assessment. There is also potential to encourage use of the existing road as a leisure route for cyclists and tourists travelling by car. The location of tourism centres such as Carrowkeel, Riverstown and Ballymote should be indicated by roadside signage in line with NRA guidelines. These considerations will help to maintain an economic stimulus to the local area and reduce the impact of any loss of passing trade on roadside businesses.

6.4.6 Economic implications

It itself, the new alignment provides only slightly improved journey times and journey time reliability although these benefits will accumulate over time in comparison with the Do-Nothing Scenario. Nevertheless, there are *major positive* economic impacts in this respect due the cumulative effect of the improved road connection given similar improvements elsewhere on the N4. An economic stimulus would result from this improved connectivity especially for businesses dependent on the N4 for communication and deliveries between the North-west and the Midlands and East of the country.

At a local level, there are relatively few local businesses with a dependence on timely transportation. There is a furniture business in Castlebaldwin and a Connaght Gold store in Riverstown. These businesses will benefit from the improved connectivity, but others could suffer a loss of passing trade. Five businesses will be adversely affected to a significant degree, but at a wider community level the net economic impact will still be

positive. However, the negative impact for the individual businesses ranges from *moderate* to *major negative* before mitigation. The service station, convenience restaurant and restaurant/pub in Castlebaldwin will be impacted by loss of passing trade given that the businesses will be barely visible from the proposed road. The negative impact would, be mitigated slightly by the fact that the businesses are well-known to regular users of the road and the service station represents the only such facility on the N4 between Collooney and Carrick-on-Shannon (although familiarity with the business could reduce over time). Limited car parking and access to the proposed landscaped mitigation site could encourage drivers to rest and avail of the grocery or restaurant facilities offered by businesses here.

A loss of passing trade would also apply to a bed and breakfast near Lackagh and to the art gallery at Tawnagh. The loss of passing trade for these businesses could, individually, amount to a *major negative* impact especially given the distance of the businesses from the tie-ins with the new alignment and despite the proximity of the junction with the L1502-32. Some mitigation could be achieved from the use of the existing road by tourist traffic.

6.4.7 Cumulative impacts

There are major positive cumulative impacts with other road improvements on the N4 due to journey time, reliability and economic impacts extending to the North-west through the enhanced connectivity of the region.

6.4.8 Interactions with non-community impacts

The assessment has considered all interactions with impacts noted by other disciplines. There are indirect impacts with natural heritage (wildlife, angling and sport shooting) and with hydrology (wells). There are also indirect impacts with landscape and cultural heritage through the opportunity to advance amenity and develop tourism through information or signage. The new alignment passes through a largely unoccupied area, although interactions occur in relation to noise due to the proximity of the new alignment to some properties. There are potential noise and visual impacts at small lakes that may occasionally be used for angling, although the overall impact is likely to be positive.

6.4.9 Do-Nothing Scenario

A Do-Minimum scenario will involve a significant increase in traffic on the N4 which would become vulnerable to longer tail backs. Some traffic could be tempted to use the R284 from Drumsna in Co. Leitrim with the effect of increasing existing adverse impacts on this road. The quality of the existing road is clearly inadequate especially now that improvements have occurred to other sections of the N4. As such it would be placing Sligo, South Donegal and North Leitrim at an economic disadvantage compared with other parts of the country that are better connected.

In addition, the narrowness and alignment of the existing road is a safety hazard. This hazard risk would increase further as the volume of traffic grows over time. The well-being of people living beside the road would deteriorate due to both this hazard and environmental impacts.

6.5 Mitigation Measures & Environmental Commitments

To ensure that the net social and economic benefits of the new alignment are maximised, the following mitigation is proposed:

- Encourage construction traffic to use new alignment where possible;
- Provide footpath (slightly elevated above road surface) and cyclepath (on the southern side of the link between Castlebaldwin village and the roundabout) at Castlebaldwin Junction (roundabout) with the realigned L1404-0;
- Use signage to direct walkers to crossing at Castlebaldwin Junction where the *Proposed Road Development* severs the L1404-0 and Historical Trail;
- Provide signage at Castlebaldwin and Toberbride junctions to encourage cyclists to use the existing road as an alternative to the new alignment in accordance with the provisions of the NRA DMRB;
- Provide tourism signage in line with NRA guidelines at Castlebaldwin Junction including for Carrowkeel Megalithic Complex;
- Provide services signage to encourage use of petrol, retail and food facilities in Castlebaldwin;
- Provide limited car parking for vehicles together with tourism information (for Carrowkeel, Castlebaldwin Fortified House, the Historical Trail and other local facilities) at the proposed

landscaped mitigation area in Castlebaldwin as described in the Landscape and Visual Impact Assessment Chapter (See Fig. 10.1.8);
- Allow for access to the landscaped area. See also mitigation proposed in the Landscape and Visual Impact Assessment Chapter.

6.6 Residual Impacts

Residual Impacts following the implementation of mitigation measures generally remain at imperceptible levels with the exception of a slight negative impact in respect to general amenity for anglers or gun clubs at lakes in the vicinity of the alignment and a slight to moderate impact for loss of passing trade for some properties along the existing N4.

An overview of pre and post mitigation impacts is provided in Appendix 6.1 contained with Volume 4 of this EIS.

6.7 Relevant Figures

6.7.1 Figures contained in Volume 3

The following figures have been produced as part of other chapters of the EIS and are relevant to the text within this Chapter:

Fig. 10.1.1 to 10.1.8: Landscape and Visual Impact Assessment;

6.8 Relevant Appendices

6.8.1 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 6.1.: Socio Economic Impact Summary;

7 Non-Agricultural Property

7.1 Introduction

This chapter details the impact of the *Proposed Road Development* on non–agricultural properties, referred to hereafter within this chapter as properties. The N4 Collooney to Castlebaldwin Realignment will involve the acquisition of part, or all of a number of Non Agricultural, Commercial and Residential properties or their gardens.

The impact of the *Proposed Road Development* on non-agricultural properties is addressed under the following headings:

- Residential property;
- Miscellaneous property:- property which is not classified as Agricultural, Residential, Commercial or Recreational.
- Commercial or Recreational property

The *Proposed Road Development* will directly impact on 26 residential properties, 13 miscellaneous properties and 2 Commercial properties. One of the commercial properties is located in Toberbride Business Park and consists of a retail unit which will be impacted upon in terms of its car parking area and access road, the second commercial property is a former Public House located in Lackagh. There are no Recreational properties directly affected by the *Proposed Road Development*. Philip Farrelly & Co. carried out the assessment in August 2013.

The study is limited to the assessment of direct impacts on properties (i.e. where there is land take on a property). Indirect impacts, such as visual, noise and vibration, are dealt with in other sections of this EIS.

The impact of the *Proposed Road Development* on agricultural properties is dealt with in Chapter 11 Agricultural Properties of this EIS.

7.2 Methodology

The assessment is based on a desktop study, landowner consultation and roadside surveys. The desktop study included a review of information consisting of landownership and mapping information which included the design mapping. The desktop survey identified those properties where the property impact was deemed to be potentially significant and required landowner consultation. Where the impact on the property consisted of public road only or where the impact is such that the impact is not likely to be significant, landowner consultation was deemed not to be required.

Of the thirty six properties directly impacted by the *Proposed Road Development*, fourteen properties were identified as requiring landowner consultation. The property survey involved consultation with landowners and a walkover survey of the affected properties. Consultation consisted of the completion of a detailed property survey of each property.

The impact of the *Proposed Road Development* on properties was determined in consideration of the following:

- Acquisition of buildings;
- Landtake;
- Severance;
- Type of property;
- Impact on access;
- Boundary impact;

The significance of effects of the *Proposed Road Development* on property is assessed using the criteria presented in Table 7-1 based on:

- *Advice notes on current practice in the preparation of Environmental Impact Statements (EPA, 2003)*; and
- *Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002)*.

There are no specific guidelines available for impact assessment of property. As a result, the criteria in Table 7-1 that define the corresponding impacts for this chapter have been prepared by Philip Farrelly & Co.

Table 7-1: Criteria for the Significance of impacts on properties

EPA Definition of Impacts	Significance Level/Degree of Impact	Definition
Neutral, Imperceptible or Slight Impact	Not Significant	Where a property is impacted upon resulting in minimal change to the environment of the property. This includes lands in the ownership of the adjacent property which are occupied by existing roads.
Significant Impact:	Minor	Minor impact occurs where the use of the property can continue where part of a property is temporarily or permanently acquired resulting in little change to the environment of the property.
	Moderate	Moderate impact occurs where the use of the property can continue where part of a property is temporarily or permanently acquired. This may result in a change to the environment of the property.
	Major	Major impact occurs when the use of the property cannot continue where a portion of the property is permanently acquired. This may result in the acquisition of a residential house or buildings.
Profound or Significant Impact:	Severe	Severe impact occurs when the use of a property cannot continue where a property is acquired in full. This may involve the acquisition and /or demolition of a residential house or buildings.

7.2.1 Assumptions and Technical Limitations

This study does not assess the impact of the *Proposed Road Development* on future development that may occur along the N4 Collooney to Castlebaldwin Realignment.

7.2.2 Difficulties encountered in compiling Information

Consultation with property owners took place in August 2013. Two property owners were unavailable at the time of the assessment. A roadside survey of the affected properties was undertaken.

7.3 Description of the Existing Environment

7.3.1 General

The existing land use environment along the *Proposed Road Development* can be described as agricultural and is addressed in Chapter 11 (Agricultural Impact Assessment) of this EIS. In general terms, agriculture is the dominant land use with livestock farms predominating areas.

The *Proposed Road Development* has been developed through the planning phases to avoid properties, as far as possible in balance with other environmental, engineering and economic considerations. In certain instances, landtake from non-agricultural properties has been unavoidable mainly due to:

- the upgrading of the existing section of the N4 between Toberbride Td. and Doorly Td.;
- to accommodate junctions; and
- to provide tie-ins to the existing road network.

It is these instances, where it is proposed to acquire land from property owners that are assessed in this section of the EIS.

7.4 Description of Likely Impacts

The *Proposed Road Development* will directly impact upon 26 residential properties, 13 miscellaneous properties and 2 commercial properties. On 5 residential properties the land take will consist only of lands currently occupied by public road. Fifteen residential properties will be acquired as part of the *Proposed Road Development*. Eight of the residential properties to be acquired are currently inhabited. The remaining seven

residential properties are uninhabited. Twelve of these properties will be demolished. Three properties will be retained for possible resale in the future.

On the remaining residential properties land take will consist of acquisition of part of the entrance, garden or boundary wall of the properties. Land take on the commercial properties will consist of the acquisition of part of the car parking area and access road for a retail unit in Toberbride Business Park and portion of public road and set back area will be acquired in front of a former public house.

Landtake on the miscellaneous properties will consist of the acquisition of the ruins of a shed and a site area on one property and on land take will consist of land and part of public road on the remaining properties. The *Proposed Road Development* will have property impacts on the following:

- Residential houses / buildings;
- Property boundary;
- Property access / entrance;
- Driveway;
- Garden shrubs and trees;

Details of the impact on each of these properties are presented in Appendix 7.1 contained within Volume 4 of this EIS.

7.5 Proposed Mitigation and Avoidance Measures

Monetary compensatory measures for the loss of land, buildings and other injurious affection will comprise part of the land acquisition procedures with property owners affected by the landtake for the *Proposed Road Development*. Such compensation measures are subject to a separate statutory process and do not from part of the EIS and are therefore not considered further in this assessment.

Where existing access is affected, this will be reinstated as described in Appendix 7.1 (Volume 4 of this EIS). In some cases it may not be feasible to reinstate the original access however an alternative access will be provided.

Where a boundary wall of a non-agricultural property is impacted upon by the *Proposed Road Development,* mitigation will involve the replacement of the boundary on a like for like basis, subject to issues of road safety. If necessary, these works will be carried out as part of the contract or the landowner may be compensated to replace the boundary wall.

Where existing services (e.g. electricity supply, water supply) are permanently affected by the *Proposed Road Development* these will be restored or alternative supplies will be provided.

7.5.1 Construction Phase

The Contractor will maintain reasonable access to all properties at all times during the construction of the *Proposed Road Development*. This may require temporary alternative access arrangements at some locations.

Information will be made available to affected landowners on the construction programme and its impact on properties.

The NRA code of practice *Guide to Process and Code of Practice for National Road Projects Planning and Acquisition of Property for National Roads* will be adhered to with respect to all land potentially impacted by the construction of the *Proposed Road Development*. These measures include the following:

- The local authority will appoint a Project Liaison Officer who will liaise and engage with the affected parties or their representatives on matters relating to the *Proposed Road Development*. The Project Liaison Officer will act as first point of contact should an individual encounter difficulties;
- Where excavations interfere with water supplies, sewers, or septic tanks, these services will be restored as a matter of urgency by the local authority or those acting on its behalf, provided the property owner facilitates all necessary access to enable this to be done;
- Steps will be undertaken to minimise dust and mud from construction activities. Measures will include, as appropriate, the watering of the road and containment of material with dust or mud potential and are further outlined in the Air Quality chapter of this EIS;
- Noise mitigation for construction activities will be incorporated into the development and mitigation measures will be further outlined in the Noise and Vibration chapter of this EIS

7.6 Residual Impacts

Following recommended mitigation works being carried out the residual impact on properties has been assessed. Summary details of the property impacts are presented in Table 7-2.

Table 7-2: Summary of property impact

Category	No. of Properties	% of Properties
Residential:		
Severe	15	57.7%
Major	0	0%
Moderate	0	0%
Minor	6	23.07%
Not Significant	5	19.23%
Total	26	100%
Miscellaneous:		
Severe	1	7.69%
Major	0	0%
Moderate	0	0%
Minor	2	15.38%
Not Significant	10	76.93%
Total	13	100%
Commercial:		
Severe	0	0%
Major	0	0%
Moderate	1	50%
Minor	1	50%
Not Significant	0	0%
Total	2	100%

Of the 41 non-agricultural properties directly impacted by the *Proposed Road Development*, there are:

- Sixteen properties with a severe residual impact;
- No properties will have a major residual impact;
- One property will have a moderate residual impact;
- Nine properties will have a minor residual impact; and
- Fifteen properties will have a not significant residual impact.

Details of the impact on each of these properties are presented in Appendix 7.1 (Volume 4 of this EIS)

7.7 Conclusions

This chapter details the impact of the *Proposed Road Development* on Non Agricultural property. The *Proposed Road Development* will directly impact on 26 residential properties, 13 miscellaneous properties and 2 commercial properties.

Of the forty one properties directly impacted by the *Proposed Road Development* there will be sixteen properties with a severe residual impact while no properties will have a major residual impact. One property

will have a moderate residual impact and nine properties will have a minor residual impact and the remaining fifteen properties will have not significant residual impacts.

7.8 Relevant Figures and Appendices

7.8.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of Chapters 7 and 11 of the EIS and are contained in Volume 3 of the EIS:

Fig. 11.1.1-11.1.8: Agriculture and Material Assets;

7.8.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 7.1: Properties affected by the permanent acquisition of part of the holding

8 Noise & Vibration

8.1 Introduction

8.1.1 General

This chapter of the Environmental Impact Statement (EIS) assesses the impacts of noise and vibration associated with both the constructional and operational phases of the N4 Collooney to Castlebaldwin *Proposed Road Development*. The proposed realignment will link the existing N4 at the N4/N17 roundabout at Collooney/Toberbride to the existing N4 at Cloghoge Lower. A number of existing residential properties are located in the vicinity of the proposed new route.

The N4 Castlebaldwin to Collooney *Proposed Road Development* follows the standard practice of adopting the traffic noise design goal contained within the NRA document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*[51].

8.1.2 Design Goal for Specifying Mitigation Measures

For new roads in Ireland, it is standard practice to adopt the traffic noise design goal contained within the NRA guidance document. This document specifies that the Authority (i.e. NRA) considers it appropriate to set the design goal for Ireland as follows:

- day-evening-night 60dB L_{den} (free field residential façade criterion)

Noise mitigation measures are deemed necessary whenever all of the following three conditions are satisfied:

(a) the combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal, and;

(b) the relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place; and

(c) the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

These conditions will ensure that mitigation measures arising out of this process are based upon the degree of impact of the scheme under consideration.

This Design Goal is applicable to new road schemes only. In EIS terms, this means that they are to be applied to existing receptors in respect of both the year of opening and the design year. In this case, an opening year of 2017 and a design year of 2032 have been assessed.

In the relevant guidance document that is being quoted in this instance it is acknowledged that it may not always be sustainable to achieve this design goal. In such circumstances, nevertheless, a structured approach should be taken in order to ameliorate as far as practicable road traffic noise through the consideration of measures such as alignment changes, barrier type (e.g. earth mounds) or low noise road surfaces.

8.2 Methodology

In order to assess the noise impact of any proposed road scheme, the following methodology is normally adopted.

The first stage is to assess and quantify the existing noise environment in the vicinity of sensitive receptors that may be affected by the proposal. In the case of a road scheme, the selected noise-sensitive locations are likely to be those in closest proximity to the upgraded road. Both the construction and operational phases of the scheme should be reviewed when selecting appropriate measurement locations.

[51] *Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1, 25 October 2004*, National Roads Authority.

Where possible, the noise levels resulting from both the construction and operational phases are then calculated using established prediction techniques. Refer to section 8.4.2 for further discussion of construction noise. The noise levels associated with the operational phase of the *Proposed Road Development* are predicted in accordance with guidance set out in *Calculation of Road Traffic Noise* (CRTN)[52], giving results in the form of $L_{A10(18hour)}$ values. These are then converted to L_{den} values in accordance with the procedures detailed in the NRA guidance. The derived values for L_{den} should be rounded to the nearest whole number, with 0.5 being rounded up.

The predicted values are then assessed against the three conditions set out in section 8.1.2 in order to assess the need for mitigation measures.

8.3 Description of Existing Conditions (Environment)

A series of environmental noise surveys were conducted in order to quantify the existing noise environment in the vicinity of noise-sensitive locations that may be affected by the *Proposed Road Development*.

8.3.1 Noise

8.3.1.1 Survey Methodology

8.3.1.1.1 *Unattended Monitoring*

Unmanned continuous measurements were performed over a 24-hour period at four locations. L_{den} values are derived directly from the results of the continuous monitoring.

8.3.1.1.2 *Attended Monitoring*

Five additional locations were identified in the vicinity of each location for attended measurements. In total attended measurements were undertaken at twenty four locations.

The survey work was conducted in accordance with the shortened measurement procedure as laid down in the NRA guidance document.

When surveying traffic noise, the acoustical parameters of interest are $L_{A10(1hour)}$ and $L_{A10(18hour)}$, expressed in terms of decibels (dB) relative to 2×10^{-5}Pa. The value of $L_{A10(1hour)}$ is the noise level exceeded for just 10% of the time over the period of one hour. $L_{A10(18hour)}$ is the arithmetic average of the values of $L_{A10(1hour)}$ for each of the one hour periods between 06:00 and 24:00hrs.

The shortened measurement procedure involves a method whereby L_{den} values are obtained through a combination of measurement and calculation as follows:

- noise level measurements are undertaken at the chosen location over three consecutive hours between 10:00 and 17:00hrs;
- the duration of the sample period during each hour is selected to encompass sufficient traffic flows to ensure reliable results;
- the $L_{A10(18hour)}$ for the location is derived by subtracting 1dB from the arithmetic average of the three hourly sample values, i.e. $L_{A10(18hour)} = ((\sum L_{A10(1hour)}) / 3) - 1$ dB.
- The L_{den} for the location is then derived from the calculated $L_{A10(18hour)}$ value, i.e. $L_{den} = 0.86\ L_{A10(18hour)} + 9.86$ dB.

The location reference and a description of each survey position are given in Table 8-1. Refer to Figures 8.1.1 to 8.1.8 contained within volume 3 of this EIS for further details of site locations. Attended measurements were conducted at 1.4m above ground.

52 *Calculation of Road Traffic Noise*, Department of Transport Welsh Office, HMSO, 1988.

Table 8-1: Details of Survey Locations

Location	Description of Survey Location	Grid Reference	
		E	N
S01	At Toberbride, west of existing N4, in vicinity of a number of noise sensitive dwellings	568,232	825,016
S02	Along existing N4 in the townland of Mullaghnabreena. In vicinity of a noise sensitive dwelling	568,280	824,299
S03	Adjacent from the L3606-9 junction with the N4 in the townland of Ardcurley. Along existing N4	568,621	823,774
S04	East of Lisconny Bridge, in vicinity of a noise sensitive dwelling	569,790	822,918
S05	At Doorly Td., along access lane, west of existing N4	569,413	822,236
S06	At Knocknagroagh, in vicinity of a number of noise sensitive dwellings, west of existing N4	569,765	821,642
S07	Along roadside of N4, north of Drumfin Cross Roads	570,742	820,783
S08	Along roadside, west of Drumfin Cross Roads	570,833	820,343
S09	Drumfin townland, along access lane west of existing N4	570,878	820,149
S10	Along existing N4, in vicinity of a noise sensitive dwelling	571,253	819,604
S11	Drumfin townland, along roadside, south of existing N4	571,135	819,545
S12	Along lane in Cloonlurg	571,206	818,591
S13	In vicinity of Carrownagark Cross Roads south of existing N4	572,558	818,064
S14	Cloonlurg townland, north of Kilmorgan Bridge	571,502	818,052
S15	At Carrownagark, in vicinity of a noise sensitive dwelling	572,075	817,875
S16	At Tawnagh, in vicinity of a noise sensitive dwelling	573,909	817,504
S17	At Ardloy, just south of existing N4, in vicinity of a noise sensitive dwelling	573,533	816,802
S18	At Kingsbrook, south of existing N4, in vicinity of a noise sensitive dwelling	572,620	817,137
S19	At Tawnagh townland, along roadside east of existing N4	574,108	816,656
S20	Cloonymeenaghan, in vicinity of a noise sensitive dwelling	574,951	816,025
S21	At Sheerevagh, in the vicinity of a noise sensitive location	574,956	815,645
S22	At Sheerevagh townland, in vicinity of a crèche	575,531	815,445
S23	East of Castlebaldwin, in vicinity of a noise sensitive dwelling	575,651	814,785
S24	Along access lane south of Castlebaldwin	575,549	814,092

8.3.1.1.3 *Survey Periods*

Attended measurement survey periods were as follows:

- S19 to S24 on 5 August 2010;
- S13 to S18 on 6 August 2010;
- S07 to S12 on 10 August 2010, and;
- S01 to S06 on 11 August 2010.

Unattended 24-hour monitoring was conducted at the following locations:

- S21 on 4 August to 5 August 2010;
- S13 on 5 August to 6 August 2010;

- S10 on 9 August to 10 August 2010, and;
- S06 on 10 August to 11 August 2010.

The weather during the survey periods was mild, with occasional brief passing showers with wind speeds in the range of 2 to 4m/s.

8.3.1.1.4 *Personnel and Instrumentation*

Louis Smith of AWN Consulting conducted the noise level measurements.

The shortened measurements were performed using a Brüel & Kjær Type 2260 Sound Level Meter.

The continuous measurements were conducted using a Brüel & Kjær Type 3592 Environmental Kit with a Brüel & Kjær Type 2238 Sound Level Meter.

The measurement apparatus were check calibrated before and after each survey using a Brüel & Kjær Type 4231 Sound Level Calibrator.

8.3.1.1.5 *Procedure*

Shortened measurements were conducted at survey locations on a cyclical basis. Sample periods were 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample, and were also saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

For 24-hour monitoring, sample periods were 1-hour long. The results were saved to the instrument memory for later analysis.

8.3.1.1.6 *Results*

The survey results are presented in terms of the following three parameters.

L_{Aeq} is the A-weighted equivalent continuous steady sound level during the sample period and effectively represents an average value.

L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period; generally used to quantify background noise.

L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period; this parameter gives an indication of the upper limit of fluctuating noise such as that from road traffic.

The results for all locations, along with the derived L_{den} values, are presented in Table 8-2 to Table 8-6.

Table 8-2: Shortened Measurement Results and derived Lden Values

Survey Location Reference	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			dB L_{den}
		L_{Aeq}	L_{A10}	L_{A90}	
S01	10:01 - 10:16	62	61	52	61
	11:00 - 11:15	58	59	53	
	11:59 - 12:14	57	59	53	
S02	10:18 - 10:33	64	69	46	69
	11:18 - 11:33	65	70	49	
	12:19 - 12:34	65	70	50	
S03	10:35 - 10:50	76	81	53	79
	11:40 - 11:55	75	81	50	
	12:38 - 12:53	76	81	52	
S04	13:00 - 13:15	53	53	46	55

Survey Location Reference	Start Time	Measured Noise Levels (dB re.$2x10^{-5}$Pa)			dB L_{den}
		L_{Aeq}	L_{A10}	L_{A90}	
	14:00 - 14:15	54	53	45	
	15:01 - 15:16	59	53	46	
S05	13:20 - 13:35	53	55	49	53
	14:18 - 14:33	47	49	43	
	15:22 - 15:37	48	50	43	
S06	13:38 - 13:53	52	55	46	56
	14:41 - 14:56	52	54	46	
	15:43 - 15:58	51	54	46	
S07	09:59 - 10:14	74	80	47	77
	11:00 - 11:15	74	79	48	
	12:01 - 12:16	74	80	50	
S08	10:19 - 10:34	52	52	43	54
	11:21 - 11:36	53	53	45	
	12:22 - 12:37	52	53	45	
S09	10:37 - 10:52	52	56	43	58
	11:40 - 11:55	55	58	44	
	12:43 - 12:58	54	57	45	
S10	13:38 - 13:53	67	70	49	69
	13:59 - 14:14	64	69	49	
	15:01 - 15:16	64	69	50	
S11	13:18 - 13:33	55	53	42	55
	14:18 - 14:33	56	53	43	
	15:22 - 15:37	56	53	43	
S12	13:00 - 13:15	42	45	37	48
	14:39 - 14:54	44	45	38	
	15:43 - 15:58	46	45	37	
S13	13:01 - 13:16	47	46	38	50
	14:01 - 14:16	45	47	40	
	14:59 - 15:14	47	49	42	
S14	13:37 - 13:52	50	38	30	42
	14:40 - 14:55	49	38	32	
	15:42 - 15:57	49	39	28	
S15	13:18 - 13:33	51	45	36	48
	14:21 - 14:36	55	44	36	

Survey Location Reference	Start Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			dB L_{den}
		L_{Aeq}	L_{A10}	L_{A90}	
	15:19 - 15:34	51	48	36	
S16	09:59 - 10:14	38	39	31	44
	11:41 - 11:56	54	41	33	
	12:42 - 12:57	45	40	33	
S17	10:20 - 10:35	52	56	40	58
	11:22 - 11:37	54	57	44	
	12:21 - 12:36	55	58	42	
S18	10:45 - 11:00	52	41	25	47
	11:01 - 11:16	47	42	29	
	12:21 - 12:36	55	58	42	
S19	13:20 - 13:35	50	45	37	47
	14:19 - 14:34	46	46	37	
	15:19 - 15:34	44	43	34	
S20	13:39 - 13:54	41	44	34	47
	14:41 - 14:56	40	43	34	
	15:39 - 15:54	43	45	29	
S21	13:00 - 13:15	45	47	41	49
	14:00 - 14:15	46	48	41	
	15:01 - 15:16	44	47	40	
S22	10:48 - 11:03	53	50	31	55
	11: 05 - 11:20	59	55	32	
	12:37 - 12:52	61	58	35	
S23	10:18 - 10:32	59	55	34	52
	11:25 - 11:40	57	52	34	
	12:18 - 12:33	58	43	33	
S24	10:00 - 10:15	52	56	38	58
	11:43 - 11:58	53	57	37	
	12:00 - 12:15	53	57	37	

Table 8-3: 24-Hour Monitoring Results at Survey Location S21 (24hr)

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:00	52	54	48
17:00	51	53	46
18:00	51	54	46

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
19:00	48	51	43
20:00	47	50	41
21:00	46	50	38
22:00	43	47	34
23:00	43	47	31
00:00	43	47	34
01:00	41	46	29
02:00	40	45	27
03:00	40	44	31
04:00	40	44	25
05:00	42	46	34
06:00	45	49	36
07:00	47	50	42
08:00	49	52	44
09:00	49	52	43
10:00	47	50	42
11:00	47	50	42
12:00	48	50	43
13:00	47	50	42
14:00	47	49	42
15:00	46	48	40
Lden	51		

Table 8-4: 24-Hour Monitoring Results at Survey Location S13 (24hr)

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:00	48	48	38
17:00	49	48	38
18:00	48	49	37
19:00	49	50	39
20:00	50	52	38
21:00	50	53	39
22:00	48	50	33
23:00	46	49	31
00:00	45	48	29

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
01:00	41	45	27
02:00	42	46	28
03:00	38	41	23
04:00	37	40	---
05:00	43	46	22
06:00	46	49	28
07:00	50	51	39
08:00	51	51	40
09:00	59	49	38
10:00	48	49	38
11:00	49	48	38
12:00	48	49	40
13:00	50	48	39
14:00	47	48	40
15:00	49	48	39
L_{den}	53		

Note --- indicates an under range value (<20dB(A) in this instance)

Table 8-5: 24-Hour Monitoring Results at Survey Location S10 (24hr)

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:00	65	70	49
17:00	66	70	50
18:00	66	70	49
19:00	65	70	46
20:00	63	69	42
21:00	62	68	36
22:00	60	65	34
23:00	59	61	32
00:00	55	52	23
01:00	56	54	28
02:00	55	50	28
03:00	57	54	33
04:00	55	50	33
05:00	57	56	35

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
06:00	61	65	36
07:00	65	71	47
08:00	66	71	50
09:00	66	71	49
10:00	65	70	49
11:00	66	71	51
12:00	65	70	50
13:00	67	71	49
14:00	66	70	52
15:00	65	70	51
L_{den}	67		

Table 8-6: 24-Hour Monitoring Results at Survey Location S06 (24hr)

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:00	51	54	46
17:00	51	54	46
18:00	51	53	46
19:00	52	55	44
20:00	50	52	43
21:00	52	53	44
22:00	48	51	39
23:00	46	49	36
00:00	44	49	26
01:00	40	43	22
02:00	39	44	21
03:00	45	50	23
04:00	45	50	22
05:00	43	47	24
06:00	44	47	33
07:00	48	52	38
08:00	51	54	45
09:00	52	54	46
10:00	53	55	47
11:00	53	54	44

Time Period (Hour Beginning)	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
12:00	51	54	45
13:00	52	55	47
14:00	51	54	45
15:00	51	54	46
L_{den}	53		

Location S01 The main sources of noise identified at this location were road traffic noise from the existing N4 and wind generated noise from nearby foliage. During the first measurement period a number of local vehicle movements were also observed. Noise levels were in the range 57 to 62dB L_{Aeq} and 59 to 61dB L_{A10}. The derived L_{den} at this location is 61dB.

Location S02 The main sources of noise identified at this location were road traffic noise from the existing N4, birdsong and wind generated noise from nearby foliage. Noise levels were in the range 64 to 65dB L_{Aeq} and 69 to 70dB L_{A10}. The derived L_{den} at this location is 69dB.

Location S03 The noise environment at this location was dominated by road traffic noise from the existing N4 mainline. Noise levels were in the range 75 to 76dB L_{Aeq} and of the order of 81dB L_{A10}. The derived L_{den} at this location is 79dB.

Location S04 The background noise environment at this location was affected by distant road traffic noise from the existing N4 mainline, birdsong and a degree of wind generated noise. Very occasional passing vehicles along local roads and dogs barking were also observed. Noise levels were in the range 53 to 59dB L_{Aeq} and of the order of 53dB L_{A10}. The derived L_{den} at this location is 55dB.

Location S05 The background noise environment at this location was dominated by wind generated noise from nearby foliage. Vehicle movements along the existing N4 were also audible in the distance. Noise levels were in the range 47 to 53dB L_{Aeq} and 49 to 55dB L_{A10}. The derived L_{den} at this location is 53dB.

Location S06 Noise sources noted to be contributing to noise build up at this location included distant road traffic noise from the existing N4 and very occasional local vehicle movements. Noise levels were in the range 51 to 52dB L_{Aeq} and 54 to 55dB L_{A10}. The derived L_{den} at this location is 56dB.

This was also the location of the 24-hour continuous unattended measurements. The measured L_{den} at this location is 53dB.

Location S07 Noise levels measured at this location were dominated by vehicle movements along the N4. Noise levels were of the order of 74dB L_{Aeq} and in the range of 79 to 80dB L_{A10}. The derived L_{den} at this location is 77dB.

Location S08 Noise levels measured at this location were affected by very occasional passing local movements and distant road traffic noise from the N4. Other sources noted include birdsong and emissions from a nearby garage. Noise levels were in the range 52 to 53dB L_{Aeq} and 52 to 53dB L_{A10}. The derived L_{den} at this location is 54dB.

Location S09 Noise sources noted at this location included distant road traffic noise from the N4, a degree of wind generated noise and birdsong. Measured levels during the first measurement period were affected by farm machinery in operation in a nearby field. Noise levels were in the range 52 to 55dB L_{Aeq} and 56 to 58dB L_{A10}. The derived L_{den} at this location is 58dB.

Location S10 The dominate source of noise at this location was road traffic noise. Other sources noted included dogs barking form a nearby garden and a degree of wind generated noise. Noise levels were in the range 64 to 67dB L_{Aeq} and 69 to 70dB L_{A10}. The derived L_{den} at this location is 69dB.

This was also the location of the 24-hour continuous unattended measurements. The measured L_{den} at this location is 67dB.

Location S11 Noise levels measured at this location were affected by very occasional passing local movements, distant road traffic noise from the N4, a degree of wind generated noise and birdsong. Noise levels were in the range 55 to 56dB L_{Aeq} and of the order of 53dB L_{A10}. The derived L_{den} at this location is 55dB.

Location S12 The background noise environment at this location was dominated by wind generated noise, birdsong and cattle noise. Noise levels were in the range 42 to 46dB L_{Aeq} and of the order of 45dB L_{A10}. The derived L_{den} at this location is 48dB.

Location S13 Noise levels measured at this location were dominated by distant road traffic noise from the N4 and by occasional local passing. Noise levels were in the range 45 to 47dB L_{Aeq} and 46 to 49dB L_{A10}. The derived L_{den} at this location is 50dB.

This was also the location of the 24-hour continuous unattended measurements. The measured L_{den} at this location is 53dB.

Location S14 Noise levels measured at this location were affected by very occasional local traffic movements, a degree of wind generated noise and birdsong. Noise levels were in the range 49 to 50dB L_{Aeq} and 38 to 39dB L_{A10}. The derived L_{den} at this location is 42dB.

Location S15 The dominant noise sources at this location were noted as being distant traffic movements along the N4, very occasional traffic passing by, birdsong and a degree wind generated noise. Noise levels were in the range 51 to 55dB L_{Aeq} and 44 to 48dB L_{A10}. The derived L_{den} at this location is 48dB.

Location S16 The sources leading to build up of environmental noise at this location included distant vehicle movements along the N4, occasional passing vehicles and birdsong. Noise levels were in the range 38 to 54dB L_{Aeq} and 39 to 41dB L_{A10}. The derived L_{den} at this location is 44dB.

Location S17 Measured noise levels at this location were dominated by road traffic from the N4. Noise levels were in the range 52 to 55dB L_{Aeq} and 56 to 58dB L_{A10}. The derived L_{den} at this location is 58dB.

Location S18 The observed noise sources at this location were distant road traffic noise, intermittent dog barking from an adjacent farm yard and bird song. During the first measurement period three local car movements were noted. Noise levels were in the range 47 to 52dB L_{Aeq} and 41 to 49dB L_{A10}. The derived L_{den} at this location is 47dB.

Location S19 The noise sources noted at this location were distant traffic movements along the N4 and very occasional local traffic movements. Noise levels were in the range 44 to 50dB L_{Aeq} and 43 to 46dB L_{A10}. The derived L_{den} at this location is 47dB.

Location S20 The background noise environment at this location was dominated by distant road traffic noise from the existing N4. Noise levels were in the range 40 to 43dB L_{Aeq} and 43 to 45dB L_{A10}. The derived L_{den} at this location is 47dB.

Location S21 The noise environment at this location was dominated by distant road traffic noise and a degree of wind generated noise. Noise levels were in the range of 44 to 46dB L_{Aeq} and 47 to 48dB L_{A10}. The derived L_{den} at this location is 49dB.

This was also the location of the 24-hour continuous unattended measurements. The measured L_{den} at this location is 51dB.

Location S22 Noise levels measured at this location were affected by very occasional local traffic movements on the surrounding roads and birdsong. Passing tractors and jeeps with trailers significantly affected all measurements. Noise levels were in the range 53 to 61dB L_{Aeq} and 50 to 58dB L_{A10}. The derived L_{den} at this location is 55dB.

Location S23 Background levels at this location were dominated by distant road traffic noise from the N4. Also noted were birdsong and very occasional passing vehicles. Noise levels were in the range 57 to 59dB L_{Aeq} and 43 to 55dB L_{A10}. The derived L_{den} at this location is 52dB.

Location S24 Noise sources noted at this location included road traffic noise from the N4, birdsong and a degree of wind generated noise. Noise levels were in the range 52 to 53dB L_{Aeq} and 56 to 57dB L_{A10}. The derived L_{den} at this location is 58dB.

8.3.2 Vibration

A survey of vibration along the proposed route corridor was not undertaken, as levels associated with existing roads would not be expected to be of a magnitude sufficient to cause disturbance to people or structural damage to property. Furthermore, vibration was not perceptible at any of the noise survey locations.

8.4 Description of Likely Impacts

8.4.1 Operational Noise

8.4.1.1 Noise Model

A computer-based prediction model has been prepared in order to quantify the traffic noise level associated with the operational phase of the *Proposed Road Development*. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

8.4.1.2 Brüel & Kjær Type 7810 *Predictor*

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates traffic noise levels in accordance with CRTN and NRA guidance.

Brüel & Kjær Type 7810 *Predictor* is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. *Predictor* predicts noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of sound power or traffic flow and average velocity;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces, and;
- the hardness of the ground between the source and receiver.

8.4.1.3 Prediction of traffic noise

Noise emissions during the operational phase of the project have been modelled using *Predictor* in accordance with CRTN and with the application of the relevant conversion factors as detailed in the Method A of the NRA Guidance. The CRTN method of predicting noise from a road scheme consists of the following five elements:

- divide the road scheme into segments so that the variation of noise within this segment is small;
- calculate the basic noise level at a reference distance of 10 metres from the nearside carriageway edge for each segment;
- assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line;
- correct the noise level at the reception point to take account of site layout features including reflections from buildings and facades, and the size of source segment, and;
- combine the contributions from all segments to give the predicted noise level at the receiver location for the whole road scheme.

Note that all calculations are performed to one decimal place. For the purposes of comparison with the design goals of 60dB L_{den}, the relevant noise level is to be rounded to the nearest whole number in accordance with guidance given in the NRA document.

8.4.1.4 Input to the Noise Model

The noise model was prepared using the following data:

- Drawings, topographical data and Ordnance Survey mapping supplied by Sligo County Council;
- Traffic flow data supplied by Sligo County Council, and;
- Traffic speeds as supplied by Sligo County Council.

8.4.1.5 Output of the Noise Model

Predictor calculates noise levels for a set of receiver locations specified by the user. The results include an overall level in dB L_{den}.

8.4.1.6 Choice of Receiver Locations

Free-field traffic noise levels have been predicted at a number of properties in the vicinity of proposed and existing roads. Eighty six receivers have been considered in total. Some properties have more than one associated receiver, as different sides of the properties face different roads.

The coordinates of all locations are provided in Table 8-7. These receiver locations are detailed in Figures 8.1.1 to 8.1.8 contained within volume 3 of this EIS.

Table 8-7: Details of Receiver Locations

Receiver Location Reference	Height Above Ground (m)	Grid Reference	
		E	N
R001	3.8	568,254	825,631
R002	3.8	567,979	825,294
R003	3.8	568,213	825,182
R005	3.8	568,228	825,073
R006	3.8	568,203	824,959
R007	3.8	568,238	824,624
R008	3.8	568,196	824,415
R009	3.8	568,370	824,476
R010	3.8	568,349	824,352
R012a	3.8	568,298	824,284
R012b	3.8	568,295	824,291
R016	1.8	568,565	823,691
R101	3.8	569,043	822,997
R104	3.8	569,388	822,868
R105	3.8	569,527	822,711
R106	3.8	569,505	822,697
R108	3.8	569,708	822,448
R110	3.8	569,864	822,309
R114	3.8	570,017	821,827
R116	3.8	570,028	821,748
R117	3.8	569,930	821,711
R118	3.8	569,907	821,687
R119	1.8	569,773	821,639
R120	3.8	569,695	821,627
R121	3.8	569,698	821,582
R139	3.8	570,336	821,043
R140	3.8	570,576	820,993
R141	3.8	570,567	820,914
R148	3.8	571,039	820,438
R152	3.8	570,965	820,345
R153	3.8	570,967	820,355
R156	3.8	570,619	820,385
R158	3.8	570,762	820,164
R162	3.8	571,114	819,962
R167	3.8	571,154	819,634
R169	3.8	571,251	819,602
R171	3.8	570,780	819,042
R172	3.8	570,784	819,035
R181	3.8	571,736	819,066

Receiver Location Reference	Height Above Ground (m)	Grid Reference	
		E	N
R182	3.8	571,758	819,089
R183	3.8	571,813	819,024
R184	3.8	572,168	818,606
R186	3.8	572,055	818,440
R187	3.8	572,278	818,449
R188	3.8	572,398	818,355
R189	3.8	572,387	818,313
R190	3.8	572,280	818,250
R192	3.8	572,570	818,102
R194	3.8	572,751	818,091
R195	3.8	573,109	818,032
R196	3.8	572,508	818,018
R197	3.8	572,498	818,003
R202	3.8	572,267	817,544
R207	1.8	572,692	817,415
R208	3.8	572,618	817,160
R209	3.8	572,641	817,085
R212	3.8	572,984	817,563
R216	3.8	573,247	817,278
R218	3.8	573,102	816,885
R224	3.8	573,515	816,743
R225	3.8	573,522	816,892
R227	3.8	573,882	816,828
R236	3.8	573,880	816,817
R237	3.8	574,340	816,713
R238	3.8	574,128	816,506
R239	3.8	574,200	816,487
R242	3.8	574,398	816,116
R245	3.8	574,907	816,052
R248	3.8	575,203	815,746
R250	3.8	574,666	815,628
R253	3.8	574,719	815,280
R254	3.8	575,084	815,509
R255	3.8	575,327	815,556
R263	3.8	575,484	815,420
R266	3.8	575,014	815,150
R267	3.8	575,081	815,027
R268	3.8	575,586	815,133
R276	3.8	575,889	814,826
R284	3.8	575,304	814,614
R289	3.8	575,403	814,510
R308	3.8	575,306	814,470
R311	3.8	575,059	814,278
R351	3.8	575,565	814,308
R352	3.8	575,804	814,375
R363	3.8	575,935	813,843
R367	3.8	575,940	813,744

8.4.1.7 Traffic Noise Predictions for 2017 and 2032

Four scenarios have been considered as follows:

- Year 2017 – Do Minimum (i.e. *Proposed Road Development* does not take place);
- Year 2017 – Do Something (i.e. incorporates *Proposed Road Development*);

- Year 2032 – Do Minimum;
- Year 2032 – Do Something.

The results of the traffic noise predictions are presented in Table 8-8.

Table 8-8: Predicted Noise Levels for Years 2017 and 2032 for "Do Minimum" and "Do Something" Scenarios

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den}	L_{den}		L_{den}	L_{den}	
R001	68	67	No	68	68	No
R002	62	62	No	63	63	No
R003	63	62	No	63	63	No
R005	64	61	No	65	62	No
R006	63	61	No	63	62	No
R007	70	68	No	70	68	No
R008	61	61	No	62	62	No
R009	61	61	No	62	62	No
R010	65	68	Yes	65	68	Yes
R012a	69	68	No	70	69	No
R012b	68	67	No	69	68	No
R016	59	61	Yes	60	61	Yes
R101	56	57	No	57	58	No
R104	67	61	No	68	61	No
R105	71	61	No	71	62	No
R106	58	56	No	58	57	No
R108	67	60	No	68	61	No
R110	59	56	No	60	56	No
R114	71	61	No	71	62	No
R116	73	63	No	74	64	No
R117	58	56	No	59	57	No
R118	57	59	No	58	59	No
R119	54	60	No	55	61	Yes
R120	51	58	No	52	58	No
R121	52	57	No	53	57	No
R139	54	55	No	55	55	No
R140	73	63	No	74	64	No
R141	55	52	No	56	53	No

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den}	L_{den}		L_{den}	L_{den}	
R148	61	59	No	62	61	No
R152	73	62	No	74	63	No
R153	69	63	No	70	64	No
R156	49	56	No	50	57	No
R158	49	55	No	50	55	No
R162	73	59	No	74	61	No
R167	57	55	No	58	56	No
R169	65	54	No	66	55	No
R171	51	53	No	52	54	No
R172	53	54	No	54	55	No
R181	52	54	No	53	55	No
R182	70	53	No	70	54	No
R183	71	53	No	72	54	No
R184	71	52	No	71	53	No
R186	48	57	No	49	58	No
R187	68	52	No	69	53	No
R188	72	54	No	73	55	No
R189	68	53	No	69	54	No
R190	54	55	No	55	55	No
R192	72	51	No	73	52	No
R194	57	52	No	58	53	No
R195	51	49	No	52	51	No
R196	58	50	No	59	51	No
R197	52	56	No	53	57	No
R202	46	51	No	46	51	No
R207	47	59	No	47	60	No
R208	47	56	No	48	57	No
R209	46	55	No	47	55	No
R212	69	48	No	70	48	No
R216	72	55	No	72	56	No
R218	52	59	No	52	60	No
R224	58	56	No	59	57	No

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den}	L_{den}		L_{den}	L_{den}	
R225	72	60	No	73	61	No
R227	51	63	Yes	51	63	Yes
R236	59	57	No	60	58	No
R237	54	58	No	55	59	No
R238	68	52	No	69	53	No
R239	53	55	No	53	56	No
R242	71	48	No	72	50	No
R245	50	59	No	50	59	No
R248	48	56	No	49	57	No
R250	70	53	No	71	54	No
R253	58	49	No	58	50	No
R254	48	65	Yes	49	65	Yes
R255	49	56	No	50	57	No
R263	48	54	No	49	54	No
R266	62	47	No	63	49	No
R267	64	48	No	64	50	No
R268	48	53	No	49	54	No
R276	47	50	No	48	51	No
R284	73	49	No	74	51	No
R289	70	58	No	71	60	No
R308	58	53	No	60	55	No
R311	56	52	No	58	55	No
R351	69	57	No	70	58	No
R352	52	57	No	53	58	No
R363	70	63	No	71	64	No
R367	65	60	No	66	61	No

8.4.1.7.1 *Year 2017*

The combined expected maximum traffic noise level from the *Proposed Road Development* together with other traffic in the vicinity (i.e. Do Something scenario) is greater than 60dB L_{den} at twenty two locations.

The Do Something noise levels at nineteen of these locations is less than or equal to the Do Nothing level. Therefore Condition (b) of the Design Goals (refer to section 8.1.2) is not satisfied and hence mitigation measures are not required at these locations.

At the remaining four locations, i.e. R010, R016, R227 and R254, the Do Something noise level is higher than the Do Minimum level, and in excess of the Design Goal. Therefore it is necessary to consider mitigation measures at these locations based on the design criteria.

8.4.1.7.2 *Year 2032*

The combined expected maximum traffic noise level from the *Proposed Road Development* together with other traffic in the vicinity (i.e. Do Something scenario) is greater than 60dB L_{den} at twenty eight locations.

The Do Something noise levels at twenty three of these locations is less than or equal to the Do Nothing level. Therefore Condition (b) of the Design Goals (refer to section 8.1.2) is no longer satisfied and hence mitigation measures are not required at these twenty three locations.

At the remaining five locations, i.e. R010, R016, R119, R227, and R254, the Do Something noise level is higher than the Do Minimum level, and in excess of the Design Goal. Therefore it is necessary to consider mitigation measures at these locations based on the design criteria.

8.4.2 Construction Noise

8.4.2.1 Standards and Guidelines

As per NRA guidance noise levels associated with construction may be calculated in accordance with methodology set out in BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.* This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations. However, it is often not possible to conduct detailed prediction calculations for the construction phase of a project in support of the EIS. This is due to the fact that the programme for construction works has not been established in detail. Under such circumstances, best practice involves the consideration of appropriate mitigation measures.

It is expected that construction of the *Proposed Road Development* could potentially generate the movement (transport volume) of circa 735,000m^3 of soft geological material (including c. 307,000m^3 of PEAT and 234,000m^3 of organic clay) to identified locations predominately within the CPO. These quantities are not final, but are understood to represent a worst case scenario.

As outlined in Chapter 4 of this EIS it will be the contractor's responsibility to deal with this material in accordance with the various statutory requirements, however, in order to quantify the effects such an activity will have on the receiving Environment, this assessment examines the impact in terms of Noise & Vibration of transferring this material to the aforementioned sites (within the CPO) which are described in further detail in Chapter 4 and which are arising from the assessment carried out in the Spoil Management Report contained as appendix 4.3 of volume 4.

The NRA guidance document specifies noise levels that it typically deems acceptable in terms of construction noise. These limits are set out in Table 8-9. Note that these values are indicative only; it may be appropriate to apply more stringent limits in areas where pre-existing noise levels are low.

Table 8-9: Maximum Permissible Noise Levels at the Façade of Nearby Dwellings during Construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturday 08:00 to 16:30hrs	65	75

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Sundays and Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other than required for emergency works, will normally require the explicit permission of the relevant local authority.

8.4.2.2 Assessment of Construction Noise

A variety of items of plant will be in use, such as excavators, lifting equipment, dumper trucks, compressors and generators. It is also possible that rock breaking and blasting may be required on occasions and there will be vehicular movements between the development site and the repository sites.

Due to the nature of the activities undertaken on a large construction site, there is potential for generation of significant levels of noise. The flow of vehicular traffic to and from a construction site is also a potential source of relatively high noise levels.

The following paragraphs present calculations of indicative noise levels for typical noise sources associated with road construction.

8.4.2.2.1 *Spoil Repositories within the confines of the Proposed Road Development*

As outlined within section 4.10.2.2 of this EIS, various sites have been identified as spoil repositories within the limits of the *Proposed Road Development*. Although such activities would be typical of Road Construction activities, this chapter in recognising the increased additional activities in the more significant of these areas has been carried out.

Due to the fact that the spoil repository programme has been established in outline form only, it is not possible to quantify the number of movements associated with each potential site and calculate the actual magnitude of noise emissions to the local environment. However, the following worst case assumptions have been predicted for the calculation of the indicative noise levels from each potential site located at the nearest noise sensitive locations:

- 20 HGV movements per hour along the proposed haul roads to each of the repository sites;
- 400 tractor & trailer movements per day across the repository sites;
- 100 loading shovel movements per day across the repository sites;
- 300 excavator movements per day across the repository sites, and;
- 100 dozer movements per day across the repository sites.

BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* sets out typical noise levels for items of construction plant.

Table 8-10 lists the expected noise level, based on the assumptions set out previously, at various distances from these sites.

Table 8-10: Indicative noise levels from spoil repositories noise sources

Item of Plant (number of movements)	Predicted noise level at stated distance from edge of works (dB $L_{Aeq(1hr)}$)				
	10m	20m	40m	60m	100m
Tractor & Trailer (400 per day)	70	66	63	61	58
Loading Shovel (100 per day)	70	67	63	61	59
Excavator (300 per day)	72	69	66	64	61
Dozer (100 per day)	71	68	65	63	60
HGV Movements (20 per hour)	59	56	53	52	49

Noise models of each of the potential sites have been developed.

Again using the Brüel & Kjær Type 7810 *Predictor* package and the assumptions for the frequency of construction activity set out above, predictions have been performed for every building in the vicinity of each potential site.

Table 8-11: Range of predicted cumulative noise levels from disposal sites

Site Location	Site I.D.	Range of Site Emission Levels ($L_{Aeq,1hr}$ dB)
Sites with significant activity within the confines of the *Proposed Road Development*	SR-LI-01, SR-LI-02, SR/BP Type 2 No. 01, SR/BP Type 2 No. 2	62
	SR-LI-03, SR-LI-04	N/A[53]
	SR/BP Type 01 No. 01	61
	SR/BP Type 01 No. 02	63 – 64
	SR/BP Type 01 No. 03	58 – 59
	SR/BP Type 02 No. 02	61
	SR/BP Type 01 No. 04	63 – 65

The predicted levels at all locations assessed were in the range of 58 to 65dB $L_{Aeq,1hr,}$ less than the 70dB $L_{Aeq,1hr}$ daytime criterion presented in Table 8-9.

8.4.2.2.2 *Considerations for the Potential Treatment of Spoil Material - Outside the CPO*

Considering that there may be potential for a surplus of spoil material still accruing after utilisation of the above spoil repositories, an assessment has been undertaken in order to reflect the potential impacts which this activity may generate. The Range of Options described in Section 10 of the aforementioned Spoil Management Report is thus referred to. Although consideration of such sites is hypothetical at the current stage of consent and it is unlikely that they would all in any event be required, such a consideration allows for such an activity (worst case) to be quantified in terms of Noise & Vibration Impacts.

In this regard appendix 8.1 contained within volume 4 of this EIS assesses the potential cumulative and indirect impacts of such an activity.

8.4.2.2.3 *Consideration for the Sourcing of Material from Borrow Pits*

As described in the aforementioned Spoil Management Report some of the sites described in section 8.4.2.2.1 will be borrow pits which will be excavated with the objective of sourcing some of the required construction materials for the *Proposed Road Development*. These sites include SR/BP Type 02 No. 01 and 02 occurring in the townland of Drumfin and SR/BP Type 02 No. 03 occurring in the townland of Cloonymeenaghan each of which have potential for rock excavation.

Criteria for the operation of these pits have predominately been taken from the guidance document *Environmental Management in the Extractive Industry*, EPA 2004; *Quarries and Ancillary Activities – Guidelines for Planning Authorities* – DoEHLG, April 2004.

Whilst the extraction method for the sites has not been finalised at time of writing indication noise predictions have been performed and it is expected that the relevant noise criteria will be achievable. It will be the responsibility of the contractor operating the pit to ensure the extraction method chosen will comply with the recommended vibration criteria.

Please see Appendices 8.2 and 8.3 within volume 4 for further details on the potential noise and vibration impacts associated with these pits.

[53] Volumes of deposition at this particular location are modest; therefore, no site specific assessment was carried out. Assessment is covered in section 8.4.2.3 of this chapter.

Additional Borrow Pits include SR/BP Type 01 numbers 01, 02, 03 and 04 occurring in the townlands of Ardloy/Springfield, Tawnagh, Cloonymeenaghan and Drumderry. Impacts arising from these sites are included in section 8.4.2.3. due to the fact that there is unlikely to be any rock excavation

8.4.2.3 General Construction Works

As discussed previously, as the construction programme has been established in outline form only, it is not possible to calculate the exact magnitude of noise emissions as a result of construction to the local environment.

BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* sets out typical noise levels for items of construction plant. Table 8-12 lists the expected noise level at various distances from the roadway.

Table 8-12: Indicative noise levels from construction plant items at various distances from the development

Item of Plant (BS5228 Ref.)	Highest predicted noise level at stated distance from edge of works (dB LAeq(1hr))				
	10m	20m	40m	60m	100m
Pneumatic breaker (C.8.12)	72	66	60	56	52
Wheeled loader (C.3.51)*	68	62	56	52	48
Tracked excavator (C.3.43)*	69	63	57	53	49
Dozer (C.3.30)*	70	64	58	54	50
Dump truck (C.3.60)*	66	60	54	50	46
Vibratory roller (C.3.116)	72	66	60	56	52
Asphalt Spread (C.8.24)	76	70	64	60	56
Diesel Hoist (C.7.98)	70	64	58	54	50
Compressor (C.7.27)	67	61	55	51	47
Generator (C.7.49)	71	65	59	55	51
Road Roller (C.3.114)	74	68	62	58	54
HGV Movements (20 per hour)	59	56	53	52	49

***Note ** Assume noise control measures as outlined in Table B1 of BS 5228 – 1 (i.e. fit acoustic exhaust).

The noise levels presented are within the limit values shown in Table 8-9 for weekday daytime periods at distances greater than 10m from plant items. During scenarios where several items of plant are in operation in close proximity and simultaneously there is the potential for the limit values to be exceeded at greater distances.

8.4.2.4 Cumulative Construction Impact

Consideration has been given to the potential cumulative impact from both the repository/borrow pit operations and the general construction works.

During scenarios where construction works along the development and repository works are in operation simultaneously there is the potential for the limit values to be exceeded at locations less than 40m from both.

Notwithstanding the results of the noise modelling, the section 8.5.2 describes typical best practise measures to minimise the potential for noise disturbance to the surrounding areas.

8.4.3 Operational Vibration

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle's wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

It has been found that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Perceptible road traffic vibration can therefore be largely avoided by maintenance of the road surface.

8.4.4 Construction Vibration

The potential for vibration at neighbouring sensitive locations during construction is typically limited to demolition, excavation works, rock-breaking operations and lorry movements on uneven road surfaces. The more significant of these is the vibration from excavation and rock-breaking operations; the method of which will be selected and controlled to ensure there is no likelihood of structural or even cosmetic damage to existing neighbouring dwellings.

There is also the potential for blasting events to occur during the sourcing of material from borrow pits. Please see Appendices 8.2 and 8.3 within volume 4 for further details on the potential vibration impacts associated with these pits.

8.5 Mitigation Measures & Environmental Commitments

8.5.1 Operational Noise

The proposed mitigation measures consist of a set of barriers[54] as described in the following sections. Predicted noise levels with the mitigation measures in place are presented in Table 8-13.

8.5.1.1 Location R010

The proposed mitigation measure for Location R010 consists of a 3.5 metre high 45 metre long barrier on the east side of the proposed scheme. The location of this barrier is shown in Fig. 8.1.1 contained within volume 3.

With this mitigation measure in place, the predicted result for the year 2032 Do Something scenario is 65dB L_{den}. This means that Condition (b) of the Design Goal (refer to section 8.1.2) is no longer satisfied, and therefore the mitigated noise level satisfies the adopted criterion.

8.5.1.2 Location R016

The proposed mitigation measure for Location R016 consists of a 1.5 metre high 95 metre long barrier on the west side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.2 contained within volume 3.

With this mitigation measure in place, the predicted result for the year 2032 Do Something scenario is 60dB L_{den}. This means that Condition (a) of the Design Goal (refer to section 8.1.2) is no longer satisfied, and therefore the mitigated noise level satisfies the adopted criterion.

[54] Barriers should be solid, with no gaps at the base or between vertical joints and should have a minimum surface mass of 10kg/m^2. All barriers shall achieve the performance specified in I.S. EN 1793 – 1:1998, I.S. EN 1793-2:1998, I.S. EN 1973-3:1998, I.S. 1794-1:2003 and I.S. EN 1794-2:2003.

8.5.1.3 Location R119

The proposed mitigation measure for Location R119 consists of a 4.0 metre high 145 metre long barrier on the east side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.3 contained within volume 3.

With this mitigation measure in place, the predicted result for the year 2032 Do Something scenario is 60dB L_{den}. This means that Condition (a) of the Design Goal (refer to section 8.1.2) is no longer satisfied, and therefore the mitigated noise level satisfies the adopted criterion.

8.5.1.4 Location R227

The proposed mitigation measure for Location R227 consists of a 2.0 metre high 190 metre long barrier on the south side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.6 contained within volume 3.

With this mitigation measure in place, the predicted result for the year 2032 Do Something scenario is 60dB L_{den}. This means that Condition (a) of the Design Goal (refer to section 8.1.2) is no longer satisfied, and therefore the mitigated noise level satisfies the adopted criterion.

8.5.1.5 Location R254

The proposed mitigation measure for Location R254 consists of a 4 metre high 200 metre long barrier on the north side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.7 contained within volume 3.

With this mitigation measure in place, the predicted result for the year 2032 Do Something scenario is 60dB L_{den}. This means that Condition (a) of the Design Goal (refer to section 8.1.2) is no longer satisfied, and therefore the mitigated noise level satisfies the adopted criterion.

Table 8-13: Predicted Noise Levels for Years 2017 and 2032 for "Do Minimum" and "Do Something" Scenarios, taking into account the proposed mitigation measures

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	Lden	Lden		Lden	Lden	
R001	68	67	No	68	68	No
R002	62	62	No	63	63	No
R003	63	62	No	63	63	No
R005	64	61	No	65	62	No
R006	63	61	No	63	61	No
R007	70	68	No	70	68	No
R008	61	61	No	62	62	No
R009	61	59	No	62	62	No
R010	65	68	No	65	65	No
R012a	69	68	No	70	69	No
R012b	68	67	No	69	68	No
R016	59	59	No	60	60	No

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	Lden	Lden		Lden	Lden	
R101	56	57	No	57	57	No
R104	67	61	No	68	61	No
R105	71	61	No	71	62	No
R106	58	56	No	58	57	No
R108	67	60	No	68	61	No
R110	59	56	No	60	56	No
R114	71	61	No	71	62	No
R116	73	63	No	74	64	No
R117	58	57	No	59	57	No
R118	57	59	No	58	59	No
R119	54	59	No	55	59	No
R120	51	57	No	52	57	No
R121	52	56	No	53	57	No
R139	54	54	No	55	55	No
R140	73	63	No	74	64	No
R141	55	52	No	56	52	No
R148	61	59	No	62	61	No
R152	73	62	No	74	63	No
R153	69	63	No	70	64	No
R156	49	56	No	50	57	No
R158	49	54	No	50	54	No
R162	73	59	No	74	61	No
R167	57	55	No	58	56	No
R169	65	54	No	66	54	No
R171	51	53	No	52	53	No
R172	53	54	No	54	54	No
R181	52	54	No	53	55	No
R182	70	53	No	70	54	No
R183	71	53	No	72	54	No
R184	71	52	No	71	53	No
R186	48	57	No	49	58	No
R187	68	52	No	69	53	No

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	Lden	Lden		Lden	Lden	
R188	72	54	No	73	55	No
R189	68	53	No	69	54	No
R190	54	55	No	55	55	No
R192	72	51	No	73	52	No
R194	57	52	No	58	53	No
R195	51	49	No	52	51	No
R196	58	50	No	59	50	No
R197	52	56	No	53	57	No
R202	46	51	No	46	51	No
R207	47	59	No	47	60	No
R208	47	55	No	48	56	No
R209	46	54	No	47	55	No
R212	69	48	No	70	48	No
R216	72	55	No	72	56	No
R218	52	59	No	52	60	No
R224	58	56	No	59	56	No
R225	72	60	No	73	61	No
R227	51	59	No	51	60	No
R236	59	57	No	60	57	No
R237	54	57	No	55	58	No
R238	68	52	No	69	53	No
R239	53	55	No	53	55	No
R242	71	48	No	72	50	No
R245	50	59	No	50	59	No
R248	48	57	No	49	57	No
R250	70	53	No	71	54	No
R253	58	48	No	58	49	No
R254	48	60	No	49	60	No
R255	49	57	No	50	57	No
R263	48	54	No	49	54	No
R266	62	47	No	63	49	No
R267	64	48	No	64	49	No

Receiver Location Reference	Opening Year 2017		Mitigation Required?	Design Year 2032		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	Lden	Lden		Lden	Lden	
R268	48	53	No	49	53	No
R276	47	50	No	48	51	No
R284	73	49	No	74	51	No
R289	70	58	No	71	60	No
R308	58	53	No	60	55	No
R311	56	52	No	58	55	No
R351	69	57	No	70	57	No
R352	52	57	No	53	58	No
R363	70	63	No	71	64	No
R367	65	60	No	66	61	No

These noise levels do not satisfy the criteria set out in section 8.1.2, therefore no further mitigation is required at any of the locations assessed.

8.5.2 Construction Noise

8.5.2.1 Mitigation Measures

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1* and the *European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001*. These measures will ensure that:

- No plant used on site will be permitted to cause an on-going public nuisance due to noise;
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations;
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract;
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers;
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use;
- Any plant, such as generators or pumps, which are required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen;
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 8-9 using methods outlined in BS 5228 "*Noise and Vibration Control on Construction and open sites*".

8.5.2.2 Working Hours

Normal working times will be 07:00 to 19:00hrs Monday to Saturday. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached.

Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority.

When overtime and shift work is permitted, the hauling of spoil and delivery of materials outside normal working hours is prohibited and the noise limits outlined in Table 8-9 will apply.

8.5.2.3 Emergency Work

The emergency work referred to above may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.

8.5.3 Operational and Construction Vibration

The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in Table 8-14.

Table 8-14: Allowable Vibration Levels During Construction Phase

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Measures shall be taken to minimise vibration due to plant and machinery on the site and no machine which uses the dropping of heavy weights for the purpose of demolition shall be permitted.

Ground vibration from additional traffic due to the development under consideration would be expected to be orders of magnitude less than that required to cause cosmetic or structural damage to buildings or lead to disturbance of occupiers, hence mitigation measures are not required in respect of the operational phase.

It may be concluded that the *Proposed Road Development* is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.

8.6 Residual Impacts

8.6.1 Operational Noise

Numerous locations were identified during the course of this assessment where the implementation of the *Proposed Road Development* would result in noise impacts which would meet all of the three conditions that must be satisfied before noise mitigation measures are deemed necessary. The majority of these locations were eventually included within the CPO (for the *Proposed Road Development*) or were not considered to be noise sensitive locations (e.g. farm buildings).

The result is five locations (R010, R016, R119, R227 and R254) where mitigation measures have been specified and once mitigation measures have been assessed these locations comply with the adopted criterion.

It may be concluded that the *Proposed Road Development* complies with the appropriate guidance in relation to noise; hence the associated impact is considered acceptable.

8.6.2 Construction Noise

During the construction phase of the project there will be some small impact on nearby residential properties due to noise emissions from site traffic and other activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that noise impact is kept to a minimum.

8.6.3 Operational and Construction Vibration

It may be concluded that the *Proposed Road Development* is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.

Compliance with the limits set out in the relevant appendices will ensure that any vibration impact associated with the extraction of material will not be significant.

8.7 Conclusions

The noise environment in the vicinity of the *Proposed Road Development* has been characterised by a set of traffic noise surveys. The existing noise levels are typical of a rural area in the vicinity of a major road.

Noise levels with the road in place have been predicted to be in excess of the design goal as set down in the NRA Guidelines at a number of receiver locations. A set of barriers to reduce noise levels from the road have been specified.

Indicative noise levels during the construction phase of the *Proposed Road Development* have been predicted. It has been shown that is possible to comply with the construction noise limits in the Guidelines.

8.8 Relevant Figures and Appendices

8.8.1 Figures Contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 8.1.1-8.1.8: Noise and Vibration Impact Assessment;

8.8.2 Appendices Contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 8.1: Considerations for the potential treatment of spoil material outside the CPO;

Appendix 8.2: Spoil Repositories/Borrow Pits (Type 2) No's 1 and 2 @ Drumfin Td.: Noise and Vibration Assessment;

Appendix 8.3: Spoil Repositories/Borrow Pits (Type 2) No. 3 @ Cloonymeenaghan Td.: Noise and Vibration Assessment;;

9 Air Quality and Climate Change

9.1 Introduction and Methodology

This chapter of the EIS assesses the impacts on air quality and climate associated with both the construction and operational phases of the N4 Collooney to Castlebaldwin *Proposed Road Development*. The legislative air quality background of relevance to the *Proposed Road Development* is summarised below.

9.1.1 Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set (see Table 9-1 below and Appendix 9.1 contained within Volume 4).

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directives 2008/50/EC*, which have set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO (see Table 9-1). *Council Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$ (see Appendix 9.1 contained within Volume 4).

With regard to dust deposition, the German TA-Luft standard for dust deposition (non-hazardous dust) (German VDI 2002) sets a maximum permissible emission level for dust deposition of 350 mg/(m^2/day) averaged over a one year period at any receptors outside the site boundary. Recommendations outlined by the Department of the Environment, Health & Local Government (DEHLG 2004a), apply the Bergerhoff limit of 350 mg/(m^2/day) to the site boundary of quarries.

9.1.2 Climate Agreements

Ireland ratified the United Nations Framework Convention on Climate Change (UNFCCC) in April 1994 and the *Kyoto Protocol* in principle in 1997 and formally in May 2002 (Framework Convention on Climate Change, 1999 and Framework Convention on Climate Change, 1997). For the purpose of the European Union burden sharing agreement under Article 4 of the *Kyoto Protocol*, in June 1998, Ireland agreed to limit the net growth of the six Greenhouse Gases (GHGs) under the *Kyoto Protocol* to 13% above the 1990 level over the period 2008 to 2012 (ERM, 1998). The UNFCCC is continuing detailed negotiations in relation to GHGs reductions and in relation to technical issues such as emissions trading and burden sharing.

9.1.3 Gothenburg Protocol

In 1999, Ireland signed the *Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution*. The objective of the Protocol is to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the targets Ireland had, by 2010, to meet national emission ceilings of 42kt for SO_2 (67% below 2001 levels), 65kt for NO_X (52% reduction), 55kt for VOCs (37% reduction) and 116kt for NH_3 (6% reduction). *European Commission Directive 2001/81/EC*, the National Emissions Ceiling Directive, prescribed the same emission limits. Emissions of SO_2 and NH_3 from the road traffic sector are insignificant accounting for less than 1.5% of total emissions in Ireland in 2001. Road traffic emissions of Nitrogen Oxides (NO_X) and Volatile Organic Compounds (VOCs) are important accounting for 37% and 38% respectively of total emissions of these pollutants in Ireland in 2001 (DEHLG, 2003). A National Programme for the progressive reduction of emissions of the four transboundary pollutants has been in place since April 2005 (DEHLG, 2004b). A review of the National Programme in 2011 (EPA 2013A) showed that Ireland complied with the emissions ceilings for SO_2, VOCs and NH_3 but failed to comply with the ceiling for NO_X. The proposal to amend the National Emissions Ceiling Directive is still under preparation and should set emission ceilings to be respected by 2020 for the four currently regulated substances as well as for primary emissions of $PM_{2.5}$.

Table 9-1: Air Quality Standards Regulations 2011 S.I. 180 of 2011 (These Regulations transposed European Commission Directive 2008/50/EC*)*

Pollutant	Regulation [Note1]	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	40% until 2003 reducing linearly to 0% by 2010	200 µg/m^3 NO_2
		Annual limit for protection of human health	40% until 2003 reducing linearly to 0% by 2010	40 µg/m^3 NO_2
		Annual limit for protection of vegetation	None	30 µg/m^3 NO + NO_2
Lead	2008/50/EC	Annual limit for protection of human health	100%	0.5 µg/m^3
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	150 µg/m^3	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50%	50 µg/m^3 PM_{10}
		Annual limit for protection of human health	20%	40 µg/m^3 PM_{10}
$PM_{2.5}$ (Stage 1)	2008/50/EC	Annual limit for protection of human health	20% from June 2008. Decreasing linearly to 0% by 2015	25 µg/m^3 $PM_{2.5}$
$PM_{2.5}$ (Stage 2) [Note 2]	-	Annual limit for protection of human health	None	20 µg/m^3 $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 µg/m^3
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	60%	10 mg/m^3 (8.6 ppm)

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 EU 2008/50/EC states - *'Stage 2 — indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States'.*

9.1.4 Construction Phase - Local Air Quality Assessment

An assessment of the air quality impacts likely to arise from sites identified by Sligo County Council which are suitable for both the extraction of rock material and deposition of peat/organic clay material described in Section 4.10.2 of chapter 4 of the EIS as Spoil Repositories/Borrow Pit (Type 2) Numbers 01, 02 and 03 and labelled accordingly as:

- SR-LI-01, occurring in the townland of Drumfin;
- SR-LI-02, occurring in the townland of Drumfin;

- SR/BP Type 02-No. 01, occurring in the townland of Drumfin;
- SR/BP Type 02-No. 02, occurring in the townland of Drumfin;
- SR-LI-03, occurring in the townland of Drumfin/Cloonlurg;
- SR-LI-04, occurring in the townland of Drumfin/Cloonlurg;
- SR/BP Type 02-No. 03, occurring in the townland of Cloonymeenaghan;

Additionally there are further Spoil Repositories/Borrow Pits and landscape infilling mitigation sites described also in the aforementioned section of Chapter 4 as Spoil Repositories/Borrow Pits (Type 1) numbers 01, 02, 03 and 04. These pits are configured for the excavation of subsoil which is considered suitable for road construction purposes and the subsequent replacement with subsoil material not considered suitable for road construction purposes, they are considered generally within road construction activities rather than undertaking site specific surveys. Similarly there are Landscape Mitigation sites located along the route which are to be in-filled/re-graded with subsoil material; these also are considered under general construction activities.

The assessment quantifies the potential dust impact from construction of the road. The assessment has been carried out following procedures described in the publications by the EPA (EPA 2002, 2003) and using the methodology outlined in the guidance documents published by the USEPA (USEPA 2004a, 2004b and 2005).

It is expected that construction of the *Proposed Road Development* could potentially generate the movement (transport volume) of circa 735,000m^3 of soft geological material (including c. 307,000m^3 of PEAT and 234,000m^3 of organic clay) to identified locations predominately within the CPO.

As outlined in Chapter 4 of this EIS it will be the contractor's responsibility to deal with this material in accordance with the various statutory requirements. However, in order to quantify the effects such an activity will have on the receiving air quality environment, this assessment examines the impact on air quality of transferring this material to the aforementioned sites which are described in further detail in section 4.10.2 of Chapter 4 and which are arising from the assessment carried out in the Spoil Management Report contained as Appendix 4.3 of Volume 4.

The worst-case maximum excavation/deposition rate has been used in the model in order to conservatively estimate the impact of the extraction and repository activities on the surrounding environment. For the purpose of the assessment it was assumed that all sites were being used simultaneously in order to provide a worst-case result. In reality this is unlikely to occur and will be constrained by other factors such as controls outlined in the Outline Erosion and Sediment Control Plan for the *Proposed Road Development*. Details of the assessment are provided in Appendix 9.2 of Volume 4.

It is estimated that following the exhaustion of the repository stage of the sites mentioned above which are contained within the confines of the *Proposed Road Development* that there will potentially remain a surplus of circa 67,000m^3 of peat and circa 7,000m^3 of organic clays. In order to reflect the potential impacts which this activity may generate, the Range of Options described in Section 10 of the Spoil Management Report is referred to. Although consideration of such sites is hypothetical at the current stage of consent as explained in the aforementioned Spoil Management Report it allows for any such activity to be quantified in terms of air quality, in this regard and in order to demonstrate potential effects, the sites which are considered include LD CP 01, LD CP 04, LD CP 05, LD CP 06 (Conifer Plantation), LD AG 01 and LD AG 02 (Agricultural Land). Details of the assessment are provided in Appendix 9.3 of Volume 4.

9.1.5 Construction Phase - Climate

Based on estimates already discussed in section 9.1.4 it is estimated that peat may be spread on c. 6.6ha of land within the confines of the *Proposed Road Development*. Some peat may be used to enhance unsuitable material for the purposes of landscaping within the *Proposed Road Development*, however, the peat material is generally of limited re-use value on the *Proposed Road Development* and therefore a significant quantity will need to be dealt with. It is proposed that the residual peat will be deposited at the sites already described in section 9.1.4 within the limits of the CPO.

The greenhouse gas emissions associated with peat extraction and abandonment has been assessed using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 7 Wetlands (IPCC, 2006). Details of the assessment are provided in Appendix 9.2 and Appendix 9.3 of Volume 4.

9.1.6 Operational Phase - Local Air Quality Assessment

The air quality assessment has been carried out following procedures described in the publications by the EPA (EPA 2002, 2003) and using the methodology outlined in the guidance documents published by the UK DEFRA (UK DEFRA 2001, 2007, 2009a, 2009b; UK DETR 1998) and the NRA (NRA 2011). The assessment of air quality was carried out using a phased approach as recommended by the UK DEFRA (UK DEFRA 2009a). The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. An examination of recent EPA and Local Authority data in Ireland (EPA 2012, 2013), has indicated that SO_2 and smoke and CO are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed monitoring or assessment to be carried out.

The current assessment thus focused firstly on identifying the existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, benzene and CO in the region of the *Proposed Road Development*, both currently (by carrying out a baseline survey and by analysis of suitable EPA monitoring data), and when the *Proposed Road Development* is opened (through modelling). Thereafter, the impact of the *Proposed Road Development* on air quality at the neighbouring sensitive receptors was determined relative to "do nothing" levels for the opening and design years (2017 and 2032). The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (UK DEFRA 2007) (Version 1.03c, July 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2012) (Version 3.2 (Released September 2012)) and following guidance issued by the NRA (NRA 2011), UK DEFRA (UK DEFRA 2007, 2009a) and the EPA (EPA 2002, 2003). The inputs to the air dispersion model consist of information on road layouts, receptor locations, annual average daily traffic movements (AADT), annual average traffic speeds and background concentrations. Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptors using generic meteorological data. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentrations. The worst-case ambient concentrations are then compared with the relevant ambient air quality standard to assess the compliance of the *Proposed Road Development* with these ambient air quality standards.

Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the NRA guidelines (NRA 2011) detail a methodology for determining air quality impact significance criteria for road schemes. The degree of impact is determined based on both the absolute and relative impact of the *Proposed Road Development*. The NRA significance criteria have been adopted for the *Proposed Road Development* and are detailed in Table 9-2 to Table 9-4. The significance criteria are based on PM_{10} and NO_2 as these pollutants are most likely to exceed the limit values. However the criteria have also been applied to the predicted 8-hour CO, annual benzene and annual $PM_{2.5}$ concentrations for the purposes of this assessment.

Table 9-2: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO_2 / PM_{10}	No. days with PM_{10} concentration > 50 $\mu g/m^3$	Annual Mean $PM_{2.5}$
Large	Increase / decrease ≥4 $\mu g/m^3$	Increase / decrease >4 days	Increase / decrease ≥2.5 $\mu g/m^3$
Medium	Increase / decrease 2 - <4 $\mu g/m^3$	Increase / decrease 3 or 4 days	Increase / decrease 1.25 - <2.5 $\mu g/m^3$
Small	Increase / decrease 0.4 - <2 $\mu g/m^3$	Increase / decrease 1 or 2 days	Increase / decrease 0.25 - <1.25 $\mu g/m^3$
Imperceptible	Increase / decrease <0.4 $\mu g/m^3$	Increase / decrease <1 day	Increase / decrease <0.25 $\mu g/m^3$

Source: Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - National Roads Authority (2011)

Table 9-3: Air Quality Impact Significance Criteria for Annual Mean Nitrogen Dioxide and PM_{10} and $PM_{2.5}$ Concentrations at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration [Note 1]		
	Small	Medium	Large
Increase with Realignment			
Above Objective/Limit Value With Realignment (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Realignment (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Realignment (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Realignment (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Adverse
Decrease with Realignment			
Above Objective/Limit Value With Realignment (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Realignment (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Realignment (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Realignment (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - National Roads Authority (2011)*

Table 9-4: Air Quality Impact Significance Criteria For Changes to Number of Days with PM_{10} Concentration Greater than 50 µg/m^3 at a Receptor

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration [Note 1]		
	Small	Medium	Large
Increase with Realignment			
Above Objective/Limit Value With Realignment (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Realignment (32 - <35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Realignment (26 - <32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Realignment (<26 days)	Negligible	Negligible	Slight Adverse

Absolute Concentration in Relation to Objective/Limit Value	Change in Concentration [Note 1]		
	Small	Medium	Large
Decrease with Realignment			
Above Objective/Limit Value With Realignment (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Realignment (32 - <35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Realignment (26 - <32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Realignment (<26 days)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes - National Roads Authority (2011)*

9.1.7 Operational Phase - Regional Impact Assessment Including Climate

The impact of the *Proposed Road Development* at a national / international level has been determined using the procedures given by the NRA (NRA 2011) and the methodology provided in Annex 2 in the UK DMRB (UK DEFRA 2007). The assessment focused on determining the resulting change in emissions of CO, particulates (PM_{10}), volatile organic compounds (VOCs), nitrogen oxides (NOx) and carbon dioxide (CO_2). The Annex provides a method for the prediction of the regional impact of emissions of these pollutants from road schemes.

The inputs to the air dispersion model consist of information on road link lengths, AADT movements and annual average traffic speeds.

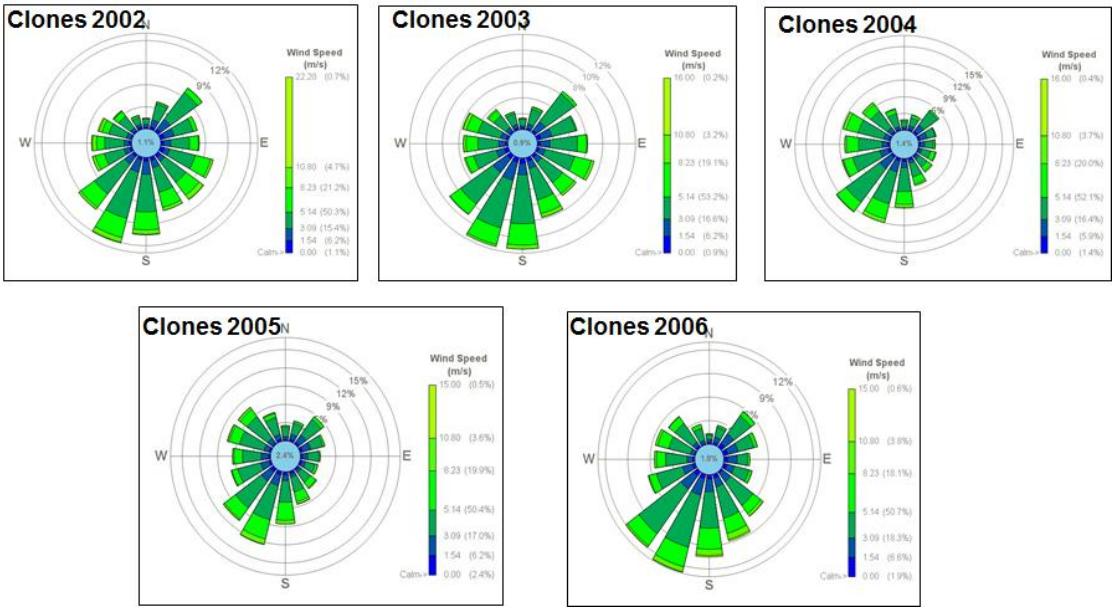
9.2 Description of the Existing Environment

9.2.1 Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels) (WHO 2006). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM_{10}, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than $PM_{2.5}$) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles ($PM_{2.5}$ - PM_{10}) will actually increase at higher wind speeds. Thus, measured levels of PM_{10} will be a non-linear function of wind speed.

The nearest representative weather station collating detailed weather records is Clones meteorological station, which is located approximately 75 km east of the southern end of the *Proposed Road Development*. For data collated during five representative years (2002 - 2006), the predominant wind ranges from southerly to westerly in direction. The mean wind speed is approximately 4 m/s over the period 1978 – 2007 (see Figure 9-1 below).

Figure 9-1: Windrose for Clones Meteorological Station (2002 – 2006)



9.2.2 Trends in Air Quality

Air quality is variable and subject to both significant spatial and temporal variation. In relation to spatial variations in air quality, concentrations generally fall significantly with distance from major road sources (UK DEFRA 2007). Thus, residential exposure in urban and suburban areas is determined by the location of sensitive receptors relative to major roads sources in the area. Temporally, air quality can vary significantly by orders of magnitude due to changes in traffic volumes, meteorological conditions and wind direction.

9.2.3 Baseline Air Quality

A baseline monitoring study was carried out close to the alignment of the proposed road. The results of the survey allow an indicative comparison with the annual limit values for NO_2, benzene, PM_{10} and $PM_{2.5}$, and the 24-hour limit value for PM_{10}. The results also provide information on the influence of road sources relative to the prevailing background level of these pollutants in the area. The monitoring methodology and results are described below.

9.2.3.1 Meteorological Conditions during the Monitoring Period

The weather during August 2010 was mainly sunny and mild but interspersed with wet periods. From the 1st to the 15th there were spells of light rain with intervals of fair weather. Winds during the period were recorded as being light to moderate and veered from westerly to northerly later in the period. From the 16th to the 24th there was some heavy rain accompanied by strong southerly winds. There were also some sunny spells between showers. From the 25th to the end of the month, drier and sunnier weather prevailed with the odd shower in coastal areas. Winds were light during this period and were mainly northerly in direction. The overall mean wind speed for the month was between 9 and 24 km/hr and the average was below normal for August.

The weather during September 2010 was wetter than average but interspersed with some settled periods. From the 1st to the 3rd the weather was mainly dry and sunny with light south easterly winds. From the 4th to the 14th there were showers every day, some very heavy, particularly from the 4th to the 7th. Winds were south to south westerly in direction and reached gale force on the 13th and 14th. From the 15th to the end of the month there were small amounts of light rain on most days with heavy showers on the 22nd and 28th. The rain was interspersed with sunny spells during this period. Winds changed to northerly in direction towards the end of the month. The overall mean wind speed for the month was between 11 and 28 km/hr and the average was above normal for September.

October 2010 was drier and sunnier than normal. From the 1st to the 8th conditions were wet with some particularly heavy showers at times in western areas. Strong south to south westerly winds prevailed during this period. Between the 9th and the 21st conditions were drier and calmer with some fog at times. From the

22nd to the end of the month wet and windy conditions returned. Colder north to north westerly winds prevailed early in this period giving way to milder south to south westerly winds at the end of the month. The mean wind speeds for the month were between 11 and 30 km/hr which about the average being normal for October.

9.2.3.2 NO_2

NO_2 was monitored, using nitrogen dioxide passive diffusion tubes, over a three month period at ten locations. The monitoring locations were sited close to the route of the *Proposed Road Development* (see Table 9-5 below and Figure 9.1.1 to 9.1.8 contained within Volume 3 of this EIS). Passive sampling of NO_2 involves the molecular diffusion of NO_2 molecules through a polycarbonate tube and their subsequent adsorption onto a stainless steel gauze coated with triethanolamine. Following sampling, the tubes were analysed using Gas Chromatography, at a UKAS accredited laboratory (ESG, Oxfordshire).

The locations were chosen in order to assess roadside and rural levels of NO_2. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of NO_2 away from existing road sources. The spatial variation is particularly important for NO_2, as a complex relationship exists between NO, NO_2 and O_3 leading to a non-linear variation of NO_2 concentrations with distance.

Studies in the UK have shown that diffusion tube monitoring results generally have a positive or negative bias when compared to continuous analysers. This bias is laboratory specific and is dependent on the specific analysis procedures at each laboratory. A diffusion tube bias of 0.82 was obtained for the Environmental Scientifics Group Oxfordshire laboratory (which analysed the diffusion tubes) from the UK Air Quality Review and Assessment website (University of West England, 2007). This bias was applied to the diffusion tube monitoring results.

The passive diffusion tube survey was designed to assess rural and roadside levels along the route of the *Proposed Road Development* and also roadside levels in Collooney and Castlebaldwin (see Table 9-5 below and Figure 9.1.1 to 9.1.8 contained within volume 3 of this EIS). The average monitoring results for the three months of monitoring indicate that rural background concentrations along the proposed route reached at most 3 µg/m^3. The average levels at the roadside locations along the N4 are higher than the average rural background level (6 - 7 µg/m^3). The average levels at the locations south of Collooney and in Castlebaldwin were 6 and 8 µg/m^3 respectively.

All average NO_2 concentrations measured over the three month period were well below the European Union (EU) annual limit value reaching at most 20% of the limit value in Castlebaldwin. Rural levels reached only 8% of the limit value.

Table 9-5: Results of NO_2 Diffusion Tube Monitoring Carried Out Near The Proposed N4 Collooney to Castlebaldwin Road Development

Location Type	Location	NO_2 (µg/m^3)[Note 1]			
		04/08/10 - 03/09/10	03/09/10 - 30/09/10	30/09/10 – 01/11/10	Average
Urban	M1 – South of N4/N17 Jct.	4	6	7	6
Roadside	M2 – Ardcurley Td.	7	7	7	7
Roadside	M3 – Doorly	5	6	[Note 3]	6
Rural	M4 – Drumfin 1	1	2	4	2
Rural	M5 - Cloonlurg	2	4	4	3
Roadside	M6 - Drumfin 2	6	7	7	7
Rural	M7 - Carrownagark	1	2	2	2
Roadside	M8 - Aghalenane	6	7	9	7
Rural	M9 - Sheerevagh	1	2	3	2
Urban	M10 - Castlebaldwin Village	8	7	9	8

Location Type	Location	NO_2 ($\mu g/m^3$)[Note 1]			
		04/08/10 - 03/09/10	03/09/10 - 30/09/10	30/09/10 – 01/11/10	Average
		Limit Value			*40*[Note 2]

Note 1 Diffusion tube bias factor of 0.82 applied to laboratory results

Note 2 EU Council Directive 2008/50/EC (as an annual average)

Note 3 Sample Tube Not Retrieved

9.2.3.3 PM_{10} / $PM_{2.5}$

The PM_{10} & $PM_{2.5}$ monitoring program was carried out by means of a Turnkey Instruments® Osiris Environmental Dust Monitor in the townland of Sheerevagh (see Figure 9.1.7 in Volume 3). The location was positioned to allow an assessment of rural background levels in the region of the *Proposed Road Development*. The Osiris instrument is a light scattering device capable of continuous measurement of Total Suspended Particulate (TSP), PM_{10}, $PM_{2.5}$ and $PM_{1.0}$. The air sample was continuously drawn into the instrument by a pump through a heated inlet at a flow rate of 600 ml/min. The incoming air passed through a laser beam in a photometer. The light scattered by the individual particles of dust was measured by the photometer and this information used to measure the size and concentration of the dust particles. A two-year inter-comparison study between PM_{10} monitoring methods in Camden, London has shown that the Osiris instrument gives similar results to the TEOM analyser (Tod *et al*. 2002), which is widely used in the UK PM_{10} monitoring network (UK DEFRA, 2005).

Daily concentrations of PM_{10} and $PM_{2.5}$ measured at the rural location are shown in Table 9-6 and Table 9-7 and Figure 9-2 and Figure 9-3.

The average PM_{10} concentration measured over the one month period was 15 $\mu g/m^3$, which is 38% of the EU annual limit value of 40 $\mu g/m^3$. The results also show that the 24-hour average levels of PM_{10} did not exceed the 24-hour EU limit value of 50 $\mu g/m^3$ over the monitoring period. The 24-hour limit value is expressed as a 90.4th%ile, which means 35 exceedances are permitted per year. The 90.4th%ile of 24-hour average PM_{10} levels measured was 31 $\mu g/m^3$, which is 62% of the limit value. There were some short-term peaks in PM_{10} concentrations on the 29th of September 2010 and the 11th, 12th and 13th of October 2010. As the periods of elevated particulate levels generally occurred overnight and were not longer than one hour in duration, it is unlikely that traffic from the existing N4 or other local roads was the source of such levels. There were no exceedances of the 24-hour limit value for PM_{10} during the monitoring period.

Daily levels of $PM_{2.5}$ measured over the one month period averaged 5.9 $\mu g/m^3$, reaching only 24% of the annual limit of 25 $\mu g/m^3$.

Table 9-6: Results of PM_{10} and $PM_{2.5}$ Monitoring Carried Out at a Rural Location in the Townland of Sheerevagh

Date	PM_{10} Conc. ($\mu g/m^3$)	$PM_{2.5}$ Conc. ($\mu g/m^3$)	Date	PM_{10} Conc. ($\mu g/m^3$)	$PM_{2.5}$ Conc. ($\mu g/m^3$)
22-Sep-10	9	3	08-Oct-10	31	17
23-Sep-10	11	3	09-Oct-10	37	25
24-Sep-10	13	5	10-Oct-10	27	15
25-Sep-10	9	2	11-Oct-10	33	7
26-Sep-10	8	3	12-Oct-10	33	3
27-Sep-10	7	3	13-Oct-10	30	5
28-Sep-10	12	4	14-Oct-10	8	3
29-Sep-10	19	3	15-Oct-10	8	3
30-Sep-10	8	4	16-Oct-10	17	5
01-Oct-10	10	5	17-Oct-10	10	5

Date	PM_{10} Conc. ($\mu g/m^3$)	$PM_{2.5}$ Conc. ($\mu g/m^3$)	Date	PM_{10} Conc. ($\mu g/m^3$)	$PM_{2.5}$ Conc. ($\mu g/m^3$)
02-Oct-10	10	5	18-Oct-10	19	10
03-Oct-10	12	5	19-Oct-10	15	6
04-Oct-10	20	10	20-Oct-10	9	3
05-Oct-10	18	9	21-Oct-10	6	2
06-Oct-10	13	6	22-Oct-10	6	2
07-Oct-10	15	7	23-Oct-10	6	2
Limit Values	*50 Note 1, 40 Note 2*	*25 Note 3*	*Limit Values*	*50 Note 1, 40 Note 2*	*25 Note 3*

Note 1 EU Council Directive 2008/50/EC - *24-hour limit value not to be exceeded >35 times per year*

Note 2 EU Council Directive 2008/50/EC (as an annual average)

Note 3 EU Council Directive 2008/50/EC - *annual limit value applicable after 2010*

Table 9-7: Summary of PM_{10} and $PM_{2.5}$ Monitoring Results in the Townland of Sheerevagh

PM_{10} / $PM_{2.5}$ Monitoring Results Summary		
PM_{10} Results	Total No. Days Sampling	32
	No. Days > 50 $\mu g/m^3$	0
	90.4th%ile of 24-hour Averages	31
	PM_{10} Average	15
	Limit Value	*50 $\mu g/m^3$ Note 1, 40 $\mu g/m^3$ Note 2*
$PM_{2.5}$ Results	Total No. Days Sampling	32
	$PM_{2.5}$ / PM_{10} Ratio	0.39
	$PM_{2.5}$ Average	5.9
	Limit Value	*25 $\mu g/m^3$ Note 3*

Note 1 EU Council Directive 2008/50/EC - *24-hour limit value not to be exceeded >35 times per year*

Note 2 EU Council Directive 2008/50/EC (as an annual average)

Note 3 EU Council Directive 2008/50/EC - *annual limit value applicable after 2010*

Figure 9-2: PM10 and PM2.5 Concentrations in Sheerevagh (22/09/10 – 23/10/10)

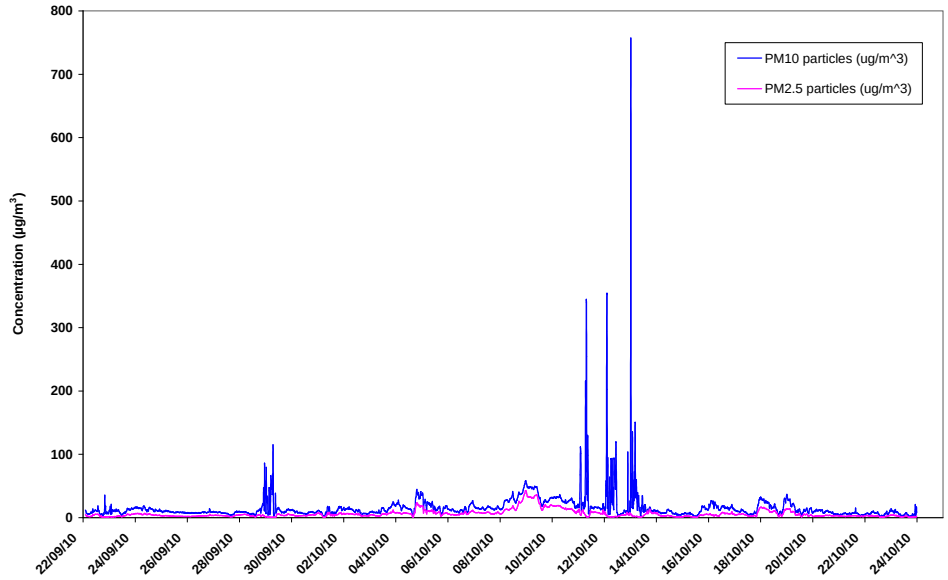
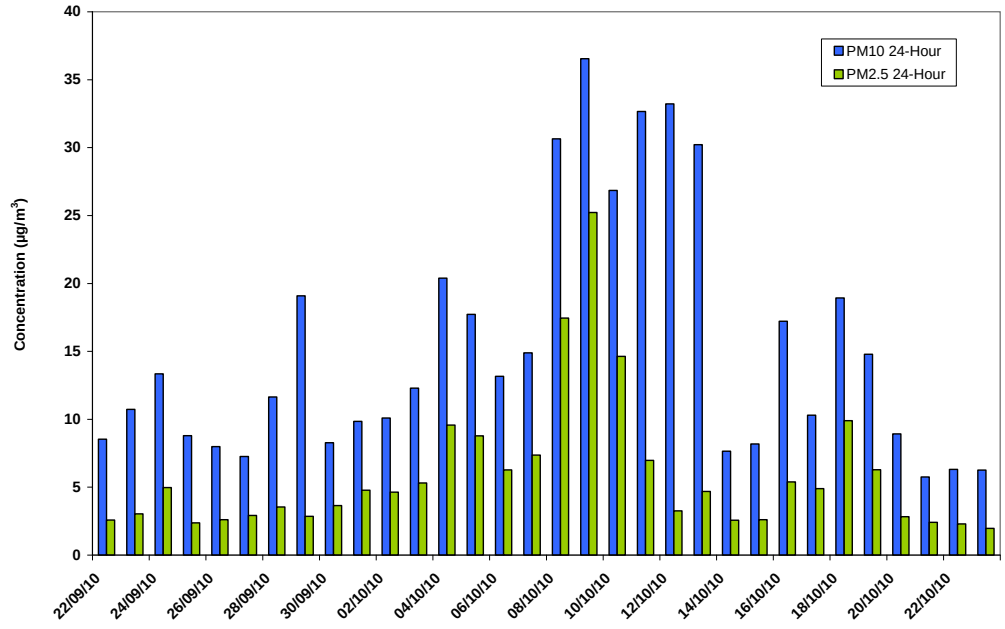


Figure 9-3: 24-Hour PM10 and PM2.5 Concentrations in Sheerevagh (22/09/10 – 23/10/10)



9.2.4 Background Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "Air Quality Monitoring Annual Report 2011" (EPA 2012), details the range and scope of monitoring undertaken throughout Ireland.

As part of the implementation of the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), four air quality zones have been defined in Ireland for air quality management and assessment purposes (EPA 2012, 2013B). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 21 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D. In terms of air monitoring, the region of the *Proposed Road Development* is categorised as Zone D (EPA 2012, 2013B).

Long-term NO_2 monitoring is carried out at two rural Zone D locations, Glashaboy and Kilkitt (EPA 2012). The NO_2 annual average in 2011 for both sites was 9 and 3 µg/m^3, respectively. The results of NO_2 monitoring

carried out at the urban Zone D locations of Castlebar and Shannon Town in 2011 indicated average NO_2 concentrations of 8 and 6 µg/m^3, respectively with no exceedances of the 1-hour limit value (EPA 2012). Hence, the long-term average concentrations measured at these locations were significantly lower than the annual average limit value of 40 µg/m^3. Based on the above information and baseline monitoring data, a conservative estimate of the 2013 background NO_2 concentration, for the region of the *Proposed Road Development* is 10 µg/m^3.

The results of CO monitoring carried out in Shannon Town (Zone D) and Old Station Road (Zone B) in 2011 showed no exceedances of the 8-hour limit value (EPA 2012), with average annual mean levels of 0.2 mg/m^3 and 0.3 mg/m^3 respectively (EPA 2012). The maximum 8-hour levels recorded at Shannon Town and Old Station Road in 2011 were 1.3 mg/m^3 and 2.7 mg/m^3 respectively (EPA 2012). Based on the above information, a conservative estimate of the long-term background CO concentration for the region of the *Proposed Road Development* in 2013 is 0.4 mg/m^3.

With regard to benzene, continuous monitoring was carried out at Shannon Town (Zone D) in 2011, with a long-term average of 0.4 µg/m^3 (EPA 2012). The results of monitoring carried out in the Zone D location of Emo Court in 2010 also indicated a long-term averages of 0.4 µg/m^3 (EPA 2012). Based on the above information and baseline monitoring data a conservative estimate of the background benzene concentration for the region of the *Proposed Road Development* in 2013 is 0.5 µg/m^3.

Long-term PM_{10} monitoring was carried out at the urban Zone D locations of Castlebar, Claremorris and Shannon Town in 2011 (EPA 2012). The average concentrations measured at the three sites were 14, 12 and 11 µg/m^3, respectively. Long-term PM_{10} measurements carried out at the rural Zone D location in Kilkitt in 2011 gave an average level of 9 µg/m^3 (EPA 2012). In addition, annual average PM_{10} levels at the urban background monitoring location in the Phoenix Park in 2011 were 12 µg/m^3, with only three exceedances of the 24-hour limit value of 50 µg/m^3 (EPA 2012). Based on the above information a conservative estimate of the 2013 background PM_{10} concentration, for the region of the *Proposed Road Development* which is defined as Zone D is 15 µg/m^3.

The results of $PM_{2.5}$ monitoring at Claremorris (Zone D) in 2011 (EPA 2012) indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.5. The results of $PM_{2.5}$ monitoring at Ennis (Zone C) in 2011 (EPA 2012) indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.64. Based on this information, a conservative ratio of 0.65 was used to generate a rural background $PM_{2.5}$ concentration in 2013 of 9.8 µg/m^3.

Background concentrations for 2017 and 2032 were calculated from the 2012 background concentrations using the Netcen background calculator, which uses year on year reduction factors provided by UK DEFRA (UK DEFRA 2009a). A summary of the background *concentrations used for the DMRB air dispersion model is detailed in Table 9-8*.

A study by the UK ODPM (UK ODPM 2000) gives estimates of likely dust deposition levels in specific types of environments. In open country a level of 39 mg/(m^2*day) is typical, rising to 59 mg/(m^2*day) on the outskirts of town and peaking at 127 mg/(m^2*day) for a purely industrial area. As a worst-case, a level of 59 mg/m^2*day can be estimated as the existing dust deposition level for the current location. A summary of the background concentrations used for the AERMOD material deposition/repository model is detailed in Table 9-9.

In relation to the annual averages, the ambient background concentration is added directly to the process concentration. However, in relation to the short-term peak concentration, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA (UK DEFRA 2009a) advises that for PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown on the following page:

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

(a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

Table 9-8: Summary of background concentrations used in the DMRB air dispersion model.

Background Values	Nitrogen Oxides ($\mu g/m^3$)	Nitrogen Dioxide ($\mu g/m^3$)	Benzene ($\mu g/m^3$)	Particulates (PM_{10}) ($\mu g/m^3$)	Particulates ($PM_{2.5}$) ($\mu g/m^3$)[Note 2]	Carbon Monoxide (mg/m^3)
Year 2013	17.1	10.0	0.50	15.0	9.8	0.40
Year 2017[Note 1]	13.5	8.0	0.50	14.7	9.6	0.39
Year 2032[Note 1]	8.5	5.0	0.53	14.5	9.5	0.42

Note 1 Reduction in future years using the Netcen background calculator (November 2002) and Netcen background calculator 3.2 (2012).

Note 2 A ratio of 0.65 has been used for the ratio of $PM_{2.5}$ / PM_{10}.

Table 9-9: Summary of background concentrations used in the AERMOD air dispersion model.

Background Values	Particulates (PM_{10}) ($\mu g/m^3$)	Particulates ($PM_{2.5}$) ($\mu g/m^3$)[Note 1]	Dust Deposition ($mg/m^2/day$)
Year 2013	15.0	9.8	59

Note 1 A ratio of 0.65 has been used for the ratio of $PM_{2.5}$ / PM_{10}.

9.3 Characteristics of the *Proposed Road Development*

9.3.1 Construction Phase

It is expected that construction of the *Proposed Road Development* could potentially generate the movement (transport volume) of circa 735,000m^3 of soft geological material (including c. 307,000m^3 of peat and 234,000m^3 of organic clay) to identified locations predominately within the CPO during the construction phase of the *Proposed Road Development* which may give rise to some dust and particulate emissions. Peat deposition would also be expected to be the dominant source of greenhouse gas emissions resulting from the construction phase of the *Proposed Road Development*.

9.3.2 Operational Phase

Road traffic is expected to be the dominant source of emissions resulting from the operational phase of the *Proposed Road Development*. Road traffic would also be expected to be the dominant source of greenhouse gas emissions resulting from the *Proposed Road Development*.

9.4 Description of Likely Impacts

9.4.1 Construction Phase – Local Air Quality

The emissions from the spoil repository processes lead to an annual average dust deposition level including background of 89.5 mg/(m^2*day) at the worst-case receptor which is only 26% of the TA Luft Limit Value of 350 mg/(m^2*day). Predicted PM_{10} and $PM_{2.5}$ concentrations are also significantly lower than the ambient air quality standards at the nearest residential receptors to the repository/recovery sites. Detailed results of the impact of the material deposition and extraction modelling on local air quality are provided in Appendix 9.2 contained within Volume 4 of this EIS.

As mentioned in Section 9.1.4, an air quality assessment was undertaken in order to consider potential spoil management activities which may be required offsite. The emissions from the peat deposition processes lead to an annual average dust deposition level including background of 99.1 mg/(m^2*day) at the worst-case receptor which is only 28% of the TA Luft Limit Value of 350 mg/(m^2*day). Predicted PM_{10} and $PM_{2.5}$ concentrations are also significantly lower than the ambient air quality standards at the nearest residential receptors to the deposition sites. Detailed results of the impact of the peat deposition modelling on local air quality are provided in Appendix 9.3 contained within Volume 4 of this EIS.

9.4.2 Construction Phase – Climate

The emissions from peat removal and deposition for sites within the CPO have been compared with the estimated total GHG emissions in Ireland in 2010 based on compliance with the Kyoto Target (DEHLG, 2000). The contribution to the total GHG emissions (which is assumed to be 62.8 million tonnes CO_2eq in 2010 (i.e. the Kyoto Target) is 0.00005% of the total in Ireland in that year and thus is an insignificant source of greenhouse gas emissions. Details of the peat deposition model are provided in Appendix 9.2 contained within Volume 4 of this EIS.

The emissions from peat removal and deposition for potential sites outside the CPO have been compared with the estimated total GHG emissions in Ireland in 2010 based on compliance with the Kyoto Target (DEHLG, 2000). The contribution to the total GHG emissions (which is assumed to be 62.8 million tonnes CO_2eq in 2010 (i.e. the Kyoto Target) is 0.0005% of the total in Ireland in that year and thus is an insignificant source of greenhouse gas emissions. Details of the peat deposition model are provided in Appendix 9.3 contained within Volume 4 of this EIS.

9.4.3 Operational Phase – Local Air Quality

Detailed traffic flow information was obtained from the traffic consultant for this project and has been used to model pollutant levels under various traffic scenarios and under sufficient spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur. The traffic data corresponded to the design years of 2017 and 2032. The traffic data used represented high-growth figures for the "do nothing" (i.e. without the *Proposed Road Development* in place) and "do something" (i.e. with the *Proposed Road Development* in place) scenarios which are the worst-case figures in terms of air quality.

Cumulative effects have been assessed, as recommended in the EU Directive on EIA (Council Directive 97/11/EC) and using the methodology of the UK DEFRA (UK DEFRA 2009a, UK DETR 1998). Firstly, background concentrations (UK DEFRA 2009a) have been included in the modelling study, for both "do nothing" and "do something" scenarios. These background concentrations are year-specific and account for non-localised sources of the pollutants of concern (UK DEFRA 2009a). Appropriate background levels were selected based on the available monitoring data provided by the EPA and Local Authorities (EPA 2012, 2013B) (see section 9.2.4 of this Chapter).

Once appropriate background concentrations were established, the existing situation, including background levels, was assessed in the absence of the *Proposed Road Development* for the opening and design years. The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (Version 1.03c) (UK DEFRA 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2012) (Version 3.2 (Released September 2012)) and the following guidance issued by the UK DEFRA (UK DETR 1998; UK DEFRA 2007, 2009a, 2009b). Ambient concentrations of CO, benzene, NO_2, PM_{10} and $PM_{2.5}$ for 2017 and 2032 were predicted at the nearest sensitive receptors to the *Proposed Road Development*. "Do nothing" and "do something" modelling was carried out at the building façade of the worst-case receptors for both 2017 and 2032. This assessment allows the significance of the *Proposed Road Development*, with respect to both relative and absolute impact, to be determined both temporally and spatially.

9.4.3.1 Receptor Locations

Twenty-three locations were modelled close to the route of the *Proposed Road Development*. The receptors modelled represent the worst-case locations along the N4 mainline and were chosen due to their close proximity to the *Proposed Road Development* as well as the existing N4. Details of the assessment locations are provided in Table 9-10.

Annual average traffic speeds are required as an input to the DMRB screening model (UK DEFRA 2007). The proposed N4 was modelled at a speed of 100 kph and the existing N4 was modelled at a speed of 80 kph except for the northern end of the existing route which was modelled at 100 kph as this section is part of the proposed route.

Table 9-10: DMRB Screening Air Quality Assessment, Proposed N4 Collooney Castlebaldwin. Details of Assessment Locations.

Receptor No.	Location / Townland	Approximate Chainage	ITM Co-ordinates
005	Toberbride	250	568220 825071
103	Doorly 1	2600	569283 823047
104	Doorly 2	2800	569385 822865
118	Knocknagroagh	4050	569911 821696
141	Drumfin 1	5000	570595 820957
152	Drumfin 2	5600	570942 820337
159	Drumfin 3	5900	570701 820062
165	Drumfin 4	6400	571234 819678
178	Drumfin 5, Near Behy Castle	6900	571566 819299
186	Carrownagark 1	8000	572072 818459
192	Carrownagark 2 (Crossroads)	8500	572567 818099
207	Kingsbrook	9250	572681 817404
216	Tawnagh, Near Knockalassa School	9850	573250 817279
225	Aghalenane	10300	573516 816890
226	Springfield	10600	573880 816822
241	Cloonymeenaghan	11350	574222 816358
251	Cloongad	12400	574697 815559
254	Drumderry 1	12500	575080 815505
267	Drumderry 2	13200	575084 814972
286	Cleavry Td. close to Castlebaldwin Crossroads	13600	575345 814558
N/A	Castlebaldwin	13400	575610 814748
290	Cleavry 2	NA	575422 814476
351	Cloghoge Upper	13900	575557 814300

9.4.3.2 Modelling Results and Impact Assessment

9.4.3.2.1 *CO and Benzene*

The results of the modelled impact of the N4 for CO and benzene in the opening and design years are shown in Table 9-11 and Table 9-12. Predicted pollutant concentrations with the *Proposed Road Development* in place are below the ambient standards at all locations. Levels of both pollutants range from 10 - 21% of the respective limit values in 2017.

Future trends indicate similarly low levels of CO and benzene. Levels of both pollutants are below the relevant limit values, ranging from 11 - 22% of their respective limits in 2032.

The impact of the *Proposed Road Development* can be assessed relative to "do nothing" levels in 2017 and 2032 (see Table 9-11 and Table 9-12). Relative to baseline levels, some small increases and decreases in pollutant levels at the worst-case receptors are predicted as a result of the *Proposed Road Development*. With regard to impacts at individual receptors, none of the 23 receptors assessed will experience an increase or decrease in concentrations of greater than 5% of the limit value in either 2017 or 2032 and thus the magnitude

of the changes in air quality are either small or imperceptible at all receptors based on the criteria outlined in Table 9-2.

The greatest impact on CO and benzene concentrations in either 2017 or 2032 will be an increase of 0.8% of their respective limit values. Furthermore, the greatest improvement in CO and benzene concentrations will be a decrease of 1.9% of their respective limit values.

Thus, using the assessment criteria outlined in Table 9-2 and Table 9-3, and applying these criteria to CO and benzene, the impact of the *Proposed Road Development* in terms of CO and benzene is negligible.

Table 9-11: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Predicted Maximum 8-Hour CO Concentrations.

Receptor	Location	Maximum 8-Hour CO Concentrations (mg/m^3)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	2.0	2.2	2.0	2.2
103	Doorly 1	2.1	2.3	2.1	2.2
104	Doorly 2	2.1	2.2	2.0	2.2
118	Knocknagroagh	2.0	2.1	2.0	2.1
141	Drumfin 1	2.1	2.3	2.0	2.1
152	Drumfin 2	2.1	2.3	2.0	2.2
159	Drumfin 3	2.0	2.1	2.0	2.2
165	Drumfin 4	2.1	2.3	2.0	2.2
178	Drumfin 5, Near Behy Castle	2.1	2.3	2.0	2.1
186	Carrownagark 1	2.0	2.1	2.0	2.1
192	Carrownagark 2 (Crossroads)	2.1	2.3	1.9	2.1
207	Kingsbrook	2.0	2.1	2.0	2.2
216	Tawnagh, Near Knockalassa School	2.1	2.3	1.9	2.1
225	Aghalenane	2.1	2.3	2.0	2.1
226	Springfield	2.0	2.1	2.0	2.1
241	Cloonymeenaghan	2.1	2.3	2.0	2.1
251	Cloongad	2.1	2.2	1.9	2.1
254	Drumderry 1	1.9	2.1	2.0	2.1
267	Drumderry 2	2.1	2.2	1.9	2.1
286	Cleavry Td. close to Castlebaldwin Crossroads	2.0	2.3	2.0	2.1
N/A	Castlebaldwin	2.0	2.1	2.0	2.2
290	Cleavry 2	2.1	2.3	2.0	2.1
351	Cloghoge Upper	2.1	2.3	2.0	2.1
Ambient Limit Value[Note 1]		10 mg/m^3	10 mg/m^3	10 mg/m^3	10 mg/m^3

Note 1 Maximum 8-hour CO Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

Table 9-12: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Predicted Annual Mean Benzene Concentrations.

Receptor	Location	Annual Mean Benzene Concentrations (µg/m^3)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	0.51	0.55	0.51	0.54
103	Doorly 1	0.53	0.57	0.52	0.56
104	Doorly 2	0.52	0.55	0.51	0.54
118	Knocknagroagh	0.50	0.53	0.50	0.54
141	Drumfin 1	0.53	0.57	0.50	0.54
152	Drumfin 2	0.54	0.58	0.51	0.54
159	Drumfin 3	0.50	0.53	0.51	0.54
165	Drumfin 4	0.54	0.58	0.51	0.54
178	Drumfin 5, Near Behy Castle	0.53	0.56	0.50	0.53
186	Carrownagark 1	0.50	0.53	0.50	0.53
192	Carrownagark 2 (Crossroads)	0.52	0.56	0.50	0.53
207	Kingsbrook	0.50	0.53	0.51	0.54
216	Tawnagh, Near Knockalassa School	0.52	0.56	0.50	0.53
225	Aghalenane	0.52	0.56	0.51	0.54
226	Springfield	0.50	0.53	0.51	0.54
241	Cloonymeenaghan	0.53	0.56	0.50	0.53
251	Cloongad	0.52	0.56	0.50	0.53
254	Drumderry 1	0.50	0.53	0.51	0.54
267	Drumderry 2	0.52	0.56	0.50	0.53
286	Cleavry Td. close to Castlebaldwin Crossroads	0.50	0.56	0.50	0.53
N/A	Castlebaldwin	0.50	0.53	0.52	0.55
290	Cleavry 2	0.53	0.56	0.51	0.54
351	Cloghoge Upper	0.53	0.56	0.50	0.54
Ambient Limit Value[Note 1]		5 µg/m^3	5 µg/m^3	5 µg/m^3	5 µg/m^3

Note 1 Annual Average Benzene Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

9.4.3.2.2 *PM_{10}*

The results of the modelled impact of the *Proposed Road Development* for PM_{10} in the opening and design years are shown in Table 9-13. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 37 - 39% of the limit value in 2017. In addition, there were no exceedances of the 24-hour PM_{10} concentration at any of the locations.

Future trends with the *Proposed Road Development* in place indicate similarly low levels of PM_{10}. Annual average PM_{10} concentrations range from 36 - 39% of the limit in 2032. Furthermore, the results show that the 24-hour limit value will not be exceeded in 2032.

The impact of the *Proposed Road Development* can be assessed relative to "do nothing" levels in 2017 and 2032 (see Table 9-13). Relative to baseline levels, some small increases and decreases in PM_{10} levels at the worst-case receptors are predicted as a result of the *Proposed Road Development*. With regard to impacts at individual receptors, none of the 23 receptors assessed will experience an increase or decrease in concentrations of over 5% of the limit value in either 2017 or 2032 and thus the magnitude of the changes in air quality are either small or imperceptible at all receptors based on the criteria outlined in Table 9-2.

The greatest impact on PM_{10} concentrations in the region of the *Proposed Road Development* in either 2017 or 2032 will be an increase of 1.6% of the annual limit value. Furthermore, the greatest improvement in PM_{10} concentrations will be a decrease of 3.8% of the annual limit value.

Thus, using the assessment criteria outlined in Table 9-2 to Table 9-4, the impact of the *Proposed Road Development* with regard to PM_{10} is negligible.

Table 9-13: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Predicted Annual Mean PM_{10} Concentrations.

Receptor	Location	Annual Mean PM_{10} Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	15.2	15.2	15.1	15.0
103	Doorly 1	15.9	16.0	15.5	15.5
104	Doorly 2	15.5	15.6	15.1	15.1
118	Knocknagroagh	14.8	14.6	14.9	14.8
141	Drumfin 1	16.0	16.1	14.8	14.6
152	Drumfin 2	16.0	16.2	14.8	14.7
159	Drumfin 3	14.7	14.5	15.1	15.0
165	Drumfin 4	16.0	16.2	14.9	14.8
178	Drumfin 5, Near Behy Castle	15.8	15.8	14.8	14.6
186	Carrownagark 1	14.8	14.6	14.8	14.6
192	Carrownagark 2 (Crossroads)	15.7	15.8	14.7	14.5
207	Kingsbrook	14.7	14.5	15.1	15.1
216	Tawnagh, Near Knockalassa School	15.7	15.7	14.7	14.5
225	Aghalenane	15.7	15.7	15.0	14.9
226	Springfield	14.8	14.6	15.0	14.9
241	Cloonymeenaghan	15.8	15.9	14.7	14.6
251	Cloongad	15.6	15.6	14.7	14.5
254	Drumderry 1	14.7	14.5	15.0	14.9
267	Drumderry 2	15.6	15.6	14.7	14.5
286	Cleavry Td. close to Castlebaldwin Crossroads	14.8	15.9	14.7	14.6
N/A	Castlebaldwin	14.8	14.6	15.3	15.3
290	Cleavry 2	15.8	15.9	14.9	14.7
351	Cloghoge Upper	15.8	15.8	14.9	14.8

Receptor	Location	Annual Mean PM_{10} Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
Ambient Limit Value[Note 1]		40 $\mu g/m^3$	40 $\mu g/m^3$	40 $\mu g/m^3$	40 $\mu g/m^3$

Note 1 Annual Average PM_{10} Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

9.4.3.2.3 *$PM_{2.5}$*

The results of the modelled impact of the *Proposed Road Development* for $PM_{2.5}$ in the opening and design years are shown in Table 9-14. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 38 - 41% of the limit value in 2017.

Future trends with the *Proposed Road Development* in place indicate similarly low levels of $PM_{2.5}$. Annual average $PM_{2.5}$ concentrations range from 38 - 42% of the limit in 2032.

The impact of the *Proposed Road Development* can be assessed relative to "do nothing" levels in 2017 and 2032 (see Table 9-14). Relative to baseline levels, some small increases and decreases in $PM_{2.5}$ levels at the worst-case receptors are predicted as a result of the proposed road. With regard to impacts at individual receptors, seven of the 23 receptors assessed will experience an increase or decrease in concentrations of over 5% of the limit value in either 2017 or 2032 and thus the magnitude of the changes in air quality at the other 16 receptors are either small or imperceptible at all receptors based on the criteria outlined in Table 9-2.

The greatest impact on $PM_{2.5}$ concentrations in the region of the *Proposed Road Development* in either 2017 or 2032 will be an increase of 2.6% of the annual limit value. Furthermore, the greatest improvement in $PM_{2.5}$ concentrations will be a decrease of 6.1% of the annual limit value.

Thus, using the assessment criteria outlined in Table 9-2 and Table 9-3, the impact of the *Proposed Road Development* with regard to $PM_{2.5}$ is negligible at all 23 of the receptors assessed.

Table 9-14: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Predicted Annual Mean $PM_{2.5}$ Concentrations.

Receptor	Location	Annual Mean $PM_{2.5}$ Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	10.1	10.1	9.9	9.9
103	Doorly 1	10.7	10.9	10.3	10.4
104	Doorly 2	10.4	10.5	10.0	10.0
118	Knocknagroagh	9.7	9.6	9.8	9.7
141	Drumfin 1	10.8	11.0	9.6	9.5
152	Drumfin 2	10.9	11.2	9.7	9.6
159	Drumfin 3	9.6	9.4	9.9	9.9
165	Drumfin 4	10.8	11.1	9.7	9.7
178	Drumfin 5, Near Behy Castle	10.6	10.7	9.6	9.5
186	Carrownagark 1	9.6	9.5	9.6	9.5
192	Carrownagark 2 (Crossroads)	10.6	10.7	9.5	9.4
207	Kingsbrook	9.6	9.4	10.0	10.0
216	Tawnagh, Near Knockalassa School	10.5	10.7	9.6	9.4
225	Aghalenane	10.5	10.7	9.8	9.8

Receptor	Location	Annual Mean $PM_{2.5}$ Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
226	Springfield	9.7	9.6	9.8	9.8
241	Cloonymeenaghan	10.7	10.8	9.6	9.5
251	Cloongad	10.4	10.6	9.5	9.4
254	Drumderry 1	9.5	9.4	9.9	9.8
267	Drumderry 2	10.4	10.6	9.5	9.4
286	Cleavry Td. close to Castlebaldwin Crossroads	9.6	10.8	9.6	9.5
N/A	Castlebaldwin	9.6	9.5	10.1	10.2
290	Cleavry 2	10.6	10.8	9.7	9.6
351	Cloghoge Upper	10.6	10.8	9.7	9.7
Ambient Limit Value[Note 1]		25 $\mu g/m^3$	25 $\mu g/m^3$	25 $\mu g/m^3$	25 $\mu g/m^3$

Note 1 Annual Average $PM_{2.5}$ Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

9.4.3.2.4 *NO_2*

The result of the assessment of the impact of the *Proposed Road Development* for NO_2 in the opening and design years are shown in Table 9-15 and Table 9-16. The annual average concentration is within the limit value at all worst-case receptors. Future trends, with the *Proposed Road Development* in place, indicate similarly low levels of NO_2. Levels of NO_2 range from 12 – 29% of the annual limit value in 2017 and 2032.

Maximum one-hour NO_2 levels with the *Proposed Road Development* in place will be significantly below the limit value, with levels at the worst-case receptor reaching 29% of the limit value in 2017 and 23% of the limit in 2032.

The impact of the *Proposed Road Development* on maximum one-hour NO_2 levels can be assessed relative to "do nothing" levels in 2017 and 2032 (see Table 9-15 and Table 9-16). Relative to baseline levels, some increases and decreases in pollutant levels are predicted as a result of the *Proposed Road Development*. For the opening year of 2017, of the 23 worst-case receptors assessed, two receptors will experience increased levels of over 5% of the limit value whilst thirteen receptors will experience decreased levels of over 5% of the limit value. The remaining eight receptors will experience an increase or decrease in levels of less than 5% of the limit value. For the design year of 2032, of the 23 worst-case receptors assessed, three receptors will experience increased levels of over 5% of the limit value whilst fifteen receptors will experience decreased levels of over 5% of the limit value. The remaining five receptors will experience an increase or decrease in levels of less than 5% of the limit value.

The greatest impact on NO_2 concentrations in the region of the *Proposed Road Development* in either 2017 or 2032 will be an increase of 7.1% of the annual or maximum 1-hour limit value. Furthermore, the greatest improvement in NO_2 concentrations will be a decrease of 16.2% of the annual or maximum 1-hour limit value.

Thus, using the assessment criteria outlined in Table 9-2 and Table 9-3, the impact of the *Proposed Road Development* in terms of NO_2 is slight beneficial at 12 receptors and negligible at the remaining 11 receptors assessed in both 2017 and 2032.

Table 9-15: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Predicted Annual Average NO_2 Concentrations.

Receptor	Location	Annual Average NO_2 Concentrations (µg/m^3)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	10.5	7.8	9.9	7.1
103	Doorly 1	13.7	11.4	11.7	9.2
104	Doorly 2	11.9	9.4	10.1	7.4
118	Knocknagroagh	8.5	5.5	9.0	6.1
141	Drumfin 1	14.1	11.8	8.4	5.5
152	Drumfin 2	14.4	12.3	8.6	5.9
159	Drumfin 3	8.0	5.0	9.9	7.1
165	Drumfin 4	14.2	12.1	8.9	6.2
178	Drumfin 5, Near Behy Castle	13.2	10.8	8.2	5.3
186	Carrownagark 1	8.2	5.2	8.3	5.4
192	Carrownagark 2 (Crossroads)	13.0	10.6	7.9	4.9
207	Kingsbrook	8.0	5.0	10.2	7.4
216	Tawnagh, Near Knockalassa School	12.8	10.4	8.0	5.0
225	Aghalenane	12.8	10.4	9.4	6.6
226	Springfield	8.5	5.5	9.4	6.6
241	Cloonymeenaghan	13.5	11.2	8.1	5.1
251	Cloongad	12.4	10.0	7.8	4.8
254	Drumderry 1	8.0	4.9	9.5	6.6
267	Drumderry 2	12.4	10.0	7.8	4.8
286	Cleavry Td. close to Castlebaldwin Crossroads	8.5	11.1	8.1	5.1
N/A	Castlebaldwin	8.5	5.6	11.0	8.4
290	Cleavry 2	13.3	11.1	8.9	6.1
351	Cloghoge Upper	13.2	10.9	8.9	6.0
Ambient Limit Value[Note 1]		40 µg/m3	40 µg/m3	40 µg/m3	40 µg/m3

Note 1 Annual Average NO_2 Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC

Table 9-16: DMRB Screening Air Quality Assessment, Proposed N4 Collooney to Castlebaldwin. Details Predicted Maximum 1-Hour NO2 Concentrations.

Receptor	Location	Maximum 1-Hour NO_2 Concentrations ($\mu g/m^3$)			
		Do Nothing		*Do Something*	
		2017	*2032*	*2017*	*2032*
005	Toberbride	52.4	39.0	49.4	35.5
103	Doorly 1	68.4	57.1	58.5	45.8
104	Doorly 2	59.6	47.2	50.5	36.8
118	Knocknagroagh	42.3	27.5	44.9	30.5
141	Drumfin 1	70.3	59.1	42.2	27.7
152	Drumfin 2	72.0	61.7	43.2	29.4
159	Drumfin 3	40.2	25.1	49.6	35.7
165	Drumfin 4	70.8	60.4	44.5	30.8
178	Drumfin 5, Near Behy Castle	66.0	54.2	41.2	26.3
186	Carrownagark 1	41.0	26.1	41.6	26.8
192	Carrownagark 2 (Crossroads)	64.9	52.9	39.6	24.4
207	Kingsbrook	40.2	25.1	51.0	37.2
216	Tawnagh, Near Knockalassa School	64.2	52.2	39.9	24.9
225	Aghalenane	64.2	52.2	47.1	32.9
226	Springfield	42.4	27.7	47.2	33.1
241	Cloonymeenaghan	67.4	55.9	40.5	25.7
251	Cloongad	62.2	50.1	39.1	24.0
254	Drumderry 1	40.2	24.6	47.4	33.2
267	Drumderry 2	62.2	50.1	39.0	23.9
286	Cleavry Td. close to Castlebaldwin Crossroads	42.3	55.6	40.6	25.7
N/A	Castlebaldwin	42.3	27.8	55.2	42.0
290	Cleavry 2	66.7	55.3	44.5	30.6
351	Cloghoge Upper	66.0	54.5	44.5	30.2
Ambient Limit Value[Note 1]		200 $\mu g/m^3$	200 $\mu g/m^3$	200 $\mu g/m^3$	200 $\mu g/m^3$

Note 1 Maximum 1-Hour NO_2 Limit Value: S.I. No. 180 of 2011 & EU Directive 2008/50/EC (as a 99.8th%ile)

9.4.3.3 "Do Nothing" Scenario – Local Air Quality

9.4.3.3.1 *CO and Benzene*

The results of the "do nothing" modelling assessment for CO and benzene in the opening and design years are shown in Table 9-11 and Table 9-12. Concentrations are well within the limit values at all worst-case receptors. Levels of both pollutants range from 10 - 23% of the respective limit values in 2017 and 2032.

9.4.3.3.2 *PM_{10}*

The results of the "do nothing" modelling assessment for PM_{10} in the opening and design years are shown in Table 9-13. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 36 - 41% of the annual limit value in 2017 and 2032. In addition, there was no exceedance of the 24-hour PM_{10} concentration at any receptor.

9.4.3.3.3 *$PM_{2.5}$*

The results of the "do nothing" modelling assessment for $PM_{2.5}$ in the opening and design years are shown in Table 9-14. Predicted annual average concentrations are below the ambient standards at all worst-case receptors, ranging from 38 - 45% of the annual limit value in 2017 and 2032.

9.4.3.3.4 *NO_2*

The results of the "do nothing" assessment of annual average and maximum 1-hour NO_2 concentrations in the opening and design years are shown in Table 9-15 and Table 9-16. Predicted levels are within the limit values at all worst-case receptors, ranging from 12 - 36% of the annual limit value in 2017 and 2032.

9.4.4 Air Quality Impacts on Sensitive Ecosystems

The EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the "Habitats Directive") as transposed into Irish Law requires an Appropriate Assessment to be carried out where there is likely to be a significant impact upon a European protected site. Under Irish law, such sites (relevant to the *Proposed Road Development*) include Special Areas of Conservation (SAC) (including candidate and proposed candidate SACs) and Special Protection Areas (SPA) (and proposed SPAs).

The NRA guidelines (NRA 2011) state that as the potential impact of a scheme is limited to a local level, detailed consideration need only be given to roads where there is a significant change to traffic flows (>5%) and the designated site lies within 200m of the road centre line.

The impact of NO_x (i.e. NO and NO_2) emissions resulting from the *Proposed Road Development* at the Unshin River NHA / cSAC was assessed. The *Proposed Road Development* is closest to the Unshin RIver NHA / cSAC at Doorly (the boundary of the cSAC is c. 110m from the *Proposed Road Development* at c. Ch.2,500), Knocknagroagh (the boundary of the cSAC is c. 50m from the *Proposed Road Development* at c. Ch. 4,000) and Drumfin (the boundary of the cSAC is c. 80m from the *Proposed Road Development* at c. Ch. 6,500). Dispersion modelling and prediction was carried out at typical traffic speeds at both of these locations. Ambient NO_x concentrations predicted for the opening and design years along a transect of up to 200m within the Unshin River NHA / cSAC are given in Table 9-17: Air Quality Assessment of Ecosystems, Proposed N4 Collooney to Castlebaldwin Realignment. Assessment of Impact along transect from Proposed Road through the Unshin RIver pNHA / SAC at Doorly (Chainage 2,500).

– Table 9-19. The road contribution to dry deposition along the transect is also given and was calculated using the methodology of the NRA (NRA 2011).

The predicted annual average NO_x level in the Unshin River NHA / cSAC near Doorly is below the limit value of 30 µg/m^3 for the "do minimum" scenario in 2017 and 2032, with NO_x concentrations reaching 46% of this limit in 2017 and 30% in 2032. Levels with the *Proposed Road Development* in place are similar reaching 46% of the limit value for the "do something" scenario in 2017 and 30% of the limit value in 2032.

The predicted annual average NO_x levels at the Unshin River NHA / cSAC near Doorly are below the limit value of 30 µg/m^3 for the "do something" scenario in both the opening and design years. The impact of the *Proposed Road Development* leads to an increase in NO_x concentrations of at most 0.07 µg/m^3 within the Unshin River NHA / cSAC. The NRA guidelines state in Appendix 9 that where the scheme is expected to cause an increase of more than 2 µg/m^3 and the predicted concentrations (including background) are close to, or exceed the standard, then the sensitivity of the habitat to NO_x should be assessed by the project ecologist.

The road contribution to the NO_2 dry deposition rate along the 200m transect within the NHA / cSAC at Doorly is also detailed in Table 9-17. The maximum increase in the NO_2 dry deposition rate is 0.002 Kg(N)/ha/yr in 2017 and 0.003 Kg(N)/ha/yr in 2032. This reaches only 0.06% of the critical load for inland and surface water habitats of 5-10 Kg(N)/ha/yr (NRA 2011).

The predicted annual average NO_x level in the Unshin River cSAC near Lackagh is below the limit value of 30 µg/m^3 for the "do minimum" scenario in 2017, with NO_x concentrations reaching 76% of the limit value and is below the limit value for the "do minimum" scenario in 2032, with NO_x concentrations reaching 65% of this limit. Levels are decreased with the *Proposed Road Development* in place, reaching 50% of the limit value for the "do something" scenario in 2017 and 35% of the limit value in 2032.

The predicted annual average NO_x levels at the Unshin River cSAC near Lackagh are below the limit value of 30 µg/m^3 for both the "do minimum" and "do something" scenario in both the opening and design years. The impact of the *Proposed Road Development* leads to a decrease in NO_x concentrations of at most 8.9 µg/m^3 within the Unshin River cSAC.

The road contribution to the NO_2 dry deposition rate along the 200m transect within the Unshin RIver cSAC at Lackagh is also detailed in Table 9-18. There is no increase in the NO_2 dry deposition rate in 2017 or 2032.

The predicted annual average NO_x level in the Unshin River cSAC near Drumfin is below the limit value of 30 µg/m^3 for the "do minimum" scenario in 2017, with NO_x concentrations reaching 73% of the limit value and is below the limit value for the "do minimum" scenario in 2032, with NO_x concentrations reaching 62% of this limit. Levels are decreased with the *Proposed Road Development* in place, reaching 49% of the limit value for the "do something" scenario in 2017 and 34% of the limit value in 2032.

The predicted annual average NO_x levels at the Unshin River cSAC near Drumfin are below the limit value of 30 µg/m^3 for both the "do minimum" and "do something" scenario in both the opening and design years. The impact of the *Proposed Road Development* leads to a decrease in NO_x concentrations of at most 8.3 µg/m^3 within the Unshin River cSAC.

The road contribution to the NO_2 dry deposition rate along the 200m transect within the cSAC at Drumfin is also detailed in Table 9-19. There is no increase in the NO_2 dry deposition rate in 2017 or 2032.

Table 9-17: Air Quality Assessment of Ecosystems, Proposed N4 Collooney to Castlebaldwin Realignment. Assessment of Impact along transect from Proposed Road through the Unshin RIver pNHA / SAC at Doorly (Chainage 2,500).

Dist to Road (m)Note 1	NOx Conc. (µg/m3) - 2017			NOx Conc. (µg/m3) - 2032			NO2 Dry Deposition Rate Impact (Kg(N) /ha/yr)	
	Do Minimum	Do Something	Impact	Do Minimum	Do Something	Impact	2017	2032
165 & 128	13.86	13.89	0.03	8.97	8.98	0.02	0.002	0.001
175 & 138	13.82	13.84	0.02	8.92	8.92	0.00	0.001	0.000
185 & 148	13.76	13.78	0.02	8.85	8.85	0.01	0.001	0.000
195 & 158	13.71	13.73	0.02	8.78	8.79	0.01	0.001	0.000
200 & 168	13.68	13.71	0.03	8.74	8.76	0.02	0.002	0.001
210 & 178	13.62	13.65	0.03	8.67	8.70	0.03	0.002	0.002
220 & 188	13.57	13.60	0.03	8.60	8.64	0.04	0.002	0.002
230 & 198	13.51	13.55	0.04	8.53	8.58	0.04	0.002	0.002
240 & 200	13.46	13.50	0.05	8.46	8.53	0.06	0.002	0.003
Standards	30 µg/m3	30 µg/m3	-	30 µg/m3	30 µg/m3	-	5 - 10 Kg(N)/ha/yr	

Note 1 First Distance is from the N4, second distance is from the proposed access road.

Table 9-18: Air Quality Assessment of Ecosystems, Proposed N4 Collooney to Castlebaldwin Realignment*. Assessment of Impact along transect from original N4 through the Unshin River cSAC at Lackagh (Chainage 4,000).*

Dist 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
18	22.67	15.12	-7.55	19.36	10.51	-8.85	-0.408	-0.456
28	20.51	14.74	-5.78	16.81	10.04	-6.77	-0.314	-0.351
38	18.95	14.46	-4.49	14.96	9.70	-5.26	-0.245	-0.274
48	17.77	14.25	-3.52	13.57	9.45	-4.12	-0.192	-0.216
58	16.87	14.09	-2.77	12.50	9.25	-3.25	-0.152	-0.171
68	16.15	13.97	-2.19	11.66	9.10	-2.56	-0.120	-0.135
78	15.59	13.87	-1.72	10.99	8.97	-2.01	-0.094	-0.106
88	15.14	13.79	-1.35	10.46	8.88	-1.58	-0.074	-0.083
98	14.78	13.73	-1.05	10.03	8.80	-1.23	-0.058	-0.065
108	14.50	13.68	-0.82	9.70	8.74	-0.96	-0.045	-0.051
118	14.28	13.64	-0.64	9.44	8.69	-0.75	-0.035	-0.040
128	14.11	13.61	-0.50	9.24	8.65	-0.59	-0.028	-0.031
138	13.99	13.59	-0.41	9.10	8.63	-0.47	-0.022	-0.025
148	13.91	13.57	-0.34	9.01	8.61	-0.40	-0.019	-0.021
158	13.87	13.6	-0.30	9.0	8.6	-0.35	-0.016	-0.019
168	13.85	13.6	-0.29	8.9	8.6	-0.34	-0.016	-0.018
178	13.80	13.6	-0.25	8.9	8.6	-0.29	-0.014	-0.016
188	13.74	13.5	-0.20	8.8	8.6	-0.23	-0.011	-0.012
198	13.69	13.5	-0.15	8.7	8.6	-0.18	-0.009	-0.010

Dist to Road (m)	NO_x Conc. ($\mu g/m^3$) - 2017			NO_x Conc. ($\mu g/m^3$) - 2032			NO_2 Dry Deposition Rate Impact (Kg(N) /ha/yr)	
	Do Minimum	Do Something	Impact	Do Minimum	Do Something	Impact	2017	2032
200	13.68	13.5	-0.15	8.7	8.6	-0.17	-0.008	-0.009
Standards	30 $\mu g/m^3$	30 $\mu g/m^3$	-	30 $\mu g/m^3$	30 $\mu g/m^3$	-	5 - 10 Kg(N)/ha/yr	

Table 9-19: Air Quality Assessment of Ecosystems, Proposed N4 Collooney to Castlebaldwin Realignment*. Assessment of Impact along transect from original N4 through the Unshin River cSAC at Drumfin (Chainage 6,500).*

Dist to Road (m)[Note 1]	NO_x Conc. ($\mu g/m^3$) - 2017			NO_x Conc. ($\mu g/m^3$) - 2032			NO_2 Dry Deposition Rate Impact (Kg(N) /ha/yr)	
	Do Minimum	Do Something	Impact	Do Minimum	Do Something	Impact	2017	2032
18 & 24	21.83	14.82	-7.02	18.46	10.18	-8.27	-0.380	-0.427
28 & 34	19.88	14.51	-5.37	16.13	9.80	-6.33	-0.292	-0.329
38 & 44	18.46	14.29	-4.17	14.44	9.52	-4.92	-0.227	-0.257
48 & 54	17.39	14.12	-3.27	13.16	9.31	-3.86	-0.179	-0.202
58 & 64	16.57	13.99	-2.58	12.18	9.14	-3.04	-0.142	-0.160
68 & 74	15.92	13.89	-2.03	11.40	9.01	-2.39	-0.111	-0.126
78 & 84	15.40	13.80	-1.60	10.79	8.90	-1.88	-0.088	-0.100
88 & 94	14.99	13.74	-1.25	10.30	8.82	-1.48	-0.069	-0.078
98 & 104	14.66	13.69	-0.98	9.91	8.75	-1.15	-0.054	-0.062
108 & 114	14.41	13.64	-0.76	9.60	8.70	-0.90	-0.042	-0.047
118 & 124	14.21	13.61	-0.60	9.36	8.66	-0.70	-0.033	-0.038
128 & 134	14.06	13.59	-0.47	9.19	8.63	-0.55	-0.026	-0.029
138 & 144	13.95	13.57	-0.38	9.06	8.61	-0.44	-0.021	-0.023
148 & 154	13.88	13.56	-0.32	8.97	8.60	-0.37	-0.017	-0.020
158 & 164	13.8	13.6	-0.28	8.9	8.6	-0.33	-0.016	-0.017

Dist to Road (m)[Note 1]	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
168 & 174	13.8	13.6	-0.27	8.9	8.6	-0.32	-0.015	-0.017
178 & 184	13.8	13.5	-0.23	8.8	8.6	-0.27	-0.012	-0.014
188 & 194	13.7	13.5	-0.19	8.8	8.6	-0.22	-0.010	-0.012
198 & 200	13.7	13.5	-0.14	8.7	8.6	-0.17	-0.008	-0.009
Standards	30 µg/m^3	30 µg/m^3	-	30 µg/m^3	30 µg/m^3	-	5 - 10 Kg(N)/ha/yr	

Note 1 First Distance is from the N4, second distance is from nearby local road

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9.4.5 Operational Phase - Regional Air Quality

The regional impact of the *Proposed Road Development* on emissions of NO_x and VOCs has been assessed using the procedures of the NRA (NRA 2011) and the UK DEFRA (UK DEFRA 2007) using the DMRB screening model (V1.03c, July 2007). The results (see **Error! Reference source not found.**) indicate that the impact of the *roposed Road Development* on Ireland's obligations under the Gothenburg Protocol is negligible. For the assessment year of 2017, the predicted impact of the proposed road is to increase NO_x levels by 0.005% of the NO_x emissions ceiling and increase VOC levels by 0.00006% of the VOC emissions ceiling which was to be complied with in 2010. For the assessment year of 2032, the predicted impact of the proposed road is to increase NO_x levels by 0.0017% of the NO_x emissions ceiling and decrease VOC levels by 0.00004% of the VOC emissions ceiling which was to be complied with in 2010.

9.4.5.1 "Do-Nothing" Scenario - Regional Air Quality

Predicted "do nothing" emissions of NO_x and VOCs in the region of the Proposed N4 are provided in

Table 9-20: Regional Air Quality Assessment. Proposed N4 Collooney to Castlebaldwin Road Development

. NO_x and VOC emissions in the region of the *Proposed Road Development* represent at most 0.07% and 0.01% respectively of the national emissions ceilings in 2017 and 2032.

9.4.6 Operational Phase - Climate

The impact of the operational phase of the *Proposed Road Development* on emissions of CO_2 was also assessed using the DMRB screening model (see Table 9-20). The results show that the impact of the *Proposed Road Development* will be to increase CO_2 emissions by 0.002% of Ireland's Kyoto target in 2017 and 0.0025% of Ireland's Kyoto target in 2032. Thus, the impact of the *Proposed Road Development* on national greenhouse gas emissions will be negligible in terms of Ireland's obligations under the Kyoto Protocol (FCCC 1997, DEHLG 2007b).

9.4.6.1 "Do-Nothing" Scenario - Climate

Predicted "do nothing" emissions of CO_2 in the region of the Proposed N4 are provided in **Error! Reference ource not found.**. CO_2 emissions represent at most 0.06% of Ireland's limits under the Kyoto Protocol (FCCC 1997, DEHLG 2007b).

Table 9-20: Regional Air Quality Assessment. Proposed N4 Collooney to Castlebaldwin Road Development

Year	Scenario	VOC (kg/annum)	NO_x (kg/annum)	CO_2 (tonnes/annum)
2017	Do Nothing	3,942	46,747	33,249
	Do Something	3,972	49,983	34,492
2032	Do Nothing	5,320	29,841	37,615
	Do Something	5,297	30,962	39,175
Increment / Reduction in 2017		31 kg	3,236 kg	1,243 tonnes
Increment / Reduction in 2032		-23 kg	1,121 kg	1,560 tonnes
Emission Ceiling		55 kt[Note 1]	65 kt[Note 1]	62,800 kt[Note 2]
Impact in 2017		0.00006%	0.005%	0.002%
Impact in 2032		-0.00004%	0.0017%	0.0025%

Note 1 kt = kilo tonnes. National Emission Ceiling (EU Directive 2001/81/EC)

Note 2 kt = kilo tonnes. Ireland's Target Under The Kyoto Protocol

9.4.7 Worst Case Scenario

The worst-case scenario corresponds to the situation where the mitigation measures fail or are not implemented. Should dust mitigation measures not be implemented during the construction phase, significant

dust nuisance is likely in areas close to the construction site. Furthermore, there is also the potential for exceedances of the PM_{10} and $PM_{2.5}$ air quality standards during the construction period. The results of the air dispersion modelling assessment show that no mitigation measures are required during the operational phase and therefore the worst-case scenario is not applicable.

9.5 Mitigation Measures & Environmental Commitments

9.5.1 Construction Phase

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 activities.

In order to minimise dust emissions during construction, a series of mitigation measures have been prepared for implementation during the construction phase of the project. These measures are as follows:

- Site roads will be regularly cleaned and maintained as appropriate. Hard surface roads will be swept to remove mud and aggregate materials from their surface while any unsurfaced roads will be restricted to essential site traffic only. Any road that has the potential to give rise to fugitive dust will be regularly watered during dry and/or windy conditions;
- Vehicles using site roads will have their speeds restricted where there is a potential for dust nuisance at nearby properties;
- Where practicable, vehicles exiting the site shall make use of a wheel wash facility prior to entering onto public roads. This will ensure that mud and other wastes are not tracked onto public roads. Public roads outside the site will 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 will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods;
- The dust minimisation procedures put in place will be monitored and assessed. In the event of dust nuisance occurring outside the site boundary, the effectiveness of existing measures will be reviewed and further mitigation will be implemented to rectify the problem.

Provided the dust minimisation measures outlined above are adhered to, the air quality impacts during the construction phase will not be significant.

9.5.2 Operational Phase - Air Quality

Mitigation measures in relation to traffic-derived pollutants have focused generally on improvements in both engine technology and fuel quality. EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (REGULATION (EC) No 715/2007) for passenger cars to be complied with in 2009 (Euro V) and 2014 (Euro VI). With regard to heavy duty vehicles, EU Directive 2005/78/EC defines the emission standard currently in force, Euro IV, as well as the next stage (Euro V) which has entered into force since October 2009. In addition, it defines a non-binding standard called Enhanced Environmentally-friendly Vehicle (EEV). In relation to fuel quality, SI No. 407 of 1999 and SI No. 72 of 2000 have introduced significant reductions in both sulphur and benzene content of fuels.

In relation to design and operational aspects of road schemes, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems (UK DEFRA 2009b). Improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

9.5.3 Operational Phase - Climate

CO_2 emissions for the average new car fleet were reduced to 120 g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels. This measure was estimated to reduce CO_2 emissions from new cars by an average of 25% in the period from 1995 to 2008/2009 whilst 15% of

the necessary effort towards the overall climate change target of the EU was met by this measure alone (DEHLG 2000).

Additional measures included in the National Climate Change Strategy (DEHLG 2006, 2007b) included: (1) VRT and Motor Tax rebalancing to favour the purchases of more fuel-efficient vehicles with lower CO_2 emissions; (2) continuing the Mineral Oils Tax Relief (MOTR) II Scheme and introduction of a biofuels obligation scheme; (3) implementation of a national efficient driving awareness campaign, to promote smooth and safe driving at lower engine revolutions; and (4) enhancing the existing mandatory vehicle labelling system to provide more information on CO_2 emission levels and on fuel economy.

9.5.4 Monitoring

No monitoring is required.

9.6 Residual Impacts

The results of the air dispersion modelling study show that the residual impacts of the *Proposed Road Development* on air quality and climate will be insignificant.

9.7 Relevant Figures and Appendices

9.7.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 9.1.1-9.1.8: Air Quality and Climate Change;

9.7.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 9.1.: Ambient Air Quality Standards

Appendix 9.2.: Construction Phase – Local Air Quality and Climate Assessment: Recovery/Repository Sites Inside the CPO

Appendix 9.3.: Construction Phase – Local Air Quality and Climate Assessment: Recovery/Repository Sites Outside the CPO

10 Landscape and Visual

10.1 Introduction

The National Road Design Department of Sligo County Council is proposing a realignment of the N4 National Primary route between the townlands of Toberbride, south of Collooney and Cloghoge Lower, south of Castlebaldwin. The road comprises approximately 13.82km of a Type 2 Dual Carriageway with a Standard Single Carriageway alignment of 0.89km at the tie in point with the existing N4 at Cloghoge Lower. Approximately 20% of the proposed road is online with the remaining 80% being offline. The proposed route is through a relatively sparsely populated rural working landscape characterised by pasture farmland on gently undulating hills, drumlins, lakes and extensive wetlands and occasional forests. The topography gradually becomes hillier at the southern end of the proposed realignment. The lower lying areas are covered by extensive boglands and smaller lakes.

MosArt was commissioned by the National Road Design Department of Sligo County Council to assess the landscape and visual impact of the N4 Collooney to Castlebaldwin *Proposed Road Development*. This report considers interaction with other impacts within the EIS such as Flora, Fauna & Fisheries, Noise & Vibration and Archaeology & Cultural heritage. This report focuses solely on predicted visual and landscape impacts. The overall objective is to present a clear and concise description of the likely landscape and visual impact of the route proposed.

10.2 Methodology

10.2.1 Guidance Documents

The landscape and visual impact assessment is based on desktop studies and fieldwork carried out in accordance with current guidance and best practice including; the Environmental Protection Agency *'Guidelines on the Information to be contained in Environmental Impact Statements'* (2002) and the *'Advice Notes on Current Practice in the Preparation of Environmental Impact Statements'* (2003); the Landscape Institute (UK) and the Institute of Environmental Management and Assessment (UK) *'Guidelines for Landscape and Visual Impact Assessment'* third edition (2013); the National Road Authority (NRA) publications *'Environmental Impact Assessment of National Road Schemes – A Practical Guide'* (NRA, 2008), the NRA *'A Guide to Landscape Treatments for National Road Schemes in Ireland'* (2006) and the NRA *'Guidelines on the Implementation of Landscape Treatments on National Road Schemes in Ireland'* (2011).

10.2.2 Distinction between Visual Impact and Landscape Impact

Landscape and visual impacts are two separate but closely related elements. Landscape impacts relate to physical changes to the landscape, visual impacts relate to visual changes resulting from a proposed development.

Landscape impacts relate to the impacts of development upon the physical characteristics or components of the landscape, which together form the character of that landscape, e.g. landform, vegetation and buildings.

- The extent of the impact upon specific landscape elements;
- The extent of the impact on any sensitive or designated landscape, amenity or conservation area;
- Degree of effects on the overall landscape pattern (at the macro scale).

Note: In the case of road developments, MosArt do not consider micro level landscape impacts at the residential property scale. For example, the loss of a front boundary wall or hedge. If such losses affect visual amenity or screening they will be assessed as visual impacts. Otherwise, they are dealt with as property impacts in the 'Non-Agricultural property' chapter of the EIS.

Visual impacts in this study are considered in relation to changes in the nature and character of the available views and visual amenity resulting from the *Proposed Road Development*. Such changes can impact on a range of receptors including road users and local residences located within the visual catchment of the proposed N4 road realignment corridor. The criteria used in the assessment of visual impacts are as follows:

- *Intrusion*, concerning the sense of visual disruption brought about by either the road or resulting traffic;

- *Obstruction*, implying the blocking of a view (whether fully, partially or intermittently) by either the road and associated structures or resulting traffic.

10.2.3 Study Approach

An outline of the methodology used in this assessment is provided below:

- Desk study review of mapping and aerial photography, and the Sligo County Development Plan (2011-2017);
- Field assessment to examine the study area and zone of visual influence;
- Preparation of a description of the existing environment;
- Estimation in the field of both visual and landscape impacts of the proposed route;
- Liaison with the design team and other specialists in form of workshops, meetings and correspondence;
- Proposing mitigation measures to reduce adverse impacts where possible;
- Estimation of residual impacts following successful completion of mitigation measures.

10.2.4 Assessment of Significance

The classification and criteria listed in Table 10-1 has been utilized to determine the level of significance of landscape and visual impacts as a result of the proposed N4 route realignment. The classification used is drawn from the EPA's '*Guidelines on the Information to be contained in Environmental Impact Statements*" and the subsequent "*Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*". The assessment is also in accordance with the Landscape Institute and Institute of Environmental Assessment guidelines (LI and IEMA, 2002). Additional classification categories have been added for circumstances where impacts arising from a proposed development have clearly positive effects. Where the rating of an impact cannot be attributed clearly to the one of the main five rating scales intermediate ratings such as 'Slight to Moderate Adverse' and 'Moderate to Significant Adverse' have been utilised where required.

Table 10-1: Assessment of Significance

Level of Impact	Description
Profound Adverse	An impact which obliterates sensitive characteristics.
Significant Adverse	An impact, which by its character, magnitude, duration or intensity considerably alters a sensitive aspect of the environment.
Moderate Adverse	An impact that would cause a noticeable deterioration of a sensitive aspect of the environment.
Slight Adverse	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
Imperceptible	An impact capable of measurement but without noticeable consequences.
Slight Positive	An impact that changes the character of the environment to a minor degree that is considered beneficial
Moderate Positive	An impact that clearly improves the character of the environment in a manner that is considered beneficial.
Significant Positive	An impact, which by its character, magnitude, duration or intensity is considered to be a substantial improvement to the character of the environment.

10.2.5 Quality of Impact

New road developments will typically result in adverse (negative) landscape and visual impacts. However, there may be situations where impacts of the *Proposed Road Development* could be positive. Positive Impacts generally arise where an existing road alignment located adjacent to a receptor would be closed or would be located further from a receptor than is the case with the existing road or where the *Proposed Road Development* would improve the scenic quality of the landscape.

10.2.5.1 Construction Impacts

Construction of road schemes typically results in the following visual and landscape impacts:

- Profound adverse impacts will arise at those locations where the visual amenity of homes or buildings would be removed or obliterated as a result of the *Proposed Road Development*.
- Landscape change is brought about by alterations to the existing character and setting of private residences including removal of existing vegetation and the creation of cuttings and embankments, specifically where the road encroaches into established residential sites;
- Visual disruption and disturbance caused by construction operations including shifting of cut and fill material, night time illumination, movement of construction related traffic and the general busyness of road construction works.

Whilst the construction activity along the route will result in high levels of change within particular construction areas due to their localised, sequential and temporary nature construction phase landscape and visual impacts resulting from the *Proposed Road Development* are not considered to be critical.

10.2.5.2 Operational Impacts

Once completed, the operation of the road can also bring about adverse landscape and visual impacts. The *Proposed Road Development* may result in bringing either the mainline alignment or new link roads closer to landscape features or settlements than the existing road. This situation will typically result in an increased sense of intrusion and obstruction for affected areas both at settlements and at major cut and fill areas within the wider landscape. Significant adverse impacts are also expected to individual dwellings at very close proximity to the proposed new road, where the road infrastructure runs above grade and may impact on the privacy of dwellings.

Houses which currently do not have a view of the N4 may after completion of the *Proposed Road Development* have an open view of the new road with the attendant traffic that will use it both night and day. In some situations, the new road may pass in fill close to houses and thus may affect the privacy of these properties or be more visible that the existing N4.

10.2.5.3 Direct and Indirect Impacts

This report deals principally with direct visual and landscape impacts as likely to be experienced on-the-ground by individual receptors. Indirect impacts are defined by the EPA as those which *"are caused by the interaction of effects or by associated or off-site developments"*. The NRA provides a fuller interpretation of Indirect Impacts as those "*which are not a direct result of the project, possibly produced some distance away from the project or as a result of a complex pathway. Many indirect impacts are related to the construction process with little information available during the preparation of an EIS"*. As outlined in Chapter 4 of this EIS, there may be some potential for surplus unsuitable material to be moved offsite during construction of the *Proposed Road Development*. As outlined in Chapter 4, it will be the contractor's responsibility to deal with this material in accordance with the various statutory requirements. However, in order to quantify landscape and visual effects such an activity could have on the receiving environment, an assessment is made in section 10.4.3 of this chapter which demonstrates such effects considering sites which have been determined to be broadly suitable in principle to accept such material as outlined in section 10 of the Spoil Management Report prepared by the design team and included as appendix 4.3 in volume 4 of this EIS.

10.2.5.4 Significance of Impact, Duration of Impacts and the Role of Mitigation Measures

The initial (pre- mitigation) impact assessment findings detailed in this chapter are concerned with short term impacts during the operational phase that would arise prior to the implementation and establishment of mitigation measures. They are defined under the current EPA Guidelines as impacts lasting *one to seven years*. The residual impact assessment assesses impacts after a 5-7 year establishment period of planting areas. After this period it is assumed that shrub and woodland planting areas are established and that areas of disturbed open ground have been largely re-colonized by surrounding vegetation.

10.2.6 Consideration of Constraints Report

The 'Aesthetics' section of the Constraints Report (November 2000) presents outline considerations of context, designations and mitigation for this *Proposed Road Development*. The paragraph states that the area is generally classified as 'Normal Rural Landscape' on Map 11 of the Development Plan (1999-2004) with two areas west of Doorly Hill and at Lough Corran classified as 'Sensitive Rural Landscape'. This map (Figure 7.D) still forms part of Section 7.4 of the current County Development Plan 2011-2017.

The document lists drumlins and small lakes as the most distinctive features of this landscape and it proposes an alignment which follows the contours and avoids cutting through the hills but rather curves around them where possible. Where embankments and cuts cannot be avoided the *'planting of trees and shrubs similar to those native in the area...'*. Areas not suitable for farmland are to be *'planted with native hardwood trees and allowed to develop into nature reserves, if possible*.'

10.3 Existing Environment

10.3.1 Landscape Baseline

The landscape context for the proposed N4 Collooney to Castlebaldwin realignment is described below in relation to Character, Image and Sensitivity. Landscape character in this report concerns the physical elements of landform and land cover, image deals with how the landscape is generally perceived and appreciated and sensitivity focuses upon the tolerance to accept change.

10.3.1.1 Landscape Character

The *Proposed Road Development* passes through the margins of a drumlin zone, comprising a series of low interlocking hills (Plate 10-1) aligned in a northeast to southwest direction. The area is relatively low lying, ranging in elevation from about 40m ASL to 100m ASL. Extensive wet and peatlands and several small lakes are found throughout this area. A relatively low hill range can be found a few kilometres to the west at Carrickbanagher and Carrigans Upper, with higher hills at Bricklieve Mountains and Kesh Corran (5km southwest and south of Castlebaldwin).

The landscape generally drains in the direction of the coast in a north-westerly direction. The main rivers in the broad study area include the Unshin River, Feorish River, Douglas River and Owenmore River all of which are tributaries of the Ballysadare River which flows from Collooney to Ballysadare Bay and onwards to Sligo Bay. Lakes in close proximity to the existing N4 alignment include Loughymeenaghan approximately 2km north-west of Castlebaldwin, Aghalenane and Ardloy Loughs, swallow holes/lake at Tawnagh, Boathole Lough, Lough Corran between Knocknagroagh and Drumfin and the Toberscanavan Loughs north of Cloonamahan Hill. The largest lake in the study area is Lough Arrow, the northern tip of which lies approximately 2km to the east of Castlebaldwin.

Plate 10-1: Drumlin and wetland character of much of the study area

In terms of land use and land cover, the area is used primarily for agriculture. Land quality is marginal and much of the land is being infested by rush (Plate 10-2). A network of hedgerows and shelterbelts, often comprising conifers, covers much of this landscape extending over hill tops to the peatland fringes. Angular conifer plantations are also frequently located within the larger peatland basins. Hedgerows mostly comprise broadleaf mixed species, including thorn, ash, sycamore and willow species. There are some large areas of conifer afforestation close to the proposed road. Lastly, dips in the drumlin landscape serving rivers and streams are mostly flanked by riparian vegetation.

Plate 10-2: Marginal farm land in inter-drumlin flats

Considering next the issue of structures, whilst the area is relatively sparsely populated there are a number of existing houses located close to the existing N4 alignment as well as strung out along side roads. The age of these houses varies considerably, some having been recently completed while others are old and derelict. With the exception of Collooney, north of the *Proposed Road Development* there are no larger settlements or towns within the vicinity of the existing or proposed N4 alignments. Riverstown approximately 2km to the east of the N4 is outside the visual envelope of the *Proposed Road Development*. Village clusters include Castlebaldwin to the south and Drumfin and Lackagh further north along the existing N4. There appears to be very little industry in the area.

The main transport corridor in the study area is the existing N4, which travels northwest to southeast between Collooney and Castlebaldwin. It connects with the N17 to the south of Collooney at Toberbride. All other roads within the area under assessment are local roads, lanes and tracks. There is no railway line in the study area.

10.3.1.2 Image

In terms of image, Sligo County is generally appreciated as a high quality landscape, popular both with domestic and foreign tourists alike. The coast, Benbulben and Lough Gill are all popular tourist destinations located to the north of the study area. The existing N4 route between Collooney and Castlebaldwin, however, does not have a particularly strong image in its own right, likely being perceived as a through route rather than a destination. At a local level, there is a monument on the existing N4 at Drumfin commemorating the memory of James Charles Morrison (1893 to 1947), a 'dancing master'.

10.3.1.3 Landscape Sensitivity

Sensitivity in this study is concerned with susceptibility of the landscape receptor in relation to its ability to accommodate a proposed road development and the various attributes and features to which values might be attached for both the landscape itself and the people who view and/or use it. In this context sensitivity is therefore a combination of the value attached to the landscape and its susceptibility to change.

Values might be due, for instance, to the attractiveness, use and/or importance of these attributes and features in the public mind. Sensitivity plays a major part in the later determination of the significance of impact and is assessed in the context of the wider region but also at specific locations, taking into account views of the surrounding landscape. The evaluation is based on experience, observation and professional judgement.

A five-point scale is typically used by landscape consultants to indicate the degree of landscape sensitivity from very *low, low, medium, high and very high – refer to Table 10-2 below.* This process is similar to that proposed by the *Department of the Environment and Local Government in their Landscape and Landscape Assessment Guidelines issued for consultation (2000*). This exercise is important as an *indication of the relative sensitivity* of a location.

Table 10-2: Landscape sensitivity judgements (receptor susceptibly vs landscape value)

Sensitivity	Description
Very High	Areas where the landscape character exhibits a very low capacity for change in the form of development. Examples of which are high value landscapes, protected at an international or national level (World Heritage Site/National Park), where the principal management objectives are likely to be protection of the existing character.
High	Areas where the landscape character exhibits a low capacity for change in the form of development. Examples of which are high value landscapes, protected at a national or regional level (Area of Outstanding Natural Beauty), where the principal management objectives are likely to be considered conservation of the existing character
Medium	Areas where the landscape character exhibits some capacity and scope for development. Examples of which are landscapes which have a designation of protection at a county level or at non-designated local level where there is evidence of local value and use.
Low	Areas where the landscape character exhibits a higher capacity for change from development. Typically this would include lower value, non-designated landscapes that may also have some elements or features of recognisable quality, where landscape management objectives include, enhancement, repair and restoration.
Negligible	Areas of landscape character that include derelict, mining, industrial land or are part of the urban fringe where there would be a reasonable capacity to embrace change or the capacity to include the development proposals. Management objectives in such areas could be focused on change, creation of landscape improvements and/or restoration to realise a higher landscape value.

The sensitivity judgements for the landscape surrounding the proposed road development are discussed under section 10.4.1.

10.3.2 Landscape Policy and Designations

10.3.2.1 Landscape Character Appraisal contained in the current County Development Plan

The current Sligo County development plan distinguishes between 'Normal Rural Landscapes' and 'Sensitive Rural Landscapes' throughout County Sligo. These areas are indicated on Figure 7.D of the County Development plan and described under section 7.4.3:

Normal rural landscapes are defined as

> *'...areas with natural enclosing features (e.g. topography, vegetation), which have the capacity to absorb a wide range of new development forms – these are the main farming areas of the County.'*

Sensitive Rural Landscapes are described as:

> *'...areas that tend to be open in character, with intrinsic scenic quality and a low capacity to absorb new development...'*

The landscape surrounding and adjacent to the *Proposed Road Development* is principally classified as 'Normal Rural Landscape' with the exception of a small number of relatively confined 'Sensitive Rural Landscape' areas in the vicinity of the route. They are located to the west of Doorly Hill, Lough Corran and Boathole Loughs at Drumfin, the Toberscanavan Loughs and the Markree Estate at the northern half of the *Proposed Road Development*. South of the study area are further 'Sensitive Rural Landscapes' including Lough Arrow and the Bricklieve Mountains. Lough Arrow is not visible from the proposed route.

10.3.2.2 Nature Conservation

There are also several nature designations relevant to the study area, comprising Unshin River (pNHA/cSAC), Lough Arrow (pNHA/cSAC/SPA), Bricklieve Mountains and Keishcorran (cSAC) *Knockmullin Fen (*pNHA) and Union Wood (pNHA). These sites are discussed in the Flora, Fauna and Fisheries chapter of this document.

10.3.2.3 Vernacular Buildings and Protected Structures

The Archaeological and Cultural Heritage Consultants have highlighted two national monuments within 2km of the *Proposed Road Development* that warrant consideration in the assessment of likely impacts in their chapter of the EIS which are namely; Castlebaldwin Castle (Nat. Mon. No. 373) and Carrowkeel Passage tomb

cemetery (Nat. Mon. No.318). Both locations were consequently assessed in the field at a joint site visit on the 21st May 2013 with the Archaeological and Cultural Heritage Consultants resulting in a concurrent visual impact judgment at both locations.

From Carrowkeel Cemetery which takes in views of Lough Allen and the mountain ranges north of Sligo, the existing N4 and the settlement at Castlebaldwin form small but clearly noticeable elements within the broad panoramic vista at this location. Chapter 15 states that whilst a section of the *Proposed Road Development*, where it curves up from the existing N4 toward the Drumderry drumlin, will be visible from Carrowkeel cemetery '*an impact is not seen as significant due to the fact that the existing road and Castlebaldwin village is already visible from the site'* and that *'the impact of the Proposed Road Development on Carrowkeel cemetery is deemed indirect and slight, being a minor visual impact only'*.

In the case of 'Castlebaldwin House' the Chapter notes that the proposed route alignment will move closer to the monument and that in conjunction with the proposed link road would result in *'a slightly greater increase of visual impact than exists already'.*

In conjunction with the Archaeological and Cultural Heritage Consultants extensive mitigation measures have been proposed in this area including hedgerow and feature planting alongside the Castlebaldwin junction embankments and at Drumderry Hill (Figure 10.1.8 contained within volume 3 of this EIS).

10.3.3 Visual Baseline

The visual baseline establishes the existing context of the *Proposed Road Development* with respect to visual amenity and sensitivity. This is considered in relation to different receptors including views of the *Proposed Road Development* from adjacent settlements and dwellings and also views experienced by road users. Views and prospects of high sensitivity are generally identified in county development plans, however, they may also be highlighted on touring maps or postcards relating to the region.

10.3.3.1 Visual Policy and Designations

Landscape Characterisation Map 7.D current Sligo County development plan '*classifies the County according to its visual sensitivity and ability to absorb new development without compromising the scenic character of the areas'*. In addition to the 'Normal' and 'Sensitive' Rural Landscapes outlined above it contains two classifications with particular reference to visual impacts. These categories are 'Visually Vulnerable Areas' and 'Scenic Routes'.

Visually Vulnerable Areas are described as:

> *'...distinctive and conspicuous natural features of significant natural beauty or interest, which have extremely low capacity to absorb new development.'*

The only designated 'Visually Vulnerable Area' in the vicinity of the *Proposed Road Development* comprises the Toberscanavan Loughs and their surrounds to the west of the existing N4 at Ardcurley.

Scenic Views are marked on map 7.D but also listed under Appendix G of the current Development Plan. They are described under section 7.4.3 as

> *'... public roads that coincide generally with popular tourist routes passing through or close to Sensitive Rural Landscapes, or adjoining Visually Vulnerable Areas, and affording unique scenic views of one or more distinctive natural features.'*

There are no designated Scenic Routes shown in the proximity of the *Proposed Road Development* between Collooney and north of Castlebaldwin. There are, however, three scenic routes located to the extreme south of the *Proposed Road Development* at Castlebaldwin, which are listed below.

- N4 Castlebaldwin to Ballinafad (views of Bricklieve Mountains, Lough Arrow and Curlew Mountains);
- Lakeshore drive around Lough Arrow from Castlebaldwin to Roscommon County boundary (L-1404, L-1403 & L-1905, Views of Lough Arrow and Bricklieve Mountains);
- From Castlebaldwin southwards to junction with R295, southwest to Templevanny Lough (L-1404 & L-5801, Views of Bricklieve Mountains, Kesh Corran and Lough Arrow).

Filtered views of the Bricklieve Mountains are displayed from several locations east of Castlebaldwin. In turn elevated panoramic views are displayed from this mountain range and Carrowkeel, which take in Castlebaldwin and Drumderry Hill.

The policies of the current County Development Plan in relation to Scenic Views are expressed under objective O-LCAP-7:

> *'Preserve the scenic views listed in Appendix G by controlling development along designated Scenic Routes and other roads, while facilitating developments that may be tied to a specific location or to the demonstrated needs of applicants to reside in a particular area. In all cases, strict location, siting and design criteria shall apply, as set out in Section 12.3 Residential Development Standards.'*

The proposed road will not necessarily detract from these scenic routes, however, instead providing new opportunities of viewing the landscape features of interest (namely Bricklieve Mountains and Castlebaldwin).

10.3.3.2 Extent of Visual Influence

The existing N4 has a relatively narrow corridor consisting of single lanes with no hard shoulders and grass verges; this is with the exception of the section between Toberbride and Doorly which has hard shoulders. It also runs largely at grade and winds around prominent landscape features such as drumlin hills or lakes. Thus, it has a small vertical and horizontal footprint and aside from traffic the road corridor and associated infrastructure is not a dominant feature within the landscape beyond a very short distance. For road users, views tend to be relatively extensive where the route passes through open bogland and mountain moorland areas with little in the way of vegetative screening at the roadside. Where the road passes through more undulating terrain, between lakes for example, views become more contained for short distances by local terrain. There are also frequent instances where scrubby woodland or conifer plantations in near proximity to the road truncate vistas at a relatively short distance and provide a greater sense of enclosure.

10.3.3.3 Visual Amenity and Sensitivity

Unlike landscape sensitivity, the sensitivity of visual receptors has an anthropocentric basis. Visual sensitivity is a two-sided analysis of receptor susceptibility (people or groups of people) versus the value of the views on offer at a particular locations. It considers factors such as the perceived quality and values associated with the view, the landscape context of the viewer, the likely activity they are engaged in and whether this heightens their awareness of the surrounding landscape. In accordance with the IEMA Guidelines for Landscape and Visual Assessment (3rd edition 2013) visual receptors most susceptible to changes in views and visual amenity are;

1. Residents at home;
2. People, whether residents or visitors, who are engaged in outdoor recreation, including use of public rights of way, whose attention or interest is likely to be focussed on the landscape and on particular views;
3. Visitors to heritage assets, or to other attractions, where views of the surroundings are an important contributor to the experience;
4. Communities where views contribute to the landscape setting enjoyed by residents in the area; and
5. Travellers on road rail or other transport routes where such travel involves recognised scenic routes and awareness of views is likely to be heightened

MosArt use a five-point scale to indicate the level of visual sensitivity, which ranges between very low, low, medium, high and very high. Whilst specific sensitivity judgements are often applied to individual receptors in the case of an extensive linear development such as a road realignment it is not considered practical or necessary to do this. Instead, a general level of visual amenity and sensitivity can be estimated using the criteria set out below:

1. **Recognised scenic value of the view** (County Development Plan designations, guidebooks, touring maps, postcards etc). These represent a consensus in terms of which scenic views and routes within an area are strongly valued by the population because in the case of County Development Plans, at least, a public consultation process is required;
2. **Views from within highly sensitive landscape areas**. Again, highly sensitive landscape designations are usually part of a county's Landscape Character Assessment, which is then incorporated with the County Development Plan and is therefore subject to the public consultation process. Viewers within such areas are likely to be highly attuned to the landscape around them;
3. **Primary views from dwellings**. Rather than highlight if a proposed development can be seen from any residential property regardless of context, this category is reserved for those instances in which the

design of dwellings or housing estates, has been influenced by the desire to take in a particular view of high amenity. This might involve the use of a slope or the specific orientation of a house and/or its internal social rooms and exterior spaces;

4. **Intensity of use, popularity**. This relates to the number of viewers likely to experience a view on a regular basis and whether this is significant at county or regional scale;
5. **Connection with the landscape**. This considers whether or not receptors are likely to be highly attuned to views of the landscape i.e. commuters hurriedly driving on busy national routes versus tourists or hill walkers directly engaged with the landscape enjoying changing sequential views over it;
6. **Provision of elevated panoramic views**. This relates to the extent of the view on offer and the tendency for receptors to become more attuned to the surrounding landscape at locations that afford broad vistas.
7. **Sense of remoteness and/or tranquillity.** Receptors taking in a remote and tranquil scene, which is likely to be fairly static, are likely to be more receptive to changes in the view than those taking in the view of a busy, fast changing view, for example a lively street scene;
8. **Degree of perceived naturalness**. Where a view is valued for the sense of naturalness of the surrounding landscape it is likely to be highly sensitive to visual intrusion by distinctly manmade features;
9. **Presence of striking or noteworthy features.** A view might be strongly valued because it contains a distinctive and memorable landscape feature such as a promontory headland, lough or castle;
10. **Historical, cultural and / or spiritual significance.** Such attributes may be evident or sensed by receptors at certain viewing locations, which may attract visitors for the purposes of contemplation or reflection heightening the sense of their surroundings;
11. **Rarity or uniqueness of the view**. This might include the noteworthy representativeness of a certain landscape type and considers whether the receptor could take in similar views anywhere in the broader region or the country;
12. **Integrity of the landscape character**. This looks at the condition and intactness of the landscape in view and whether the landscape pattern is a regular one of few strongly related components or an irregular one containing a variety of disparate components;
13. **Sense of place**. This considers whether there is special sense of wholeness and harmony at the viewing location; and
14. **Sense of awe**. This considers whether the view inspires an overwhelming sense of scale or the power of nature.

Those locations where highly susceptible receptors or receptor groups are present and which are deemed to satisfy the above criteria (for example, popular recreational places providing distinctive and highly memorable views from elevated positions involving say, rugged mountains and water, wild and remote in character) tend to be higher in terms of visual sensitivity than those which do not (e.g. non-recreational areas of strongly anthropogenic character without striking features and no sense of place).

In this 'Normal Rural Landscape' setting the visual resource between Collooney and Castlebaldwin does not provide any exceptional or highly scenic views or offers a strong sense of remoteness or tranquillity. It does, however, meet some of the visual sensitivity criteria particularly in relation to its high intensity of use and the provision elevated panoramic views over the wider landscape from some sections of the existing alignment.

It is also assumed that a considerable proportion of tourists and recreationalists are likely to travel on this route towards Sligo to experience views of the landscape and are highly attuned to it. In relation to residential receptors whilst this a sparsely populated area dwellings are often sited in elevated location or on lake edges and are oriented to take advantage of views of the surrounding landscape. The sensitivity judgements for the receptor views in relation to the proposed road development are discussed under section 10.4.2.1 and 10.4.2.2.

10.4 Description of Likely Impacts

10.4.1 Landscape Impact Assessment

This section discusses Landscape impacts where the *Proposed Road Development* brings about a change in the landscape character of the locality.

Landscape impact can arise where the proposed alignment will result in a change in the macro character of the locality. As has been described earlier, the character of this rural landscape consists of a mixed marginal farmland set in rolling drumlins and scattered with lakes and flat open bogland.

Landscape impact of roads can arise where the *Proposed Road Development* compromises features contributing to local distinctiveness of character and/or where it carves through open countryside currently 'unspoiled' by large scale schemes such as that proposed. The latter is expressed in the horizontal and vertical alignment.

The impact arising from deviation of the *Proposed Road Development* as compared to the existing N4 is described below.

Based on the judgement methodology outlined under 10.3.1.3 the landscape sensitivity of the study area in relation to the proposed road development is generally considered to be 'low'. This is concurrent with the 'Normal Rural Landscape' designation for most parts of this landscape in the current Sligo County Development Plan Landscape Characterisation outlined in section 10.3.2.1.

10.4.1.1 Horizontal alignment

The majority of the *Proposed Road Development* is offline (80%). Online sections are confined to either end of the proposed alignment. Whilst the offline sections never stray more than approximately 500m from the existing road, they would, nevertheless, encroach upon land that is currently largely undeveloped open countryside. Offline sections, where the proposed road pavement is completely off the existing paving, combined with road corridor widening can give rise to considerable adverse impacts such as mature vegetation loss where it crosses woodland clusters or where the route encroaches upon drumlin hills, lake edges or open bogland. It can be expected, therefore, that the offline sections may give rise to a higher adverse impact than those sections that are online.

Table 10-3: Horizontal alignment of the proposed road development

Area	Chainage Section (m)	Chainage Length[55]	Horizontal Alignment
Collooney N4 north of Doorly Hill (mainline)	-190m- 2,550m	2,740m	Main alignment substantially online. Separate Eastern Parallel Link proposed between Toberbride Td. and Doorly Td.
Drumlin landscape between Doorly Hill and Castlebaldwin	2,550 –14,100	11,550m	Offline. Maximum deviation: approximately 500m
Tie-in to existing N4 south of Castlebaldwin	14,100 –14,520	420m	Substantially online

10.4.1.2 Vertical Alignment

Only approximately 10.5% of the *Proposed Road Development* (mainline) will run at or close to existing grade with level differences less than 1.5m (refer to Table 10-4 below). Approximately 55% of the road will run in fill, with the highest sections being at wetland areas north and south of Doorly Hill (c. Ch. 1,350m -2,750m and 3,150m-3,850m), the area in the vicinity of the Turnalaydan Stream crossing (c. Ch. 4,200m-4,850m), the area in the vicinity of the Drumfin River crossing (c. Ch. 6,750m-7,600m), the wetland area and proposed underbridge in the townland of Carrownagark (c. Ch. 8,400-8,950m); the peatland basin surrounding Aghalenane Lough (c. Ch. 9,250m-10,300m) and the low lying farmland area between local hills south of Springfield (c. Ch. 10,550m-10,900m)

The proposed route realignment will be in cut for approximately one third of the *Proposed Road Development* through hill slopes of several drumlin hills, including Doorly Hill (c. Ch. 2,800m-3,150m), the hills in Drumfin (c. Ch. 5,750m-6,600m), at Carrownagark (c. Ch. 8,150m-8,400m), Kingsbrook (c. Ch.8,950m-9,200m), Ardloy/Springfield (c. Ch. 10,300m-10,550m), Tawnagh & Cloonymeenaghan (c. Ch. 10,900m-11,875m) and at Drumderry Hill (c. Ch. 12,600m-13,600m).

The greatest adverse landscape impact of the *Proposed Road Development* is likely to arise from these major cut and fill areas as described above. However, this impact has to be balanced against the robust nature and generally low sensitivity of the surrounding landscape.

[55] Chainages references and lengths quoted throughout this document are approximate only.

Table 10-4: Vertical alignment of the Proposed Road Development

Area	Chainage Section (approx)	Chainage Length	Vertical Alignment
Main line commencement point to Toberscanavan Loughs	-190-1350	1540m	Close to existing levels
North of Cloonamahan Hill to Doorly Hill	1350-2750	1400m	Fill – level changes up to 6.6m
Eastern slopes of Doorly Hill and proposed roundabout in Doorly townland	2750-3150	400m	Cut- level changes up to 4m.
Lackagh Fen basin south of Doorly hill in the townlands of Doorly and Knocknagroagh	3150-3850	700m	Fill- level changes up to 8.5m
Peatland area and proposed overbridge in the townland of Knocknagroagh	3850-4175	325m	Cut- level changes up to 3.5m
Peatland area north east of Lough Corran In the townlands of Knocknagroagh and Drumfin	4175-4850	675m	Fill- level changes up to 5.7m
Peatland area east of Lough Curran in the townland of Drumfin.	4850-5100	250m	Cut- level changes up to 1.8m
Peatland area and proposed overbridge in the townland of Drumfin	5100-5750	650m	Fill- level changes up to 3.3m
Local hill south in the townland of Drumfin	5750-6600	850m	Cut- level changes up to 12.1m
Drumfin River Basin peatland area and conifer forest and wet woodland at Carrowkeel	6600-8100	1500m	Predominantly Fill- level changes up to 5.0m
Local hill at Carrownagark	8100-8400	300m	Cut- level changes up to 6.6m
Peatland area and proposed underbridge at Carrownagark/ Kingsbrook	8400-8950	550m	Fill- level changes up to 12.7m
Local hill at Kingsbrook	8950-9225	275m	Cut-Level changes up to 6.0m
Peatland basin surrounding Aghalenane Lough	9225-10300	1075m	Fill- level changes up to 10.5m
Local hill at Ardloy/Springfield	10300-10550	300m	Cut-Level changes up to 13.1m
Low lying area of marginal farmland between local hills south of Springfield	10550-10900	350m	Fill- level changes up to 11.0m
Local drumlin hills at Tawnagh and Cloonymeenaghan	10900-11900	1000m	Predominantly cut-Level changes up to 7.1m
Peatland basin between Cloonymeenaghan and Sheerevagh	11900-12600	700m	Fill- level changes up to 5.3m
Drumderry Hill	12600-13600	1000m	Cut- level changes up to 11.4m
Castlebaldwin, Cloghoge Upper and Cloghoge Lower	13600-14300	700m	Fill- level changes up to 5.3m

Area	Chainage Section (approx)	Chainage Length	Vertical Alignment
Tie-in to existing N4 in Cloghoge Lower townland	14300-14520	200m	Close to existing levels

10.4.1.3 Landscape Impacts on Features Contributing to Character Distinctiveness

Whilst the predominant character of this landscape comprises 'Normal Rural Landscape' dominated by drumlin hills, wet and peatlands and marginal farmland, there are several features which add interest to the locality and help to make it distinctive from other areas. A discussion of anticipated landscape features along the route from north to south is outlined below.

10.4.1.3.1 *Collooney/Toberbride to Toberscanavan Loughs (Chainage -190m - 1,600m)*

This initial road segment extends through a transitional zone from the planar urban fringes of Collooney to its undulating pastoral hinterland further south. From the existing N4/N17 roundabout at Toberbride the N4 initially travels southwards through a short rock cutting framed by mature road side vegetation. After a short section through open farmland at Mullaghnabreena/ Ardcurley it enters a dense woodland area comprising steep embankments to the east and the densely screened Toberscanavan Loughs to the west. Above the existing N4 to the north east and separated by sloped farmland is Markree Demesne set within extensive mature woodlands. The southern outskirts of Collooney consist of dispersed industrial units set within open fields and do not contain residential settlements. Further south are small settlements at Toberbride, Mullaghnabreena and Ardcurley in an otherwise sparsely populated area. A Local Authority Transient site is located at Cloonamahan south of the Toberscanavan Loughs. In the current Sligo County Development Plan the landscape south of Collooney is predominantly classified as 'Normal Rural Landscape'. However, both Markree Demesne and the Toberscanavan Loughs and woodland surrounds are designated 'Sensitive Rural Landscapes'.

Proposed road development

The *Proposed Road Development* stays predominantly online and at grade throughout this route segment. At Toberscanavan Lough the alignment starts to rise and reaches levels of approximately 2m above ground at the southern periphery of the Toberscanavan Loughs. The proposed eastern parallel link road runs in close proximity to the alignment between Toberbride and the Toberscanavan Loughs but curves eastwards further north to connect to the Toberbride business park and encroaches into an area of agricultural pastureland. At Toberbride an overbridge connection to the eastern parallel link road is proposed and the eastern parallel link road is considerably elevated in this area. A constructed wetland (part of the development drainage design) is located at circa Ch. 1,100m.

Anticipated Impacts

From Toberbride to the 'Sensitive Rural Landscape Area' surrounding the Toberscanavan Loughs mature roadside vegetation in the proximity of the *Proposed Road Development* will be lost throughout as a result of the route corridor widening and additional road works required to accommodate the proposed parallel link road and overbridge. Extensive ground disturbances in addition to the online route widening will be also caused by the proposed eastern link road corridor through existing pasture land. The 'Sensitive Rural Landscape Area' at the Markree Estate will not be affected by the *Proposed Road Development*. Considering the predominantly 'Normal Rural Landscape' setting in the vicinity of the *Proposed Road Development* the landscape impacts anticipated for this segment are on balance judged to be **'Moderate Adverse'**.

10.4.1.3.2 *Local drumlin hills at Cloonamahan Hill and Doorly and Lackagh Fen basin (Chainage 1,600m-4,000m)*

From the Toberscanavan Loughs the existing N4 alignment travels in a straight alignment through hilly marginal pastureland at Cloonamahan and Ardcurley before skirting Doorly Hill to the east. From Doorly Hill it continues east of the open Lackagh Fen wetland basin towards the small roadside settlement of Lackagh. To the north east are the woodland covered Markree Demesne estate and Cooperhill. In addition to the settlement clusters located at Knocknagroagh and Lackagh, a small number of isolated dwellings and farmsteads are dotted along the route in this location. The landscape in this area is classified as 'Normal Rural Landscape' with the exception of a wetlands west of Doorly hill which are indicated as 'Sensitive Rural Landscape' in the current Sligo County Development Plan.

Proposed road development

The *Proposed Road Development* stays initially online between Toberbride and Cloonamahan/Ardcurley but diverts westwards at circa chainage 2,600, where it cuts through the south eastern hill slopes of Doorly Hill. The proposed eastern parallel link road continues in close proximity to the mainline throughout Ardcurley and connects to the existing N4 at chainage 2,800. A western parallel link road is proposed from Cloonamahan to the south of the Toberscanavan Loughs to Doorly ending at a roundabout connection north of Doorly Hill at chainage 2,500m. From Doorly Hill the main alignment runs at elevated levels up to 7.5m above grade along the western edge of the Lackagh Fen peatland area before crossing the existing L-55016-0 in cut at Knocknagroagh. This local road will be realigned to pass over the proposed mainline. Two constructed wetlands (part of the development drainage design) are located at Ardcurley at c. Ch. 2,100m and south of Doorly Hill at c. Ch. 3,500m

Anticipated Impacts

South of the Toberscanavan Loughs the *Proposed Road Development* travels predominantly through marginal farmland with little woodland cover and loss of mature vegetation to any major degree is not anticipated in this area. Whilst the initial sections of the *Proposed Road Development* are largely online, the route corridor is considerably extended throughout Cloonamahan and Doorly to accommodate the proposed parallel link roads and the constructed wetland area at Ardcurley and will encroach into adjacent Greenfield sites. Extensive ground disturbances will be also be created further south at the major cut and fill sections along the eastern hill slopes at Doorly Hill, at the western edge of the Lackagh Fen wetland basin and at the settlement of Knocknagroagh. The 'Sensitive Rural Landscape' areas west of Doorly Hill will not be affected by the proposed development. Considering the 'Normal Rural Landscape' setting throughout this area the landscape impacts resulting from the *Proposed Road Development* at this location is overall judged to be '**Moderate Adverse'**.

10.4.1.3.3 *Peatland basin surrounding Lough Corran (Chainage 4,000m-5,700m)*

To the west of the existing N4 route section between Knocknagroagh and Drumfin extends a large peatland area which contains the small lakes Lough Corran and Boathole Lough. The land cover throughout this lowland basin is largely bog interspersed with clusters of marginal shrub land and conifer tree plantations. On higher lying ground sloping marginal farmland with wet grassland fields and occasional hedgerows dominate, allowing for long distance views over the open landscape. The basin is largely unoccupied with the exception of isolated farmsteads on higher ground. Further dwellings are located at the small cross road settlement Drumfin and dotted along the existing N4 alignment further east. The wetlands surrounding Lough Corran area classified as 'Sensitive Rural Landscape' in the current County Development Plan, the classification for the wider vicinity is a 'Normal Rural Landscape'.

Proposed road development

The proposed N4 realignment is located up to 500m west of the existing N4 route within an area of sloping marginal farmland close to the eastern edge of the peatland basin. The *Proposed Road Development* is elevated throughout this area with fill levels of up to 5.4m. An access track is proposed in parallel to the west of the proposed mainline alignment between Lough Corran and the L-5502-0.

Three spoil repository sites including SR-LI-01, SR-LI-02 and SR/BP Type 02- No 02 are proposed adjacent to the re-routed N4 alignment where it intercepts the L-5502-0, which will be designed to pass over the proposed route. Two constructed wetlands (part of the development drainage design) are located at Knocknagroagh c. Ch. 4,200m and east of Lough Corran/ Drumfin (c. Ch. 4,900m).

Anticipated Impacts

This route section travels predominantly through marginal farmland and loss of mature vegetation to any major degree is not anticipated. Whilst the proposed alignment largely skirts the 'Sensitive Rural Landscape' area and will not require major cut sections through drumlin hills, extensive ground disturbances in close proximity to the peatland basin are expected to occur as a result of the road works. The exposed constructed wetland and spoil repository sites are adjacent in close proximity to the *Proposed Road Development* and limited in extent but will create a considerable disturbance over intact peat and wet grassland in addition to the mainline development. In summary landscape impacts from the proposed realignment within this peatland basin are considered to be **'Moderate Adverse'**.

10.4.1.3.4 *Local drumlin hills at Drumfin and Cloonlurg (Chainage 5,700m-6,900m)*

South of the peatland basin at Lough Corran and Drumfin cross roads and west of the existing N4 alignment is Drumfin hill. A further shallow hill separated by a low lying marshland lies further south in close proximity to Drumfin Hill. Both hills are broadly aligned in a north-south direction and covered by large open grazing fields and hedgerow sections. The western slopes of the Drumfin hill are divided by vertical and horizontal hedgerow lines in a distinctive regular field pattern. The hedgerows end at the lower hill slopes where the grazing fields give way to extensive bog and wet grasslands. The area is largely unoccupied with the exception of a number of isolated farmsteads and a settlement cluster along the local road (L-1502-32) at Cloonlurg south of the Drumfin hill.

This drumlin and wetland landscape is classified as 'Normal Rural Landscape' in the Current Sligo County Development Plan.

Proposed Road Development

The *Proposed Road Development* is relocated approximately 400m further west of the existing N4 where it swaps sides from the eastern to the western foothills of the Drumfin hill. As a result the alignment will cut into the sweeping western slopes of this hill site with levels up to 12.2m below existing ground. Further south an overbridge and two compact connector roads are proposed east and west the existing local road L1502-32 to Ballymote. A constructed wetland area and 2 no. spoil repository sites are proposed to the west and east respectively of the overbridge embankments at circa Ch. 6,600m.

Anticipated Impacts

The proposed realignment of the existing N4 to the west of Drumfin Hill and the considerably wider mainline corridor with the proposed overbridge and compact connector roads over the L1502-32 at Drumfin/Cloonlurg will require extensive areas of construction in a relatively confined area. Mature vegetation loss is anticipated at the distinct hedgerow patterns at Drumfin Hill and along local road L1502-32. In addition to the extensive cut slopes at the Drumfin hill the proposed rerouting with the associated connector and access roads and the constructed wetlands and spoil repository sites will also cause considerable disturbance of the existing wetland areas between both hills. For these reasons landscape impacts within this area, which is classified as 'Normal Rural Landscape', are judged to be **'Moderate Adverse'**.

10.4.1.3.5 *Drumfin River Basin and Carrownagark Hill (Chainage 6,900m- 8,600m)*

South of Drumfin Bridge at Behy Bridge the existing N4 crosses the winding Drumfin River Basin. Lower lying areas close to this river basin contain a patchwork of marginal pasture, wetlands, bogland and scrubland. Land uses on higher ground consist largely of pastoral fields which are typically enclosed by a network of hedgerows and occasional stone walls. A large conifer plantation is located north of Drumfin River between Behy Bridge and Cloonlurg. The basin area is sparsely populated. Isolated farmsteads and road side settlements are dotted along the upper slopes of the western drumlin hills and Carrownagark Hill. This drumlin and wetland landscape is classified as 'Normal Rural Landscape' in the current Sligo County Development Plan.

Proposed Road Development

The proposed route relocation runs approximately 350m west in parallel to the existing alignment and follows a north western to south eastern direction. The proposed alignment will cut through the eastern part of the extensive conifer forest northwest of Drumfin River where it crosses the river before continuing in parallel to the river basin towards the shallow Carrownagark Hill. Throughout the conifer forest and at the river crossing the alignment is in fill with levels of up to 5.1m above existing ground. An additional electricity pylon tower is proposed along the existing 220kV line to the west in close proximity of the relocated alignment within the area currently covered by conifer forest.

Southeast of the river basin the alignment will be in cut throughout the western hill slopes of Carrownagark hill with levels of up to 6.4m below existing ground. A constructed wetland (part of the development drainage design) is located north west of Carrownagark Hill at c. Ch. 7,750m. The alignment rises again further south to pass over the L5402-0 from Carrownagark to Kilmorgan with levels up to 11.2m above grade. A new accommodation track is proposed to the west of the alignment in this area.

Anticipated Impacts

The proposed relocation of the existing N4 alignment closer to the Drumfin river valley will require the removal of a number of hedgerow sections and parts of the existing conifer forest north of the river valley.

With the exception of a new river crossing the alignment will not impact directly on the Drumfin river course but considerable ground disturbances will be created throughout the linear route corridor in fill to the east of the river valley. Short but extensive cut slopes will occur at the western upper hill slopes of Carrownagark Hill. Considerable ground disturbance areas are also anticipated at the local road (L5402-0) to Kilmorgan further south where the route corridor widens to accommodate accommodation tracks and runs at considerably elevated levels. The proposed electricity pylon will require the clearing of additional conifer forest areas. As a large tower structure it will also be highly noticeable adjacent to the *Proposed Road Development*. From further afield, however, it will be partly screened by the retained sections of conifer forest to the south, west and north. It is also in keeping with similar pylons in this area. Landscape impacts resulting from the proposed pylon are therefore not considered to be critical. On balance, taking into account the 'Normal Rural Landscape' setting the landscape impacts of the *Proposed Road Development* for this location is overall considered to be '**Moderate Adverse'**

10.4.1.3.6 *Local drumlin hills at Kingsbrook and peatland basin surrounding Aghalenane Lough (Chainage 8,600m- 10,250m)*

South of Carrownagark hill is a further lowland area which stretches from the N4 to the eastern foothills of Kingsbrook Hill. This wetland area consists largely of open bog and lacks any larger vegetation. Shrub and hedgerow cover, however, increases considerably towards the foothills of Kingsbrook Hill. The eastern hill slopes of Kingsbrook facing the existing N4 are covered with pasture fields and have a distinctive hedgerow pattern with equally spaced parallel hedgerow lines. Southeast of Kingsbrook Hill in close proximity to the existing N4 alignment is a second wetland area which surrounds Aghalenane Lough and two smaller lakes. This lowland area is framed to the west by a series of undulating low lying hills. Further south is the small elevated settlement at Aghalenane. To the east of Aghalenane Lough, adjacent to the existing N4 alignment, rises the elongated Ardloy/Springfield Hill followed by Tawnagh Hill further east. In addition to the small settlement at Aghalenane a small number of dwellings are located in the vicinity of Carrownagark Cross Roads and further south at Tawnagh and Springfield. This undulating drumlin and wetland landscape is classified as 'Normal Rural Landscape' in the current Sligo County Development Plan.

Proposed Road Development

The *Proposed Road Development* is initially relocated approximately 380m westwards and in parallel with the existing alignment before turning eastwards towards Ardloy/Springfield hill where it crosses over the existing N4 alignment. It will initially run in cut with levels of up to 6.8m below ground along the western hill slopes of Kingsbrook hill but will continue southwards in fill, where it passes over local road L-54033-0. Moving south it skirts the western peatland edge at Aghalenane Lough in fill towards Ardloy/ Springfield. Elevated levels of up to 9.1m are proposed in this area. Two constructed wetlands (part of the development drainage design) are located north and south of Kingsbrook Hill at c. Ch. 8,800m and c. Ch. 9,400m with a further located adjacent to the existing attenuation pond in the townland of Aghalenane.

Anticipated Impacts

The proposed relocation of the existing N4 alignment close to the hill top of Kingsbrook will require extensive cut slopes and will result in a considerable disturbance to its eastern hill slopes. It will also necessitate the loss of hedgerow lines and an interruption of the regular hedgerow pattern on this hill side. Vegetation losses to a lesser extent are anticipated along the western edge of Aghalenane Lough. Whilst the *Proposed Road Development* will not impact directly on this lake its elevated course will enclose these lowlands to the south and will form a barrier towards the rising ground further south. The two proposed constructed wetlands to north of Kingsbrook and the constructed wetland area to the south of Ardloy Lough will require extensive excavations to confined areas within the established wetland zone. Taking into account the 'Normal Rural Landscape' setting landscape impacts resulting from the *Proposed Road Development* for the Kingsbrook and Aghalenane Lough are on balance judged to be '**Moderate Adverse.'**

10.4.1.3.7 *Local drumlin hills at Ardloy/Springfield, Tawnagh & Cloonymeenaghan (Chainage 10,250m- 11,900m)*

South east of Aghalenane Lough is a succession of drumlin hills. Closest to Ardloy Lough is the local hill at Ardloy/Springfield. This unoccupied hill extends in north-south direction adjacent to the east of the existing N4. Its steep slopes overlook the lowlands surrounding Aghalenane Lough and the elevated settlement of Aghalenane further west. The Ardloy/ Springfield hill is largely covered with open pasture fields revealing a gently curved and evenly shaped sweeping ridgeline, which is pronounced by a continuous hedgerow line

along the hill top. In close proximity to the south east is Tawnagh Hill, a further elongated shallow drumlin hill. Tawnagh Hill is orientated in northwest to southeast direction and lies adjacent to local road L5401-0, which branches off the existing N4 alignment at Ardloy Bridge and continues towards Tawnagh to the north east. An isolated farmstead is located on its southern hill top, which is accessed by a narrow lane from the north. The western hill slopes are largely covered by marginal grass land with overgrown patches of scrubland and gorse. Sporadic hedgerows sections line the sweeping hill slopes in vertical and horizontal direction. Between Tawnagh Hill and the existing N4 extend horizontal wetlands with little shrub or tree cover. In close proximity south of this hill is a third hill at Cloonymeenaghan. This unoccupied shallow drumlin hill lies adjacent to the east of the existing N4 alignment. It extends from northwest to southeast parallel to the existing N4 alignment in close proximity to Loughymeenaghan, a local lake, further west. To the east of the hill is a lowland basin which is enclosed to all sides by undulating drumlin hills. Similar to its neighbouring hills Cloonymeenaghan hill comprises large sized open pastoral fields delineated by a diagonal network of hedgerows of various height and quality. The hedgerows extend over the gently rising ridgeline and contain occasional clusters of mature trees further north. A small number of dwellings are located at the western foothills of Ardloy/Springfield hill and at Loughymeenaghan. A small settlement lies at Tawnagh to the north of the drumlin cluster. This undulating drumlin landscape is classified as 'Normal Rural Landscape' in the current Sligo County Development Plan.

Proposed Road Development

From the Aghalenane Lough the proposed alignment continues in a south easterly direction, where it passes over the existing N4 in fill and cuts diagonally through the Ardloy/ Springfield hill. Extensive cut slopes on either side of the alignment will be required in this area to accommodate level changes up to 12.7m below existing ground. East of Ardloy/Springfield hill the route crosses over local road L5401-0 to Tawnagh at elevated levels of up to 10.5m above ground before curving southwards cutting through the upper western slopes of Tawnagh Hill. The alignment will run up to 7.2m below existing levels with extensive cut embankments in this location. From this local hill the proposed route runs in parallel approximately 300m east of the exiting N4 alignment on the opposite side of Cloonymeenaghan hill. To the east of the proposed mainline an access track is proposed to between Tawnagh Hill and Cloonymeenaghan. At Cloonymeenaghan hill the *Proposed Road Development* is in cut with levels up to 7.2m below existing ground will necessitate further extensive cut slopes along its foothills. Constructed wetlands (part of the development drainage design) area are located at Kingsbrook Td., between Ardloy/Springfield hill and Tawnagh Hill in close proximity to the *Proposed Road Development* at circa Ch. 8,800m and at the eastern foothills of Cloonymeenaghan Hill at circa Ch. 11,600m. Spoil Repository/ Borrow Pits Type 01 (No. 01, 02 and 03) are proposed at all three hill sites at c. Ch 10,400m, c. Ch 10,900m and c. 11,600m. Spoil Repository/Borrow Pit Site Type 02 (No.03) is proposed at the eastern foothills of Cloonymeenaghan Hill at c. Ch. 11,600m.

Anticipated Impacts

The proposed major cut and fill sections throughout this drumlin landscape will require far-reaching and broad excavations particularly at Ardloy/Springfield hill but also on the sweeping hill slopes of both Tawnagh and Cloonymeenaghan. These works and the additional constructed wetland and spoil repository sites will create considerable disturbance over extensive surface areas on and adjacent to all three hills. The *Proposed Road Development* will necessitate the disruption of the existing hedgerow patterns throughout this area. Considering the permanent alternation of the drumlin topography in this area, the proposed major cut through Ardloy/ Springfield hill and the enclosure of Cloonymeenaghan Hill from both sides by the existing and proposed N4 routes pre-mitigation landscape impacts within this 'Normal Rural Landscape' are judged to be **'Significant Adverse'.**

10.4.1.3.8 *Peatland basin between Tawnagh and Drumderry (Chainage 11,900m-12,600m)*

South of Cloonymeenaghan Hill are extensive lowlands stretching to the northern foothills of Drumderry Hill in the south east. They are enclosed by Cloongad hill to the west and Sheerevagh further east. This largely inaccessible area consists predominantly of open bogland with small clusters of vegetation and hedgerow sections. Higher lying areas and the surrounding hills largely comprise rolling farmland and a network of hedgerows. Whilst the wetlands are unoccupied a string of houses is located along a local road to the east of the lowland basin at Sheerevagh and along the existing N4 alignment at the foothills of Cloongad. This area is classified throughout as 'Normal Rural Landscape' in the current Sligo County Development Plan.

Proposed Road Development

South of Cloonymeenaghan the proposed rerouted N4 alignment continues in a straight line in fill approximately 300m in parallel to the existing N4 alignment towards the eastern foothills of Drumderry Hill. It will run at elevated levels through the central parts of the wetland basin up to 5.0m above existing ground. Accommodation tracks to both sides of the proposed alignment are planned at local road L54041-0 at Sheerevagh. A constructed wetland (part of the development drainage design) is located at circa Ch. 12,400m.

Anticipated Impacts

The proposed realignment of the N4 through the centre of these wetlands at elevated levels will avoid any impacts to the surrounding drumlin hills but will divide this area and result in considerable disturbance over sections of intact bogland. It will also require the part removal of the existing regular hedgerow patterns largely to the west and south of this area. Considering the 'Normal Rural Landscape' setting landscape impacts resulting from the *Proposed Road Development* for this location are judged to be '**Slight to Moderate Adverse'**.

10.4.1.3.9 *Drumderry Hill and Castlebaldwin (Chainage 12,600m- 14,500m)*

South of Cloongad Hill and the wetlands at Sheerevagh is Drumderry Hill and the small crossroad settlement at Castlebaldwin. The evenly shaped, unoccupied hill extends in northwest to southeast direction in parallel to the existing N4 and overlooks Castlebaldwin to the southwest. To the east and south of the hill is an undulating patchwork of low-lying marginal farmland, wet grassland and boglands, which are subdivided by hedgerows of various height and density. This rectilinear hedgerow network continues over its eastern hill slopes and ridgeline. In addition to Castlebaldwin to the south east further small settlements are located at Sheerevagh to the east of the alignment. Whilst the local road L1403-0/L1404-0 south of Drumderry Hill from Castlebaldwin to Bellarush landscape is designated as a Scenic Route in the current Sligo County Development Plan Drumderry hill and Castlebaldwin are shown as 'Normal Rural Landscape' on the relevant landscape designations map.

Proposed Road Development

At Drumderry Hill the *Proposed Road Development* curves south westwards towards Castlebaldwin and will run in cut throughout the eastern hill slopes of Drumderry Hill with proposed levels of up to 10.1m below ground. A local access track to the hill top is proposed in parallel above the main alignment. Close to the southern end of the hill a roundabout in fill is proposed with elevated link roads to Castlebaldwin to the west and Sheerevagh to the north east. From the roundabout the proposed N4 alignment continues in fill at an angled southwest direction east of the existing N4 to join the existing alignment south of Castlebaldwin.

Two landscape mitigation infill sites – LS Mit. 01 and LS Mit.02 are proposed adjacent to the south west of the roundabout within the triangular shaped area between the new and existing alignment at Castlebaldwin. A constructed wetland (part of the development drainage design) is located at circa Ch. 14,000m.

Anticipated Impacts

The proposed major cut and fill sections along the eastern hill slopes and the southern vicinity of Drumderry hill will cause extensive disruptions to the pasture fields and hedgerows across its eastern hill slopes and will require considerable cut slopes throughout this area. The proposed extensive fill and soil infill areas in the vicinity of the proposed Castlebaldwin roundabout further south will also necessitate the loss of hedgerow lines and interruption of the hedgerow pattern between the proposed and existing N4 alignment at Castlebaldwin and along the new local road branching of to the east of the roundabout towards Bellarush.

Considering the relatively short but permanent alternation of eastern hill slopes of Drumderry Hill and the extensive ground disturbances and level changes across the eastern and southern vicinity of the hill in close proximity to Castlebaldwin and Bellarush in close proximity to a designated scenic route landscape impacts within this 'Normal Rural Landscape' are judged to be **'Moderate to Significant Adverse'.**

10.4.1.3.10 *River Crossings*

The proposed route intercepts a number of river and stream crossings which will have to be maintained as part of the works. The most significant of these crossings occur at c. Ch. 4,480m and c. Ch. 7,350m which will both require clear span river bridge crossings with the remaining crossings on the project requiring culvert structures. These crossings may result in some adverse landscape impact as the road will likely be in fill and will sever the relaxed serpentine river valley. This impact is not highly significant, however, due to the low

visual presence of the streams concerned (and thus their insignificant contribution to the greater character of this locality).

It is proposed to highlight significant river crossings with feature planting.

10.4.1.3.11 *Features of Local Cultural Heritage*

The Cultural Heritage report lists a total of 101 cultural heritage constraints (CHC) along or adjacent the proposed route. As discussed under section 10.3.2.3 two National Monuments are located within the vicinity of the proposed route, where Slight Adverse visual impacts are predicted. However, the Archaeological and Cultural Heritage Chapter states that 'there will be no direct impacts on any known Recorded Monuments' and 'Protected Structures'. Markree Demesne is listed in several places in the report. The castle is, however, located approximately 2km from the proposed route and no adverse impacts are mentioned in the report in connection with the Demesne.

10.4.2 Visual Impact Assessment

10.4.2.1 Individual Properties

The following paragraph discusses impacts to views and visual amenity at individual properties along the route that are likely to give rise to 'Moderate Adverse' and 'Significant Adverse' impacts. Typically they include sections where the *Proposed Road Development* passes in close proximity to existing houses or where considerable road level changes occur. Dwellings where 'Moderate Adverse' or 'Significant Adverse' impacts would most likely arise are marked in blue and orange on Figures 10.1.1 to 10.1.8 contained within Volume 3 of this EIS, Slight Adverse, Imperceptible and Positive Impacts, are coloured in yellow, grey and shades of green respectively. A short description of impacts to individual properties within the 'Slight adverse' to 'Positive' impact range is provided in appendix 10.1 contained in Volume 4 of this EIS.

In some cases the impact may arise on one side of the road only, whereas in others, impact may arise on both sides. An indication as to how the impact can be mitigated and how mitigation measures affect impact levels is provided under the section 10.5 and section 10.6.

The visual impacts for 152 occupied properties or property groups within the view shed of the *Proposed Road Development* have been assessed in-the-field. Based on the visual sensitivity methodology outlined under 10.3.3.3 taking into account the 'Normal Rural Landscape' setting the receptor sensitivity for individual properties in relation to the proposed road development is considered to be range from 'High' for elevated properties where panoramic or high amenity views exist to 'Medium' for highly sheltered properties.

Impacts on derelict or unoccupied properties and properties to be acquired through the CPO process have not been considered in this study. Impacts have been assessed according to the following scale in accordance with the significance criteria presented earlier:

- Significant Positive;
- Moderate Positive;
- Slight Positive;
- Imperceptible;
- Slight Adverse;
- Moderate Adverse;
- Significant Adverse; &
- Profound Adverse

No 'Profound Adverse', 'Moderate Positive' and 'Significant Positive' visual impacts have been recorded for this development.

10.4.2.1.1 *Discussion of Visual Impact Assessment at individual properties*

10.4.2.1.1.1 *Chainage -190m to Chainage 2,200m (Figure 10.1.1 and 10.1.2 of Volume 3)*

This initial segment of the *Proposed Road Development* extends from the N17/N4 roundabout junction at Toberbride at the southern outskirts of Collooney to Ardcurley/Cloonamahan. The main settlement clusters in this area are at Toberbride east of the alignment and Toberscanavan to both sides of the existing N4. A Local Authority Transient site is located south of Toberscanavan Loughs.

Assessment

A number of properties in the elevated settlement of Toberbride and the Local Authority Transient site at Cloonamahan will experience higher rated adverse visual impacts as a result of the *Proposed Road Development*. Occupied properties are to be acquired through the CPO process and are not considered in this assessment.

- Elevated property No. 03 is set back above the existing N4 which runs slightly in cut in this location. It is separated from the N4 by a narrow road side embankment with a screen planting strip and a separate access track. The property currently has filtered views of the passing N4 traffic. The proposed corridor widening will encroach into the road side embankment and necessitate the removal of screen planting. As a result the *Proposed Road Development* will expose the considerably extended route corridor and eastern parallel link road to this property. Impacts to visual amenity and views for this property in this location are therefore judged to be **Moderate Adverse**.
- Elevated property No. 05 will experience **Moderate Adverse** impacts as a result of the *Proposed Road Development*. A broad access road and sloped buffer zone with dense screen planting is located between this property and the N4 alignment blocking any views of the N4. This screen planting and road side embankment will be removed to accommodate the *Proposed Road Development and re-aligned access road*. In addition the property will be partly overlooked by the elevated local access road proposed further south.
- Dwelling No. 06a is located at a considerable distance to the west of the existing N4 alignment and has No. views of the proposed mainline alignment. **Moderate Adverse** visual impacts are, however, predicted for this property resulting from the proposed local access track skirting this property in close proximity to the north and affecting its westerly views over currently undeveloped open farmland.

Several properties at Mullaghnabreena are located in close proximity to the existing N4 and will experience higher rated adverse visual impacts as a result of the *Proposed Road Development*.

- Properties No. 9 and No. 9a are both considerably set back upslope to the east of the existing N4 and have broad elevated westerly views over the wider area. Both have limited visibility of the existing N4 alignment due to its alignment partly in cut and dense clusters of roadside screening in this area. Whilst the existing road side screening will be largely retained and continue to provide a high level of screening the proposed eastern parallel link road will run in close proximity of both properties through currently undeveloped farmland at short distance to both properties feature prominently in their westerly views. For these reasons visual impacts for these properties are judged to be **Moderate Adverse.**
- Property No. 10 is situated in close proximity to both the N4 and the local road servicing east Mullaghnabreena. It is highly screened to the south along the existing N4 but has oblique filtered northerly views of sections of the N4 over an oven field in front of the property. The proposed eastern parallel link road will introduce a third road in close proximity of this property and feature prominently on its primary views to the north. Whilst an increased buffer zone to the property will be created by the proposed realignment of the local access road, the property is at risk of being overlooked from both elevated local roads. For these reasons impacts to the visual amenity of this property are judged to be **'Significant Adverse'.**

Toberscanavan Loughs and Ardcurley

- The Local Authority Transient site No. 16 (Cloonamahan) is enclosed by a soil berm and has currently No. view of the existing N4. The *Proposed Road Development* and local access road to the north of the site will run at elevated levels in this location. As a consequence the site will be partly overlooked from sections of the *Proposed Road Development*. The increased visual exposure and loss of privacy for this receptor resulting from the *Proposed Road Development* is judged to be **Moderate Adverse**.

10.4.2.1.1.2 *Chainage 2,200m to Chainage 3,420 (Figure 10.1.2 of Volume 3)*

This 1.22km section of the proposed N4 route realignment runs from Cloonamahan/Ardcurley north of Doorly Hill to the edge of the peatland basin south of the hill before continuing towards Knocknagroagh. Properties found in this area are largely located adjacent to the existing N4 alignment.

Assessment

In this area one property, located to the east of the proposed road corridor in close proximity to the western foothills of Doorly Hill, is predicted to experience a higher rated adverse visual impact.

- As a result of the *Proposed Road Development* dwelling No. 105 will be surrounded in close proximity both by the existing and proposed alignment to the east and west, thus creating an island effect. The property is, however, heavily screened by mature vegetation and outbuildings to the rear and the proposed mainline runs in predominantly in cut in this location. For these reasons visual impacts for this property are judged to be **Moderate Adverse**.

10.4.2.1.1.3 *Chainage 3,420m to Chainage 5,340m (Figure 10.1.3 of Volume 3)*

This 1.92km section of the proposed N4 route realignment extends from Doorly townland to the lowland basin surrounding Lough Corran. Properties located in this area include the small settlements of Lackagh and Knocknagroagh to both sides of the existing N4 alignment and clusters of roadside properties north of Drumfin.

Assessment

At Knocknagroagh to the west of Lackagh and the existing N4 alignment is a cluster of 10 dwellings, which are aligned in east west direction along a local access road. The proposed N4 realignment further west will run in cut through this settlement cluster resulting in higher rated visual impacts on a number of these dwellings.

- The three properties closest to the *Proposed Road Development* are predicted to experience a **Significant Adverse** impact (No. 117,118,119), due to their close proximity to the road alignment resulting in considerable restrictions to previously open panoramic views over the surrounding peatland from these dwellings and potential overlooking from elevated sections of the road .
- Visual impacts at property No. 121 are judged to be **Moderate Adverse**. This dwelling has elevated panoramic views over the surrounding peatland and the proposed N4 route alignment will feature prominently in southerly views from this dwelling.

10.4.2.1.1.4 *Chainage 5,340m to Chainage 7,200m (Figure 10.1.4 of Volume 3)*

This 1.86km section of the *Proposed Road Development* extends between Drumfin and Cloonlurg townlands. Properties located in this area are largely concentrated along the existing N4 alignment and at the local access roads L5502-0 and the L1502-32 to both sides of Drumfin Hill.

Assessment

There is one property (No. 156) north of Drumfin hill to the west of the existing N4 alignment, which have elevated panoramic views over open peatlands further west.

- Relocation of the proposed new route alignment further west would result in close proximity views of elevated route sections and potential overlooking from the proposed overpass at property No. 156. Consequently impacts to the visual amenity of this property are judged to be **Significant Adverse**.

10.4.2.1.1.5 *Chainage 7,200m to Chainage 9,050m (Figure 10.1.5 of Volume 3)*

This 1.85km section of the proposed N4 route realignment continues south through the conifer forest at Cloonlurg to Kingsbrook. Properties located in this area are largely located along the existing N4 alignment, at Carrownagark Cross Roads and the L5402-0 local road to Kilmorgan Bridge.

Assessment

There are two dwellings to both sides of the realigned N4 road at the L5402-0 (197 and 199) where higher rated visual impacts are anticipated. Occupied property No. 198 is to be acquired through the CPO process and is not considered in this assessment.

- The highest impact is expected at the property to the immediate west of the proposed road corridor (No. 199). This property will have close range views of the *Proposed Road Development* including access tracks from three sides and is potentially being overlooked by the considerably elevated route alignment in this location resulting in **Significant Adverse** visual impacts.
- A further dwelling is located further east on the L5402-0 local road between the existing and proposed N4 alignment (No. 197). This property is at greater distance to the *Proposed Road Development* and is therefore not immediately impacted on. A **Moderate Adverse** visual impact still

arises from the fact that the elevated sections of the proposed road are likely to cut across existing views to the front of the building.

10.4.2.1.1.6 *Chainage 9,050m to Chainage 10,950m (Figure 10.1.6 of Volume 3)*

This 1.9km section of the proposed N4 route realignment extends from Kingsbrook through the peatland basin west of Aghalenane Lough towards the drumlin hills at Ardloy/ Springfield and on to the Tawnagh townland. Properties located in this area are largely concentrated at Tawnagh, along the existing N4 and the elevated settlement at Aghalenane south-west of Aghalenane Lough.

Assessment

A number of properties at Aghalenane (No. 218, 219, 220, 221), north of Aghalenane Lough (No. 206, 207) and at Ardloy/ Springfield (No. 224, 225 and 227) are anticipated to be considerably affected by the proposed alignment.

- Two properties north of Aghalenane Lough are judged to experience a **Significant Adverse** impact as a result of the proposed rerouting of the existing N4 alignment further west. Property No. 207 is located closest to the *Proposed Road Development* which runs at elevated levels at close proximity to this property with elevated above the property. The proposed alignment and realigned access route will also require removal of existing hedgerow and screen planting at close proximity to this property.
- The visual impact of the elevated *Proposed Road Development* on property No. 206 further east is also judged to be **Significant Adverse.** The *Proposed Road Development* will feature prominently in panoramic open westerly and northerly views over the peatland basin from this location.
- At Aghalenane to the west of the rerouted N4 are several properties which currently have elevated views of their surroundings. The impact to views on the properties No. 218 and 219 closest to the proposed road are considered to be **Significant Adverse**. Both properties have elevated panoramic views over the peatland basin surrounding Aghalenane Lough and the drumlin hills at Springfield and the proposed route realignment to the west of the Lough will feature prominently in panoramic vistas from this location.
- The two properties opposite dwellings No. 220 and No. 221 are partly screened by the foreground buildings and vegetation and are likely to have filtered views of the peatland area and realigned N4 route. Visual impacts to both properties are judged to be **Moderate Adverse**.

Three properties to the south of the drumlin hill at Ardloy/Springfield are likely to experience considerable adverse impacts (No. 224, 225 and 227) as a result of the *Proposed Road Development*.

- Properties No. 225 and 227 are located at close proximity to elevated sections of the proposed route corridor. They will have short distance views of the *Proposed Road Development* and are at risk of being overlooked from elevated stretches of the route corridor resulting in **Significant Adverse** Impacts.
- Further south is elevated property No. 224 adjacent to the local access road to Aghalenane where a **Moderate Adverse** impact to panoramic easterly views resulting from the proposed cut through the Ardloy/Springfield hill is predicted.

10.4.2.1.1.7 *Chainage 10,950m to Chainage 12,800m (Figure 10.1.7 of Volume 3)*

This 1.85km section of the proposed N4 route realignment leads from Townland of Tawnagh through the lowland basin at Sheerevagh and to the townland of Drumderry. Properties located in this area are largely concentrated in the vicinity of Cloonymeenaghan and Cloongad along the existing N4 alignment and at Sheerevagh further east.

Assessment

The visual amenity of a number of properties at Cloonymeenaghan Hill (No. 239, 240) to the west of the proposed N4 alignment and at Sheerevagh (No. 245,247 and 255) to the east of the proposed alignment is anticipated to be considerably affected by the proposed works.

Properties No. 239 and 240 adjacent to the existing N4 alignment at Cloonymeenaghan Hill have rear views towards a local drumlin hill further east.

- The proposed realignment will cut into the western slopes of this hill and will feature prominently in elevated position on easterly views from property 239 and to a lesser extent at property 240, which is

more sheltered with a higher level of existing screening. Impacts to views are therefore anticipated to be **Significant Adverse** at property 239 and **Moderate Adverse** at property 240.

- Dwelling No. 245 to the south-east of Cloonymeenaghan hill has elevated open views over the surrounding peatland areas. The proposed alignment will run at elevated levels in close proximity of this property and feature prominently in its vista resulting in **Significant Adverse** impacts.
- A **Moderate Adverse** impact is predicted for two further dwellings at Sheerevagh (No. 247 and 255). Both properties have elevated westerly views over the low lying wetlands and drumlin hills further west. The proposed alignment will cut through these lowlands at elevated levels featuring prominently within medium distance views from these locations.

10.4.2.1.1.8 *Chainage 12,800m to Chainage 14,522m (Figure 10.1.8 of Volume 3)*

This final 1.72km section of the proposed N4 route realignment extends from the Drumderry Hill to Cloghoge Lower and Castlebaldwin. Properties located in this area are largely concentrated at Castlebaldwin and Bellarush east of Drumderry Hill.

Assessment

Whilst visual impact levels at the settlement of Castlebaldwin remain largely within the Slight Adverse to Imperceptible range, a number of dwellings at Drumderry/ Annaghcor will experience higher levels of impact as a result of the proposed N4 realignment. In this instance the proposed road development will move further east to the opposite side of the Drumderry hill, which previously screened the existing N4 from properties located to the east and will include illuminated junction infrastructure. As a result the visual amenity of an array of properties will be adversely affected to various degrees, ranging from Slight to Significant depending on the existing open views provided.

- There are two properties (No. 264 Drumderry & 271A Annaghcor) at Bellarush to the west of a local road L1403-0 which runs parallel to the proposed new road which have elevated open views towards eastern slopes of Drumderry Hill and foreground peatlands. The proposed alignment will feature prominently at elevated levels in cut against the hill slopes from these locations and Impact to the visual amenity of these properties has been judged as **Significant Adverse**.
- For seven further properties to the east of this local road the impact is predicted to experience **Moderate Adverse** impacts (No. 263,265,271,276,277,278,279) due to impacts to their filtered medium distance views towards Drumderry Hill and Castlebaldwin including night time views of the illuminated junction infrastructure.

10.4.2.1.2 *Summary of likely visual pre-mitigation impacts at occupied properties*

The key findings for the 152 assessed properties can be summarised as follows:

- None of the properties are judged to experience a **Profound Adverse** Visual Impact.
- **Significant Adverse** impacts are anticipated to arise at 15 (10%) of the properties assessed. Significant Adverse impacts may typically be experienced where there is currently No. view of the *Proposed Road Development* and where the proposed alignment would considerably affect existing panoramic views, where the route alignment is highly visible in close proximity to the property, where road sections run at elevated levels in close proximity to properties resulting in potential overlooking or where part of the property is directly impacted or removed. In these cases, mitigation measures will be especially critical in order to reduce the level of adverse impact.
- **Moderate Adverse** impacts are anticipated at 22 (14.5%) of the dwellings assessed. This level of impact typically arises where elevated or panoramic medium distance views are affected by the development. Mitigation measures should be capable of alleviating adverse impact without great difficulty.
- A **Slight Adverse** level of impact is anticipated at a further third (54 properties – 35.5%) of the properties. These residents will not experience a critical level of impact.
- The greatest proportion of residents will either experience an **Imperceptible** (41 properties – 26%) or **Slight Positive** level of Impact (21 properties – 14%). Imperceptible impacts normally occur where existing views remains largely unchanged or where slight impacts to views are balanced against a reduction in traffic along the existing route at road side properties. Minor mitigation may be required for residents at these locations. Positive impacts may arise in situations where there is an overall reduction of impact, due to the likely reduction of traffic on the existing road and consequent reduction in visual blurring caused by passing traffic.

Table 10-5: Summary of likely impacts to views and visual amenity at occupied properties within the visual envelope of the proposal prior to mitigation.

Impact level	No. of properties	Percentage of total
Profound Adverse	0	0%
Significant Adverse	15	10%
Moderate Adverse	22	14.5%
Slight Adverse	54	35.5%
Imperceptible	40	26%
Slight Positive	21	14%
Moderate Positive	0	0%
Significant Positive	0	0%

10.4.2.2 Visual Impact Assessment from Road Sections

The following paragraph discusses visual impacts for road users of the N4. As previously indicated the *Proposed Road Development* passes through the margins of a drumlin zone, comprising a series of low hills, marginal farmland, open wetlands and boglands. Due to proposed considerable horizontal and vertical deviation from the existing alignment and the proposed post and rail fencing of all boundaries within the proposed land take visual impacts to existing views for road users are anticipated throughout the proposed route development. Impact assessment to views takes into account the 'Normal Landscape' Sensitivity classification for the vast majority of the study area. Based on the visual sensitivity methodology outlined under 10.3.3.3 taking into account the 'Normal Rural Landscape' setting the receptor sensitivity for road users in relation to changes to views and vistas resulting from the proposed road development is generally judged to range from 'low to medium'.

10.4.2.2.1 *Collooney to Toberscanavan Loughs (Chainage -190m - 1,600m)*

South of the planar urban fringes of Collooney the existing N4 travels initially in cut through undulating pastoral hinterland towards the woodland covered Toberscanavan Loughs and views of the wider surrounds are largely screened by road side vegetation or the undulating topography. The proposed online road development and considerable route corridor widening will result in roadside vegetation loss throughout this segment. Whilst this will open views of the wider hinterland in some areas the widespread encroachment of the *Proposed Road Development* into established roadside vegetation and greenfield sites will also result in a considerable visual disharmony throughout this segment and pre-mitigation impacts on views for road users are anticipated to be **'Moderate Adverse'** in this location.

10.4.2.2.2 *Doorly Hill through Lackagh Fen basin and Knocknagroagh (Chainage 1,600m-4,000m)*

Between Cloonamahan Hill and Doorly Hill the existing N4 travels through undulating farmland and views from this segment are largely restricted to adjacent fields and hill slopes whilst panoramic views of its wider hinterland are rarely displayed. The *Proposed Road Development* is elevated throughout this section and improving views of the surrounding landscape for road users. In turn the considerably widened route corridor and its adjacent link and access roads will feature prominently on any long distance views throughout this road segment. South of Doorly Hill the existing N4 currently displays open views of the low lying Lackagh Fen wetland area, which is viewed against low lying hill ridges further west. Due to the proposed road alignment to the western edge of Lackagh Fen this wetland basin would appear to be dissected by the *Proposed Road Development*. A considerable visual disharmony will also occur at Doorly Hill, where the proposed alignment and roundabout cuts into its eastern hill slopes. The proposed post and rail fence (boundary fence to CPO) to both sides of the route corridor is largely below the alignment at Lackagh Fen but will be highly noticeable along the eastern slopes of Doorly Hill. On balance, for these reasons impacts on views from this route segment are judged to be **'Moderate Adverse'.**

10.4.2.2.3 *Lowland basin surrounding Lough Corran (Chainage 4,000m-5,700m)*

The proposed N4 alignment is located close to the eastern edge of the Lough Corran lowland basin and will display elevated panoramic views over this landscape. Whilst this is expected to improve views of the surrounding area, the elevated and considerably widened route corridor and its associated constructed wetland and spoil repository sites will in turn feature prominently within this largely exposed landscape. The proposed post and rail fencing will be largely below the road embankments throughout this route segment but will be highly noticeable at the proposed Knocknagroagh and Drumfin overpasses. On balance impacts to views for road users from this road segment are judged to be '**Slight to Moderate Adverse'.**

10.4.2.2.4 *Local drumlin hills at Drumfin and Cloonlurg (Chainage 5,700m-6,900m)*

South of the Lough Corran basin the *Proposed Road Development* skirts the western slopes of Drumfin Hill and will be in cut for most of this segment. The resulting cut slopes will appear to dissect these slopes and in combination with the proposed associated infrastructure such as the constructed wetlands, spoil repository site and rerouting of local road L-1502-32 create a considerable visual disharmony with highly noticeable fencing. Visual impacts from this road segment are therefore judged to be **'Moderate Adverse'.**

10.4.2.2.5 *Drumfin River Basin and local hill at Carrownagark (Chainage 6,900m- 8,600m)*

The proposed route relocation at the Drumfin River basin will initially run at elevated levels through the eastern edge of a mature conifer forest and the river basin before cutting through the western slopes of Carrownagark Hill. A highly noticeable electricity tower adjacent to the new alignment is proposed within this area of cleared conifer forest. Whilst views from elevated route alignment over the Drumfin river basin are expected to be improved the route corridor will be in turn also be highly noticeable within this open landscape. The proposed segment in cut at the upper western slopes at Carrownagark Hill will cause considerable visual separation and disharmony at this hill site. The post and rail fencing will be largely below the road embankments throughout the Drumfin basin but is elevated and clearly visible at Carrownagark hill. Impacts to views for road users are for these reasons anticipated to be **'Moderate Adverse'**.

10.4.2.2.6 *Local drumlin hills at Kingsbrook and peatland basin surrounding Aghalenane Lough (Chainage 8,600m- 10,250m)*

At Kingsbrook hill the *Proposed Road Development* is initially in cut before continuing in fill along the western edge of the Aghalenane peatland basin. Whilst this is expected to improve views of the Aghalenane lake area, the elevated route corridor will in turn appear as a visual barrier between the basin and its drumlin hinterland. The proposed post and rail fencing will be largely below the road embankments throughout the basin but will be highly noticeable at Kingsbrook hill. Taking into account the visual disharmony resulting from the proposed dissection of the eastern slopes at Kingsbrook Hill and the frequency of constructed wetlands proposed for this area visual impacts from the road development are judged to be **'Moderate Adverse'.**

10.4.2.2.7 *Local drumlin hills at Ardloy/ Springfield, Tawnagh & Cloonymeenaghan (Chainage 10,250m- 11,900m)*

The *Proposed Road Development* south east of Aghalenane Lough cuts through the slopes of three successive hills – Ardloy/ Springfield, Tawnagh and Cloonymeenaghan and is only elevated for a short section between Ardloy/ Springfield and Tawnagh Hill where medium range views of the surrounding landscape are afforded. The broad route corridor with associated extensive cut slopes, the disturbance of hill slopes resulting from the proposed soil repositories/ borrow pits in combination with the perceived dissection of hill slopes and elevated fence lines throughout this route segment will impose a considerable visual disharmony on this drumlin landscape. Visual impacts in this area are therefore anticipated to be **'Moderate to Significant Adverse'**.

10.4.2.2.8 *Peatland basin between Tawnagh and Drumderry (Chainage 11,900m-12,600m)*

The *Proposed Road Development* south of Cloonymeenaghan Hill continues in fill through a wetland basin towards Drumderry Hill. Whilst this is expected to improve views of the surrounding area, the elevated broad route corridor will introduce a visual barrier throughout this lowland area. In addition the proposed constructed wetland site and proposed access track will feature prominently in this open landscape. The proposed fencing will be largely below the road embankments throughout this route segment. On balance impacts to views for road users from this road segment are judged to be '**Slight to Moderate Adverse'.**

10.4.2.2.9 *Drumderry Hill and Castlebaldwin (Chainage 12,600m- 14,520m)*

The *Proposed Road Development* cuts through the eastern hill slopes of Drumderry Hill and features a local access track to the hill top resulting in a wide ranging disturbance and visual disharmony on this locally prominent hill. Further south extensive visual impacts are also anticipated as a result of the proposed elevated roundabout, the new junctions with the existing N4 and realignment of the designated scenic route towards Bellarush, which will necessitate the loss of hedgerow lines and field patterns and introduce linear fencing to all areas. For these reasons visual impacts in this location are anticipated to be **'Moderate to Significant Adverse'**. *As outlined earlier in relation to longer ranging views the Proposed Road Development* will not necessarily detract from the scenic views towards the Bricklieve Mountains and Castlebaldwin, instead providing new opportunities of viewing these landscape features of interest.

10.4.3 Direct and Indirect Impacts

Section 10.2.5.3 outlines potential direct and indirect impacts as a result of the *Proposed Road Development*. This includes six sites outside of the CPO which include areas such as conifer plantations and low lying agricultural lands. Residual landscape and visual impacts for deposit areas identified in section 10 of the Spoil Management Report (appendix 4.3 in volume 4 of this EIS) are considered to range from 'Imperceptible' to 'Slight Adverse' within existing conifer plantation and agricultural sites with the exception of one site, which is considered to result in 'Slight to Moderate Adverse' impacts. In the case that all 6 sites should be utilized cumulative residual landscape and visual impacts are considered to be 'Slight to Moderate Adverse'

10.5 Mitigation Measures & Environmental Commitments

A series of mitigation measures has been prepared for the project with a view to integrating the *Proposed Road Development* into the surrounding landscape, reducing the sense of intrusion and obstruction for nearby residents, maximising ecological potential and framing views where appropriate for future road users.

The proposed mitigation measures and planting proposals are based on the NRA publication *'A Guide to Landscape Treatments for National Road Schemes in Ireland' (2006).* They consist of various planting mixes which are proposed to reduce adverse impacts and enhance the scheme to integrate with the local landscape. They are graphically represented in detail drawings contained within Volume 3 of this EIS (Fig. 10.1.1 to 10.1.8).

10.5.1 General Mitigation Measures

In relation to avoidance measures there have been several refinements of the proposed route upgrading works. Each successive design has managed to reduce the level of 'Significant Adverse' landscape or visual impacts, as would be expected from an appropriate iterative EIA process. The refinement of the *Proposed Road Development* was not driven solely by landscape and visual considerations but by the full gamut of potential impacts, including, for example, those relating to Flora, Fauna & Fisheries, Hydrology, Hydrogeology, Geology, Archaeology and Cultural Heritage and Agriculture & Material Assets etc. Although design changes can sometimes result in compromise across the various realms of impact, in this instance the majority of design changes are mutually beneficial.

Landscape and visual mitigation measures for this *Proposed Road Development* are predominantly in the form of roadside screen planting, the assimilation of embankments within the land take boundary of the proposed road, and the incorporation of measures for wildlife as informed by the Flora, Fauna & Fisheries Impact Assessment. These mitigation measures are shown on Figures 10.1.1 to 10.1.8 contained within Volume 3 of this EIS. Given the linear constraints of the planting zone, the structure of the landscape planting is generally intended to reflect the existing hedgerows and woodlands.

The species composition of the screen planting will reflect the landscape context of each section of road. Throughout woodland areas proposed planting mixes include high and low canopy woodland mixes, riparian woodland mixes, hedgerow and shrub mixes as listed in the tables below. Generally high canopy woodland is proposed within established woodland or forest areas with low canopy woodland, hedgerow or shrub mixes at woodland fringes. Riparian woodland is proposed at constructed wetlands and river crossings. In farmland areas shrub and hedgerow mixes are to be used to reinstate existing planting areas. A mature high canopy woodland and shrub mix is proposed for the landscape mitigation site a Castlebaldwin. This woodland mix contains a small proportion of standard size trees at planting stage. A suitable grassland treatment is proposed for all areas of open ground within the CPO where no screen or feature planting is proposed.

The species mixes in these woodland areas are to reflect species found and in accordance with the Native Woodland Scheme Guidelines (Department of Agriculture, Fisheries and Food - Native Woodland Scheme – Establishment August 2011). In conjunction with the ecological consultant a list of tree and shrub species for the various habitats has been compiled that occur along the route and the appropriate species mix will be applied for each zone. The habitat mixes are provided in the table 10-6 below.

At individual properties, the landscape and visual mitigation proposals are primarily focused on screening and reinstatement works including the replacement of existing boundary vegetation in order to integrate the *Proposed Road Development* into the existing landscape context. Mitigation measures at individual properties in a woodland setting normally comprise high or low canopy woodland planting.

All areas including embankments and road verges outside proposed planting zones are to be seeded with a suitable semi-natural dry or wet grassland seed mix, similar to the species composition found in the locality in accordance with section 6.1 of the NRA Guide to Landscape Treatments for National Road Schemes in Ireland.

Where the proposed alignment cuts into drumlin hills all cut slopes outside rock faces will be seeded with a suitable grass mix. Type 1 Spoil Repository/Borrow Pits located within hill sites will be re-graded to restore existing hill slopes and subsequently turned into grassland mimicking existing pastoral fields. Hedgerow planting is proposed in areas where existing hedgerow patterns existing to reconnect disrupted hedgerow lines.

At constructed wetlands outside pool areas and areas proposed for riparian woodland planting a wet grassland treatment is to be implemented in accordance to 4.5.2 of the *NRA Guide to Landscape Treatments for National Road Schemes in Ireland*. At pool areas a marsh habitat containing sedges, grasses, Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be planted. Surrounding banks in wetland areas will be graded to gentle slopes and shallow edges to allow further colonisation with marsh plant communities.

Type 2 Spoil repository sites are to be re-graded with reclaimed peat material from the road works and be reseeded with a verge mix similar to the specie*s composition of the existing verge, with a high concentration of seed* mix to encourage rapid re-colonisation to control the spread of invasive species. The *measures outlin*ed for this *type of repository* are proposed t*o mimic bog wet*land conditions and to encourage re-colonization.

An extensive infill area which is required to re-grade existing lands is proposed as Landscape Mitigation at Castlebaldwin south of Drumderry Hill. Details of this area are included in Figure 10.1.8 contained within Volume 3 of this EIS.

10.5.2 Planting Mixes

A number of planting mixes, including a short and medium version of high canopy woodland, are proposed for different sections of the proposed road. The objective behind each planting mix is outlined below with specific plant mixes listed thereafter:

- High canopy woodland mix– a collection of trees and shrubs which will eventually establish mature broadleaf woodland containing dominant species such as oak. Areas proposed for high canopy woodland mix are confined to established mature woodland clusters along the route. A mature woodland mix containing a small proportion of standard size trees is proposed at the landscape mitigation site at Castlebaldwin.
- Low canopy woodland mix – a collection of sub-dominant canopy woodland species with a reduced or no presence of dominant species such as oak. Areas proposed for low canopy woodland mix comprise woodland edges and small woodland clusters where dominant tree species are largely absent.
- Riparian woodland mix – a collection of riparian dominant and sub-dominant canopy woodland species. Areas proposed for wet woodland mix comprise river and lake edges where established wet woodland species occur.
- Shrub mix – a collection of high and low shrub species with a reduced presence or omission of low canopy tree species. Areas proposed for shrub planting comprise the proposed landscape mitigation area at Castlebaldwin. Shrub species are also contained within woodland areas.
- Hedgerow and Mature Hedgerow mix – a collection of traditional hedgerow species proposed for locations where existing hedgerow lines are in existence and have been interrupted or disjointed by the proposed development. A mature hedgerow mix contains a small proportion of standard size trees.

- Grass seeding – in all areas within the CPO where no woodland, shrub, hedgerow or feature planting is proposed a suitable grassland mix with species similar to the locality is to be applied. In general a dry meadows and grassy verges grass mix is to be applied to all road verges, embankments and areas within the constructed wetlands not subject to periodic flooding. A wet grassland mix is to be applied to poorly drained lowland areas, river banks and areas at constructed wetlands which are subject to periodic flooding. At pool areas a marsh habitat containing sedges, grasses, Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be planted.
- Grass mixes
  The selection of suitable grass mixes at detailed design stage will take into account the characteristics of specific locations. Reference is to be made to the Flora, Fauna and Fisheries Impact Assessment in devising an appropriate species list for each location.
- Feature planting – consisting of specimen trees in linear or clustered arrangement to highlight landscape features or gateways

The proposed plant mixes have been selected in consultation with the Flora, Fauna and Fisheries consultant having regard to 'A Guide to Habitats in Ireland' (Fossitt, 2000) and the NRA publication 'A guide to landscape treatments for National Road Schemes in Ireland' and consists of the following:

Table 10-6: Proposed Plant Mixes

Planting mix	Species mix	Habitat Code	Proposed locations
High canopy woodland mix *Plant species range from Sub-Canopy Dominants to Lower shrubs*	Oak-birch-holly woodland Oak-ash* hazel woodland	WN1/ WN2	Established Woodland Areas
Low canopy woodland mix *Plant species range from Sub-Canopy Dominants to Lower shrubs*	Oak-birch-holly woodland Oak-ash* hazel woodland Riparian woodland mix	WN1/ WN2 WN5	Embankments and elevated areas Wetlands/ Lowlands
Shrub mix	Shrubs	WS1	Shrub/ Transitional Areas
Hedgerow mix	Hedgerows	WL1	All areas
Feature planting	Tree lines	WL2	Gateways and road cuttings
	Scattered trees and parkland	WD5	River crossings and park land areas
Dry meadows and grassy verges grass mix	Semi-natural grasslands with high percentage of tall coarse and tussocky grasses	GS2	Grass verges and embankments/ constructed wetlands
Wet grassland/ Marsh	Grass mix containing rushes and small sedges/ Marsh containing Iris, Reeds and Bulrush	GS4	Lowland areas/ constructed wetlands
Amenity grassland	Low growing grass species including Fescues	GA2	Proposed Amenity grassland at Castlebaldwin

* In accordance to NRA circular 05/2013 ash planting on national road schemes is not permitted until further notice.

10.5.2.1 Plant Material

Irish provenance plant material will be utilised on the *Proposed Road Development*. The Contract Documents will require the Contractor to consult with a nursery early in the construction implementation stage to ensure such plant material is available at the end of the construction period. Note that Ash planting on national road schemes is not permitted (refer to NRA circular 05/2013) and ash trees are therefore excluded from the plant lists until further notice.

The proposed minimum planting size for all woodland mixes are 2-3 year old tree seedlings (whips) of a height between 60-150cm – 60cm for shrubs and 120cm-150cm for trees. The minimum planting size for marshland plants such as Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be 70 to 90cm. Mature hedgerows to include standard (8-10cm girth) Oak and Rowan trees. Scots pine to be planted at 40cm height. Feature planting to consist of Extra Heavy Standard trees (14-16cm girth). Where

mature plant material for reinstatement works such as standard trees are required then the Contractor must acquire whips in a nursery, at the commencement of the construction implementation stage, and ensure that these will have reached standard size by the end of construction such that Irish provenance standard trees will be available.

Reinstatement works at individual properties will not include invasive species or potential invasive species (also refer to Invasive Species Ireland website invasivespeciesireland.com).

Plant spacing shall be staggered at 1-2m centres. Planting density of the marshland pollution control species should be 4 per square metre. For hedgerows a staggered double row at 0.5m spacing should be planted.

Table 10-7: High Canopy Woodland Mix / Mature High Canopy Woodland Mix at Castlebaldwin

Latin Name	Common Name
Alnus glutinosa	Common alder
Betula pubescens	Downy Birch
Corylus avellana	Common hazel
Crataegus monogyna	Hawthorn
Ilex aquifolium	Holly
Prunus spinosa	Blackthorn
Quercus petraea	Sessile Oak
Salix aurita/cinerea/caprea	Willow spp.
Viburnum opulus	Elder
*Pinus sylvestris**	Scots Pine
5% Tree planting added in addition species listed above (planted at whip sizes) at landscape mitigation site at Castlebaldwin	
Quercus petraea (8-10cm girth)	Sessile Oak
Sorbus aucuparia (8-10cm girth)	Rowan

*Scots pine planted in groups for targeted screening.

Table 10-8: Low Canopy Woodland Mix

Latin Name	Common Name
Betula pubescens	Downy Birch
Corylus avellana	Common hazel
Crataegus monogyna	Hawthorn
Ilex aquifolium	Holly
Prunus avium	Wild Cherry
Prunus spinosa	Blackthorn
Rosa canina	Dog rose
Salix aurita/cinerea/caprea	Willow spp.

Table 10-9: Riparian Woodland Mix

Latin Name	Common Name
Alnus glutinosa	Alder
Betula pubescens	Birch
Crataegus monogyna	Hawthorn

Latin Name	Common Name
Prunus spinosa	Blackthorn
Quercus petraea	Sessile Oak
Salix aurita/cinerea/caprea	Willow spp.

Table 10-10: Scrub MIx

Latin Name	Common Name
Crateagus monogyna	Hawthorn
Ulex europeaus	Gorse
Corylus avellana	Hazel
Ilex aquifolium	Holly
Prunus spinosa	Blackthorn
Sambucus nigra	Elder
Sorbus aucuparia	Rowan
Viburnum opulus	Guelder Rose

Table 10-11: Hedgerow Mix / Mature Hedgerow Mix

Latin Name	Common Name
Crateagus monogyna	Hawthorn
Corylus avellana	Hazel
Ilex aquifolium	Holly
Prunus spinosa	Blackthorn
Sambucus nigra	Elder
Viburnum opulus	Guelder Rose
5% Tree planting added in addition species listed above (planted at whip sizes)	
Quercus petraea (8-10cm girth)	Sessile Oak
Sorbus aucuparia (8-10cm girth)	Rowan

Table 10-12: Feature Planting

Latin Name	Common Name
Alnus glutinosa	Alder
Quercus petraea	Sessile Oak

10.5.2.2 Soil Geographic Factors

A walkover survey during construction will be undertaken to identify available soil types and soil pH in order to verify the appropriate native woodland mix from the lists provided under section 10.5.2. The survey will be undertaken in accordance to the native woodland scheme manual (*Department of Agriculture Fisheries and Food publication – Native Woodland Scheme Manual 2008*) and the establishment report (*Department of Agriculture Fisheries and Food publication -Native Woodland Scheme – Establishment August 2011*).

10.5.3 Proposed mitigation measures in relation to Landscape Features contributing to Character Distinctiveness

This section sets out planting mitigation measures in relation to woodland, hedgerow and shrub planting. In addition all areas within the CPO where no screen and feature planting is proposed are to be seeded with a suitable grass mix as detailed under 10.5.2

10.5.3.1 Collooney to Toberscanavan Loughs (Chainage -190m - 1,600m)

- Clusters of roadside low canopy woodland and hedgerow planting are recommended to both sides of the *Proposed Road Development* and at the eastern parallel link throughout Toberbride, at Toberscanavan and east of the Toberscanavan Loughs.
- Riparian woodland planting is proposed throughout the Toberscanavan Loughs woodlands.

10.5.3.2 Lackagh Fen basin between Doorly Hill and Lackagh (Chainage 1,600m-4,000m)

- Clusters of roadside low canopy woodland and sections of hedgerow planting will be planted to both sides of the *Proposed Road Development* and at the western parallel link throughout the Cloonamahan and Ardcurley townlands.
- Riparian woodland clusters are proposed at the constructed wetlands south in Ardcurley.
- Hedgerow planting and pockets of low canopy woodland planting is recommended along the eastern slopes of Doorly Hill to the south of the proposed alignment.
- Riparian woodland planting clusters are proposed at the constructed wetlands to the south of Doorly Hill.
- At the overbridge at local road L-55016-0 west of Lackagh low canopy woodland planting, hedgerow planting and riparian woodland planting is proposed.

10.5.3.3 Lowland basin surrounding Lough Corran (Chainage 4,000m-5,700m)

- Along the alignment east of Lough Corran pockets of riparian woodland planting, hedgerow planting and shrub land planting are recommended.
- Low canopy woodland planting and hedgerow planting will be carried out at proposed L-5502-0 local road overbridge south of the Lough Corran area. Shrub land planting is proposed at the local access track to the constructed wetlands further north.
- Feature planting is proposed to mark the River crossing at Lough Corran and at Drumfin overbridge.

10.5.3.4 Local drumlin hills at Drumfin and Cloonlurg (Chainage 5,700m-6,900m)

- At the western foothills of Drumfin Hill mitigation measure include planting of hedgerow sections to reconnect disrupted hedgerow lines.
- South-west of Drumfin riparian woodland planting is recommended surrounding the proposed constructed wetland area.
- Further hedgerow planting to reconnect disjointed hedgerows will be carried out along the proposed overbridge at local road L1502-32 south of Drumfin and associated access tracks and link road.
- Feature planting is recommended at the L1502-32 overbridge south of Drumfin.

10.5.3.5 Drumfin River Basin and local hill at Carrownagark (Chainage 6,900m- 8,400m)

- High canopy woodland planting is proposed along the existing forest area north of Drumfin River on either side of the proposed alignment.
- Riparian woodland and feature planting is proposed at the Drumfin River crossing and further south at the proposed constructed wetlands.
- Hedgerow planting is recommended throughout the western slopes of Carrownagark Hill to reconnect disrupted hedgerow lines.
- Further hedgerow, low canopy woodland and feature planting clusters are proposed at the L-5402-0 underpass south of Carrownagark hill.
- Hedgerow planting is suggested where existing hedgerow lines are disrupted to both sides of the proposed constructed wetland access track west of Carrownagark hill.

10.5.3.6 Local drumlin hills at Kingsbrook and peatland basin surrounding Aghalenane Lough (Chainage 8,400m- 10,250m)

- Riparian woodland planting is proposed at the constructed wetlands north east of Kingsbrook Hill.
- Hedgerow planting willbe carried out throughout the eastern slopes of Kingsbrook Hill to reconnect disrupted hedgerow lines.
- Further hedgerow, low canopy woodland and feature planting clusters are proposed at a mainline bridge over a local road south of Kingsbrook Hill.
- Linear mature hedgerow planting is proposed at the western road embankments throughout the *Proposed Road Development* west of Aghalenane and Ardloy Lough.
- Further Riparian woodland planting is recommended at the constructed wetlands south of Ardloy Lough.

10.5.3.7 Local drumlin hills at Ardloy/ Springfield, Tawnagh & Cloonymeenaghan (Chainage 10,250m- 11,900m)

- Ground conditions permitting clusters of low canopy woodland and reconnection of hedgerow planting willbe provided at the cut slopes and the spoil repository/ borrow pit site at Ardloy/ Springfield hill.
- Low canopy woodland planting, riparian woodland planting and hedgerow planting clusters are proposed at the alignment between Ardloy/ Springfield Hill and Tawnagh Hill.
- Low canopy woodland planting and hedgerow planting is recommended at the cut slopes and the spoil repository/ borrow pit site at Tawnagh Hill (ground conditions permitting).
- Feature planting is proposed to the west of Ardloy/Springfield hill and east of Tawnagh Hill.
- Hedgerow planting to reconnect disrupted hedgerow lines willbe planted at the eastern slopes and spoil repository/ borrow pit site at Cloonymeenaghan hill (ground conditions permitting).

10.5.3.8 Peatland basin between Tawnagh and Drumderry (Chainage 10,900m- 12,600m)

- Where the proposed route crosses the peatland basin between Tawnagh and Drumderry at elevated levels low canopy woodland and hedgerow planting clusters are recommended along its eastern embankments,
- Riparian woodland planting is proposed at the constructed wetlands north of Drumderry Hill.

10.5.3.9 Drumderry Hill and Castlebaldwin (Chainage 12,600m- 14,522m)

- Extensive mature hedgerow planting to reconnect existing hedgerow lines is recommended along the eastern slopes of Drumderry hill on either side of the proposed mainline development as well as at the access track and spoil repository/ borrow pit site west of the alignment.
- Mature hedgerow planting is also proposed along the realigned L-1404-0 towards Annaghcor to the south east of Drumderry hill, along the boundary of the proposed infill area east of Castlebaldwin and at the proposed roundabout south of Drumderry Hill.
- Feature planting is recommended at the roundabout south of Drumderry Hill, at the northern and eastern infill site boundary and at the link roads to Castlebaldwin.
- High canopy woodland underplanted with shrub planting is proposed at the shaped mounds within the proposed landscape mitigation site.
- Riparian woodland planting is proposed at the constructed wetlands south of Castlebaldwin.
- Hedgerow planting is recommended at the tie in section with the existing N4 to replace disrupted hedgerow lines.
- A landscaped area with amenity grassland is proposed north of the infill site at Castlebaldwin with a viewing area towards the Castlebaldwin historic site.

10.5.4 Mitigation and avoidance Measures in the vicinity of individual properties

Mitigation proposals in addition to reinstatement measures are discussed under this section for properties anticipated to experience 'Moderate or Significant Adverse' impacts. Mitigation measures for properties with lesser anticipated impacts are listed in Appendix 10.1 contained within volume 4 of this EIS.

10.5.4.1 Chainage -190m to Chainage 2,200m (Figure 10.1.1 and 10.1.2 of Volume 3)

- A broad low canopy woodland planting strip is proposed on the roadside slopes below properties No. 03 and 05 at Toberbride. Further low canopy woodland planting is proposed on the opposite side of the alignment at the top of the eastern cut slopes to provide screening of the eastern parallel link.
- A hedgerow mix is also proposed along the local elevated access road at property 06a.
- At Toberscanavan mitigation measures include clusters of low canopy planting and hedgerow planting along the main line and parallel eastern link to the west of elevated properties No. 9a and 9 and at road side property No. 10. At this property a solid noise barrier is also proposed.
- Hedgerow planting and a solid noise barrier is proposed at receptor No. 16.

10.5.4.2 Chainage 2,200m to Chainage 3,420m (Figure 10.1.2 of Volume 3)

- Hedgerow and low canopy woodland planting clusters are proposed along the eastern edge of the *Proposed Road Development* at Doorly Hill to the rear of property No. 105 to provide additional screening.

10.5.4.3 Chainage 3,420m to Chainage 5,340m (Figure 10.1.3 of Volume 3)

- To the north of the three dwellings No. 117,118 and 119 mitigation measures include planting of a generous swath of low canopy woodland. In addition a solid noise barrier is proposed to the east of property No. 119.
- Further stretches of hedgerow and low canopy woodland planting are recommended on the road embankments to both sides of the mainline route corridor to the east and west of properties No. 117, 118, 119 and 121.
- Riparian woodland planting surrounding proposed constructed wetlands is proposed south and north of properties No. 117 and 118.

10.5.4.4 Chainage 5,340m to Chainage 7,200m (Figure 10.1.4 of Volume 3)

- Proposed mitigation measures at property 156 include low canopy woodland planting to both sides of the embankments along the proposed overbridge west of this property to ensure the privacy of this property.

10.5.4.5 Chainage 7,200m to Chainage 9,050m (Figure 10.1.5 of Volume 3)

- Mitigation measures are recommended for the proposed mainline overpass east of property No. 199, comprising low canopy woodland planting to ensure the privacy of this property. In addition hedgerow planting is recommended along the proposed accommodation track to the north of both properties.
- Further hedgerow planting will be carried out at the overbridge west of property No. 197. South-west of this property riparian woodland planting is recommended to enclose the proposed constructed wetlands in this area.

10.5.4.6 Chainage 9,050m to Chainage 10,950m (Figure 10.1.6 of Volume 3)

- West of properties No. 206 and 207 at the eastern slopes of Kingsbrook hill hedgerow planting is recommended to both sides of the *Proposed Road Development* to provide screening and to reconnect existing hedgerow lines.
- In addition a low canopy woodland mix is recommended at the eastern overbridge embankments adjacent to property No. 207 to ensure the privacy of this property.
- North of the elevated settlement cluster at Aghalenane which includes properties No. 218, 219, 220 and 221 continuous mature hedgerow planting will be carried out along the southern road embankment extending from Kingsbrook to Ardloy/Springfield to provide screening of the *Proposed Road Development* whilst retaining filtered views of the lake areas further north.
- Recommended mitigation measures for property No. 225 comprise low canopy woodland screening to protect the privacy of this dwelling. This will also provide screening to property No. 224.
- At property No. 227 a noise barrier, low canopy woodland and hedgerow planting are proposed to the south of the route alignment to protect the privacy of this dwelling and to reconnect existing hedgerow lines.

10.5.4.7 Chainage 10,950m to Chainage 12,800m (Figure 10.1.7 of Volume 3)

- North of properties No. 239 and 240 generous swaths of low canopy woodland planting, hedgerow planting and feature planting along the cut slopes facing the affected properties are recommended to provide a high level of screening of the *Proposed Road Development* and accommodation track.
- West of properties No. 245 and 247, where the *Proposed Road Development* runs at elevated levels clusters of low canopy woodland and mature hedgerow planting is proposed.
- North-west of elevated property No. 255 riparian woodland planting is recommended within the proposed constructed wetlands and mature hedgerow planting further south along the proposed access track.

10.5.4.8 Chainage 12,800m to Chainage 14,520m (Figure 10.1.8 of Volume 3)

- At the eastern hill slopes of at Drumderry Hill facing properties No. 263, 264, 265, 268, 269, 271,271A, 272, 273and 274 extensive mature hedgerow planting is proposed to both sides of the route between circa Chainage 12,500m and circa Chainage 13,500m to provide screening and to reconnect disjointed hedgerow lines.
- Further mature hedgerow and feature planting will be carried out along the L1404-0 west of the proposed alignment, the proposed roundabout at Castlebaldwin and to the east of the proposed landscape mitigation site to provide screening for properties 276,277,278 and 279.

10.6Residual Impacts

10.6.1 Predicted Residual Impacts on a Marco Landscape Level

In general mitigation measures available to reduce visual and landscape impacts of the *Proposed Road Development* will focus on reinstatement measures for the majority of the route, particularly where it travels within open bogland or drumlin areas. Tree and shrub planting is largely limited to areas where established hedgerows and woodlands lands exist. Considerable impact reductions can be achieved if proposed cut and fill areas are integrated sensitively into the surrounding landscape context; reseeded and allowed to re-colonize.

The residual impact assessment assesses impacts after a 5-7 year establishment period of planting areas. After this period it is assumed that shrub and woodland planting areas are established and that areas of disturbed open ground have been largely re-colonized by surrounding vegetation. This will gradually reduce the exposure of the *Proposed Road Development* and assist integration into its existing landscape setting.

A summary of the likely residual impacts are presented in Table 10-13 below.

Table 10-13: Summary of the Likely Residual Impacts

Impacts on Landscape features along the route	Pre- Mitigation Landscape Impacts	Post Mitigation Landscape Impacts	Pre- Mitigation Visual Impacts	Post Mitigation Visual Impacts
Collooney to Toberscanavan Loughs (Chainage -190m-1,600m)	Moderate Adverse	Slight to Moderate Adverse	Moderate Adverse	Slight to Moderate Adverse
Lackagh Fen basin between Doorly Hill and Lackagh (Chainage 1,600m-4,000m)	Moderate Adverse	Slight to Moderate Adverse	Moderate Adverse	Slight to Moderate Adverse
Wetland basin surrounding Lough Corran (Chainage 4,000m-5,700m)	Moderate Adverse	Slight to Moderate Adverse	Slight to Moderate Adverse	Slight Adverse
Local drumlin hills at Drumfin and Cloonlurg (Chainage 5,700m-6,900m)	Moderate Adverse	Slight to Moderate Adverse	Moderate Adverse	Slight to Moderate Adverse
Drumfin River Basin and local hill at Carrownagark (Chainage 6,900m-8,400m)	Moderate Adverse	Slight to Moderate Adverse	Moderate Adverse	Slight to Moderate Adverse
Local drumlin hills at Kingsbrook and peatland basin surrounding Aghalenane Lough (Chainage	Moderate Adverse	Slight to Moderate Adverse	Moderate Adverse	Slight to Moderate Adverse

Impacts on Landscape features along the route	Pre- Mitigation Landscape Impacts	Post Mitigation Landscape Impacts	Pre- Mitigation Visual Impacts	Post Mitigation Visual Impacts
8,400m- 10,250m)				
Local drumlin hills at Ardloy/ Springfield, Tawnagh & Cloonymeenaghan (Chainage 10,250-11,900m)	Significant Adverse	Moderate to Significant Adverse	Moderate to Significant Adverse	Moderate Adverse
Peatland basin between Tawnagh and Drumderry (Chainage 10,900m-12,600m)	Slight to Moderate Adverse	Slight Adverse	Slight to Moderate Adverse	Slight Adverse
Drumderry Hill and Castlebaldwin (Chainage 12,600m- 14,520m)	Moderate to Significant Adverse	Moderate Adverse	Moderate to Significant Adverse	Moderate Adverse

The majority of Macro Landscape areas surrounding the *Proposed Road Development* have been judged to continue to experience 'Slight to Moderate Adverse' landscape impacts following completion of reinstatement and mitigation works and after a planting establishment and re-colonization period of 5-7 years. The highest rating impacts remain at the local drumlin hills at Springfield, Ardloy Bridge and Cloonymeenaghan with 'Moderate to Significant Adverse' post-mitigation landscape impacts and at Drumderry Hill and Castlebaldwin with 'Moderate Adverse' Impacts.

Visual impacts to road users post mitigation have been judged to range from 'Slight Adverse' or 'Slight to Moderate Adverse' on the majority of route sections. The highest ratings remain at the local drumlin hills at Springfield, Ardloy Bridge and Cloonymeenaghan and at Drumderry Hill and Castlebaldwin with 'Moderate Adverse' Impacts.

10.6.2 Predicted Residual Impacts for individual properties

Following the successful implication of mitigation measures as proposed and the completion of an establishment period of 5-7 years, residual visual impacts are expected to be considerably reduced. The roadside screen planting and reinstatement works proposed in the vicinity of dwellings with a 'Moderate Adverse' or 'Significant Adverse' pre-mitigation level impact will in many cases reduce the visibility of the carriageway and associated vehicles. It will also soften the appearance of the *Proposed Road Development* and help to establish it within the context of the surrounding landscape. It will often not, however, mask the presence of the road other than from longer distance viewpoints and dwellings that have likely been judged to have no more than 'Slight Adverse' impacts in the first instance. Where dwellings have been judged to incur impacts in the higher orders of magnitude, it is usually due to the loss of part of their close proximity to substantial sections of cut and fill, foreshortening of existing views or intrusion on views of high amenity. In some of these cases the screening and softening of views of the carriageway and associated infrastructure and vehicles is not sufficient to warrant a reduction in the anticipated level of impact. That is not to say that the proposed mitigation is ineffective in these instances, only that it is not likely to be effective enough to warrant a step down in the impact category.

10.6.2.1 Chainage -190m to Chainage 2,200 (Figure 10.1.1 of Volume 3)

- It is expected that following the establishment of screen planting measures visual impacts for properties No. 03, 05 and 06a at Toberbride will be reduced to **Slight Adverse.**
- At Toberscanavan establishment of screen planting will reduce impacts to visual amenity to **Slight Adverse** for elevated properties No. 9a and No. 9.
- **Significant Adverse** impacts to visual amenity will remain at property No. 10 due to its permanent loss of its front boundary area and enclosure by two road alignments in close proximity.

10.6.2.2 Chainage 2,200m to Chainage 3,420m (Figure 10.1.2 of Volume 3)

- Visual impacts post-mitigation are expected to remain **Moderate Adverse** at property No. 105 due to its enclosure by the existing and proposed N4 carriageway in close proximity.

10.6.2.3 Chainage 3,420m to Chainage 5,340m (Figure 10.1.3 of Volume 3)

- Visual impacts post-mitigation are expected to remain **Significant Adverse** for the three properties No. 117,118 &119, due to their close proximity to the *Proposed Road Development* and local overbridge in this area.
- Impacts to visual amenity at property No. 121 classified as **Moderate Adverse** are also anticipated to remain within this rating due to the permanent changes to its southerly panoramic views.

10.6.2.4 Chainage 5,340m to Chainage 7,200m (Figure 10.1.4 of Volume 3)

- The mitigation measures are expected to result in a reduction from Significant Adverse to **Moderate Adverse** impact for the property to the north of the access road (No. 156) following establishment of the proposed mitigation measures.

10.6.2.5 Chainage 7,200m to Chainage 9,050m (Figure 10.1.5 of Volume 3)

- Whilst the proposed mitigation and planting measures will considerably improve the road development, long term visual impacts on the properties No. 197 and 199 will remain high due to the their close proximity and location below *Proposed Road Development* . It is therefore anticipated that impacts to property No. 197 will remain **Moderate Adverse**. At property No. 199, which is set back further from the proposed alignment a reduction to **Moderate Adverse** is expected to be achieved following the establishment of proposed mitigation measures.

10.6.2.6 Chainage 9,050m to Chainage 10,950m (Figure 10.1.6 of Volume 3)

- The mitigation measures post the planting establishment period are expected to lower impacts to views from elevated property No. 206 to **Moderate Adverse**.
- Despite mitigation measures the impact on property No. 207 is expected to remain within the **Significant Adverse** range due to its close proximity to the elevated road development in this location.
- Impacts to lake views at the four elevated properties at Aghalenane are expected to reduce from Significant Adverse to **Moderate Adverse** for the properties No. 218 and 219 and from Moderate Adverse to **Slight Adverse** for the dwellings No. 220 and 221 following the establishment of hedgerow screen planting in this area.
- Visual Impacts to properties No. 225 and 227 are judged to remain **Significant Adverse**, due to the their close proximity to the elevated road development.
- Impacts on elevated property No. 224 are anticipated to reduce to **Slight Adverse** following establishment of the recommended mitigation measures.

10.6.2.7 Chainage 10,950 to Chainage 12,800 (Figure 10.1.7 of Volume 3)

- The proposed mitigation measures are expected to reduce impacts to views from properties No. 239 and 240 previously judged as Significant Adverse and Moderate Adverse once the planting measures are established to **Moderate Adverse** and **Slight Adverse** respectively.
- At property No. 245 visual impacts will also reduce as result of the mitigation measures but will remain at a **Moderate Adverse** level due to permanent adverse impacts to elevated views from this property.
- Impact levels are expected to reduce from Moderate Adverse to **Slight Adverse** at property No. 247 after the mitigation establishment period.

10.6.2.8 Chainage 12,800m to Chainage 14,520m (Figure 10.1.8 of Volume 3)

- At Sheerevagh the screen planting measures post establishment are expected to result in a reduction to **Moderate Adverse** visual impacts for the two properties (No. 264 and 271A) judged as Significant Adverse.
- **Moderate Adverse** impacts are anticipated to remain at properties No. 255, 263 and 265, which have clear views of the *Proposed Road Development* in the context of Drumderry Hill.
- At property No. 271 impacts are likely to be reduced to **Slight Adverse** following the establishment of the mitigation measures.
- The four properties to the south of the access road (No. 276- 279) are likely to remain **'Moderate Adverse'**, due to the elevated nature of the *Proposed Road Development* and pertinent changes to their westerly views from this area.

Following successful completion of mitigation measures as proposed, the residual visual impact is expected to be considerably reduced for the 154 assessed occupied properties from what has been depicted at the pre-mitigation assessment. A summary of the likely residual impact is presented in Table 10-14 below. On examination of these findings, the following summary can be made:

- The number of dwellings where Significant Adverse visual impacts occur will reduce from 15 dwellings (10% of assessed properties) to 6 dwellings (4% of the properties assessed) following completion and establishment of mitigation measures. The highest adverse impacts to visual amenity remain where the *Proposed Road Development* is elevated and located in very close proximity to existing properties.
- Moderate Adverse impacts are anticipated to arise at 19 (12.5%) of the houses assessed, slightly less from the pre-mitigation assessment. This is due to a downgrading of impacts levels from Significant Adverse to Moderate Adverse and Moderate Adverse to Slight Adverse pre-mitigation levels for a number of properties following establishment of mitigation measures.
- Slight Adverse visual impacts may be experienced in a further 66 (43.5)% of the properties, increasing from the 35.5% of dwelling houses or housing clusters where this impact level occurred prior to mitigation. These receptors will not experience a critical level of impact. This increase is due to down grading of impacts levels from Moderate Adverse pre-mitigation levels for a number of properties following establishment of mitigation measures.
- A large proportion of residential receptors (40%) will continue to experience imperceptible or positive visual impacts post mitigation.

Table 10-14: Summary of likely impacts at dwellings before and after mitigation

Impact level	No. of properties pre mitigation	Percentage of total pre mitigation	No. of properties post mitigation	Percentage of total post mitigation
Profound Adverse	0	0%	0	0%
Significant Adverse	15	10%	6	4%
Moderate Adverse	22	14.5%	19	12.5%
Slight Adverse	54	35.5%	66	43.5%
Imperceptible	40	26%	40	26%
Slight Positive	21	14%	21	14%
Moderate Positive	0	0%	0	0%

Overall, therefore, the proposed mitigation measures should bring about a considerable reduction in visual impacts for many local residents with a sizable majority of impacts (82%) in the 'Positive' to 'Slight Adverse' range. A number of 'Significant Adverse' visual impacts remain at the locations as shown on figures 10.1.1 to 10.1.8 (volume 3). A table summarising pre and post mitigation impacts for each assessed property is provided in Appendix 10.1 contained within volume 4 of this EIS.

10.7 Summary

10.7.1 Landscape

The proposed N4 Road Development between Toberbride and Castlebaldwin will permanently introduce a broad road corridor largely in addition to the existing N4 alignment into a sparsely populated rural working landscape. This 'normal rural landscape' setting within the margins of a drumlin zone, is considered to be of a generally low sensitivity in relation to the proposed road development and has a *'capacity to absorb a wide range of new development'.* Following assessment, the predicted post mitigation landscape impacts resulting from the *Proposed Road Development* range from 'Slight to Moderate Adverse' throughout most areas. Higher impact ratings are predicted where drumlin hills would be permanently altered. In these locations post mitigation landscape impacts range from 'Moderate Adverse' at Springfield, Ardloy Bridge and Cloonymeenaghan to 'Moderate to Significant Adverse' at Drumderry Hill.

10.7.2 Visual

Visual impacts of the development in relation to individual properties post mitigation measures and following completion of a 5-7 year establishment period are summarised as 'imperceptible to positive' for 40% of properties assessed. 'Slight adverse' impacts will be experienced by a further 43.5% of properties as result of

the *Proposed Road Development*. 'Moderate Adverse' impacts will be experienced by 13.5% of the receptor dwellings, whilst 'Significant Adverse' Impacts will be experienced by 4% of properties assessed.

Visual impacts to road users post mitigation are summarized as 'Slight Adverse' to 'Slight to Moderate Adverse' for most road sections with some localized 'Moderate Adverse' impacts where the alignment cuts through Drumlin hills.

10.8 Difficulties Encountered in Compiling Information

No difficulties were encountered compiling this information.

10.9 Cumulative Impacts and Impact Interrelations

Consideration has also been given to the combined landscape and visual effects of the *Proposed Road Development* in conjunction with the existing N4 alignment taking into account the 'Normal Rural Landscape' sensitivity of the vast majority of its receiving environment.

10.9.1 Landscape Effects

With the *Proposed Road Development* a second major transport corridor in addition to the existing N4 will be introduced into this rural working landscape. As outlined above the new road surface and infrastructure will result in the severance of field pattern, hill slopes and interruption of boundaries. It will also introduce additional traffic movement, lighting and noise to the region. Cumulative landscape effects are, however, not considered to be critical in this case, due to the substantial spatial separation between both alignments for the majority of the *Proposed Road Development* and their diverse and undulating marginal farmland setting. The existing bypassed N4 alignment sections are also expected to evolve into a quieter country road which will be clearly subordinate to the much broader proposed new road corridor. For this reason both alignments will appear as largely insulated stand alone route corridors throughout the majority of the offline sections of the *Proposed Road Development*. An increased combined massing of both alignments will be largely limited to the tie in locations of both alignments at Doorly to the north and Castlebaldwin to the south of the *Proposed Road Developments* and at the proposed overpass at Ardloy/ Springfield Hill.

10.9.2 Visual Effects

The proposed road development will introduce visual intrusion resulting from the substantial road corridor, associated road infrastructure and the additional traffic movement into the region. The considerable spatial separation between the existing and proposed N4 alignments, the undulating farmland and peatland setting of both alignments and the extensive screening by established roadside vegetation along many parts of the existing N4 will provide a considerable visual separation between both road corridors. In addition there will be a clear visual hierarchy between the dual carriage way corridor functioning as the main transportation link within this wider rural setting and the existing single carriage way which is anticipated to become a much less frequented local access road. For these reasons cumulative visual impacts resulting from additional changes caused by the *Proposed Road Development* in conjunction with the existing N4 alignment are not considered to be critical.

10.10 Relevant Figures and Appendices

10.10.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 10.1.1 to 10.1.8: Landscape and Visual Impact Assessment;

10.10.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 10.1.: Visual Impact Assessment Table: Occupied Properties;

11 Agriculture

11.1 Introduction

This chapter of the Environmental Impact Statement (EIS) consists of an assessment of the potential agricultural impact of the construction of the *Proposed Road Development* – Collooney to Castlebaldwin which will run from Collooney/Toberbride Td to Cloghoge Lower, south of Castlebaldwin.

The route will traverse mainly agricultural land passing through seven Electoral Divisions (EDs). These EDs are Collooney, Lisconny, Drumfin, Riverstown, Bricklieve, Lakeview, and Templevanny. The area to be removed from agricultural production is approximately 170 Ha.

The *Proposed Road Development* will directly impact on 92 farms by either sub-dividing them or reducing the area of the farm. Philip Farrelly & Company carried out the study from October to December 2006, November 2009, November to December 2012 and June to August 2013. On two farms, an additional assessment was conducted by an equine specialist, Mr. Michael Sadlier, as to how the *Proposed Road Development* would impact on equine enterprises. The impact from on equestrian enterprises arising from these assessments has been incorporated into this chapter.

11.2 Methodology

11.2.1 General

An assessment of the existing agricultural environment was carried out through the completion of detailed farm surveys. The surveys assessed how the *Proposed Road Development* would impact on the current farming activities carried out on the land affected by the route and what mitigation measures would be necessary to alleviate negative impact. The landowner was interviewed where possible and a detailed farm survey was carried out. The surveys assessed how the *Proposed Road Development* would impact on current farming activities carried out on the land affected by the *Proposed Road Development* and what mitigation measures would be necessary to alleviate negative impact.

The following definitions were used in carrying out the assessment of the agricultural impact:

- **Field** - An area of land, which is surrounded by a permanent boundary (fence, ditch, hedge wall, etc) and is not subdivided by any permanent boundary.
- **Land Parcel** - An integral undivided area of land comprising one or more fields, which is in single ownership.
- **Farm Holding** - A single farming enterprise. Some farms will comprise of just one land parcel but others may consist of two or more land parcels.

11.2.2 Impact assessment

The Impact Assessment considers the overall effect of a road on a farm holding. Various elements of both the construction and operational phases have the potential to impact on agriculture. The likely potential impacts for both construction and operation of the *Proposed Road Development* prior to mitigation are described in this section of the EIS. The mitigation measures are described in Section 11.5 of this chapter and the residual impacts after the proposed mitigation measures which have been implemented are described in Section 11.6. The magnitude of the impact takes into account the type and range of impact that will occur as well as the duration over which the impact will occur. The degree to which a new road impacts upon an individual farm depends on:

- Land take;
- The degree of sub-divsion of land parcels
- The type of farm enterprises carried out;
- Farm size;
- Impact on farm buildings, facilities such as water sources, drainage and shelter

The significance of effects of the proposed road on farms is assessed using the criteria presented in Table 11-1 which is based on the Environmental Protection Agency (EPA) *"Advice notes on current practice in the preparation of Environmental Impact Statements" 2003*. These advice notes contain guidelines for describing

the significance of impacts. The guidelines have been adopted in the main with minor adjustments that are appropriate for agricultural impact assessment.

11.2.2.1 Landtake

The landtake for the *Proposed Road Development* will consist of lands to be acquired permanently. Lands may also be required during the construction phase on a temporary basis for items such as traffic diversion, construction compounds, sediment and erosion control points as well as construction of boundary/retaining walls for residential properties. The proposed land take will comprise of land used for the carriageway and embankments, drainage features, accommodation roads, landscaped areas and spoil repositories/borrow pits. The magnitude of the impact on a farm will increase with the area of land take required, the quality of the land involved and intensity of land use.

The following is a brief description of how landtake impacts elements of agricultural property.

11.2.2.1.1 *Individual Fields*

In general the larger the field size the more useful the field. This is particularly because of the ease of use of machinery in larger fields. Reduction in the field size results in increased costs.

11.2.2.1.2 *Land Holdings*

The land take is one of the main impacts on a farm. The degree of the impact varies with the area of the land taken and the quality of the land taken. The impact of the loss of land on a particular farm is complex.

The location of the land taken is also a factor. For example land take on the main land parcel will have a greater impact on a fragmented farm holding than a land parcel which is removed from the main land parcel or has no farm buildings. Also in the case of a dairy farmer, taking land laid out as paddocks adjacent to a milking parlour would have a larger impact than taking land located on an out-farm.

The size of the farm affected is also of interest. In general, land take on a smaller farm would have a greater impact.

An overview of agricultural properties affected by the route is given in Fig. 11.1.1 to 11.1.8 contained within Volume 3 of this EIS.

11.2.2.1.3 *Intensity of Land Use*

Farming systems can vary with regard to the intensity of use to which the land is put. In general the impact will be greater on more intensively farmed lands.

11.2.2.2 The degree of Sub-division

11.2.2.2.1 *General*

Sub-division of a farm holding as a result of a roads project occurs when the alignment splits a field or parcel of land into two or more portions. This results in the fragmentation of the farm into a greater number of management units. Sub-division is important because it affects the future management of the remaining land, which is not taken for the purposes of the development. It extends the impact of the road outside the footprint of the actual land take.

Farmers will require access to sub divided land parcels during the construction period. It is to be expected that there will be increased difficulties in maintaining such access during the construction phase due to the need to allow construction machinery and equipment continual movement along the corridor. This may conflict with a farmer's requirements to access lands or to move livestock from one part of a farm holding to another in order to utilise all available grazing areas. The impact on access is expected to be short term and occasional during construction

11.2.2.2.2 *Sub-division of Individual Fields or Land Parcels*

Farm holdings are more efficient in single land parcels. For the purpose of preparing the EIS, Sub- division of a land parcel occurs when a *Proposed Road Development* splits a field or land parcel into two or more pieces. This results in the fragmentation of the farm into a greater number of management units. Access may involve travelling a considerable distance to the severed area of land. Fragmentation of farms results in greater costs

due to increased livestock and grassland management involved in farming more than one unit e.g. movement of livestock between land parcels and increased travel distances for grassland, silage and tillage machinery.

Where farm buildings are located on the land parcel being sub-divided the impact of removing access to these buildings from the remainder of the land must be considered. Land isolated from the farm buildings is left without access to facilities previously available. The greater the area of land sub-divided from the farm buildings the greater the impact. Constructing new farm buildings in certain cases can mitigate this impact. The impact of sub-division on farm buildings is particularly acute in the case of dairy farming where the dairy and milking parlour are sub-divided from the grazing paddocks. The impact is greater because dairy cows require twice-daily access from the grazing area to a milking parlour.

Animal handling facilities such as cattle pens may be present for loading/unloading and treatment of livestock. The impact of sub-division on such holdings can be mitigated by the replacement of the facilities on the sub-divided area.

In many instances land parcels do not have any farm buildings or animal handling facilities. This may occur when the farm buildings are located on another part of the farm. Where it involves short distances it may be the traditional practice to walk livestock along the public road to the farm buildings.

The following significance criteria presented in Table 11-1 are used to rank sub-division of individual fields or land parcels.

Table 11-1: Significance Criteria used to rank sub-division of land parcels

EPA Glossary of Impacts	Level of Impact	Criteria
Neutral, Imperceptible or Slight Impact	Not Significant	There is no sub-division on the affected lands. The route passes generally along the external field boundary leaving the bulk of the land in one unit.
Significant Impact: Negative only	Minor	The route passes generally along the external boundary leaving the bulk of the land in one unit. There may be sub-division resulting in the division of a small area. Farmyard facilities are not affected.
	Moderate	The route passes through the land parcel causing sub-division. The land parcel is divided into two units. Access is available to the two areas. The severed area is less than one third of the land parcel. Where present, the farm buildings and facilities remain on the larger area.
	Major	The route passes through the land parcel causing sub-division It is divided into two units and the sub-divided area is greater than one third of the land parcel. There is no access to the sub-divided area or it may be a by way of a considerable distance. Farm buildings and facilities are left on less than half the original area. In addition both areas may be irregularly shaped and less useful.
Profound or Significant Impact: Negative only	Severe	The route passes through the land parcel causing sub-division. The land parcel is divided into two units. There is no access to the sub- divided area. The sub-divided area is greater than two thirds of the land parcel. There is a loss of access to farm buildings and / or facilities.

Land take and sub-division are two terms, which outline the effects of the proposed route on a field or land parcel. However many farm holdings may be fragmented and may consist of several land parcels. The proposed route may impact on the main land parcel consisting of farm buildings and facilities or on a second land parcel where no facilities are present. Although land take and sub-division on both land parcels would be comparable, the overall impact on the farm holding could differ significantly.

Fragmented farms may also be affected by the proposed route on more than one land parcel. Different impacts on each land parcel may not accurately reflect the overall impact on the farm holding.

Other components that contribute towards the overall impact on a farm include:

11.2.2.3 The type of farm enterprise

The farm enterprise types, which will be most severely affected by the *Proposed Road Development*, are those of high stocking rates, which are intensively farmed. As explained above these would frequently be dairy farms and intensive beef farms. Dairy farming is one of the most profitable farming enterprises in this country. A reduction in the available forage area may result in a reduction in the number of dairy cows that can be maintained on the farm. A significant reduction in land take, or sub-division of the grazing paddocks from the

farm buildings, may result in the farmer being forced to change the enterprise type to a less profitable enterprise.

Certain farm enterprises may be impacted to a greater extent by the proposed route. Horses are of a more nervous disposition than other stock types. They are prone to stress caused by irregular noise and moving vehicles. Land take and sub-division of land parcels may result in fields of an irregular shape (e.g. triangular shaped fields with sharp/ narrow corners), which may be unsuitable for grazing with equine stock. Horses risk injury when galloping around such fields.

Drystock enterprises such as beef and sheep are generally less affected than dairy farms. Stock on these farms are not moved from field to field as frequently as on a dairy farm. Although there is a significant impact, the farming practices on these farms can be adapted to mitigate the overall impact.

11.2.2.4 Impact on farmyard buildings and/ or facilities

The removal of farm buildings and / or facilities on the farm will contribute towards the overall impact on the farm. This will depend on the type of farm buildings affected and the extent that the facilities are affected.

11.2.2.5 Impact on Shelter

The removal of mature trees and strong hedgerows, which provide shelter to crops and livestock, especially younger stock, will have an impact on the farm holding. It will depend on the extent of the shelter removed and the type of enterprise.

It should be noted that this is an impact that is mitigated in certain cases by the replanting of boundary hedgerows and replanting of suitable tree species.

The following significance criteria presented in Table 11-2 are used to rank the overall impact on a farm holding.

Table 11-2: Significance criteria for overall impact on the farm holding

EPA Glossary of Impacts	Level of Impact	Criteria
Neutral, Imperceptible or Slight Impact	Not Significant	An impact is not significant where the farm enterprise suffers a slight inconvenience such as relocation of access or loss of shelter.
Significant Impact: Negative only	Minor	Minor impact occurs where the farm enterprise suffers inconvenience as a result of the *Proposed Road Development*. Sub-division would not occur or is insignificant and the farm buildings and facilities would be left in place. Typically only a small portion of land would be removed at the boundary of the farm.
	Moderate	Moderate impact occurs where the farm enterprise can be continued as before but with increased management or operational difficulties. While portions of the land would be sub-divided the enterprise mix would be such that the farming system could continue perhaps with reduced stock numbers or additional labour, contractor or other charges.
	Major	Major impact occurs where the farm enterprise cannot be continued without considerable management or operational changes. There would be significant landtake and/or sub-division on the affected land parcel(s). The route may affect farm buildings and / or facilities. Access to the sub-divided portions of land can only be achieved through the use of non-farm roadways to access sub-divided lands. Where the impact is major an enterprise change may be necessitated e.g. from dairy to drystock.
Profound or Significant Impact: Negative only	Severe	Severe impact occurs where the farm enterprise cannot be continued as a result of the *Proposed Road Development*. This would occur where land-take and sub-division was of such a nature to make the holding unworkable and/or where important farm buildings and facilities were removed. Impact of this degree would be rare and is most likely to occur on a dairy or stud farm.

11.2.3 Difficulties in compiling Information

- On one land parcel (which is a bog area) a roadside inspection was carried out as all of the landowners could not be contacted. This parcel is not farmed and is predicted to receive a minor impact;

- On twelve farms with not significant impacts, and one farm with a moderate impact the farm visit did not take place as the landowner could not be contacted or cooperation with the assessment was withheld. Where the farm visit did not occur a detailed desktop assessment was undertaken on the basis of a roadside inspection, land registry details and professional opinion.

11.3 Description of the Existing Environment

In assessing the impact of the new road construction on agriculture, it is useful to compare the general agricultural activity at a national and county level with that of the area immediately affected by the *Proposed Road Development*. This will indicate if there is any significantly unusual agricultural production taking place along the route of the road.

11.3.1 Existing Agricultural Environment

County Sligo has a total Utilisable Agricultural Area (U.A.A.) of 115,450 hectares (excluding commonage) (CSO Census of Agriculture, 2010). This represents approximately 2.53% of the national agricultural land area. There are 4,395 farms in Co. Sligo with the average farm size in the county being 26.3 hectares. This is lower than the national average farm size of 32.7 hectares.

Grassland based livestock farming is very important in County Sligo. The predominant farm enterprise is specialist beef with a total of 2,971 farms (67.59% of total farms) involved. Specialist dairying, mixed livestock and specialist sheep enterprises are also practiced with 141 farms (3.2%), 456 farms (10.4%) and 492 (11.19%) involved in these enterprises respectively. Tillage enterprises are less common with only 0.04% of farmers involved in tillage.

11.3.2 Agriculture along the Proposed Route

The new road will pass through seven Electoral Divisions (E.D.'s) along the preferred route, including Collooney, Lisconny, Drumfin, Riverstown, Bricklieve, Lakeview, Templevanny. The topography is generally drumlin in nature with soils being a dry mineral soil along the proposed route. The soils along the route are of a somewhat limited use range and although they can be used for tillage the soil is best suited to grassland.

11.3.3 Soil

The soils are described in detail in the Soils and Geology Chapter of the EIS (Chapter 13). Soil types influence the nature and intensity of farming carried out. The soil types through which the proposed route passes through are typical of soil associations, number 28 and 43. A soil association is a mapping unit on a soil map, which consists of two or more soils. A soil map is a representation of the distribution of soil types of a given landscape (An Foras Taluntais – Soil Associations of Ireland and their land use potential).

The soil association characteristics are outlined in Appendix 11.1 contained within volume 4 of this EIS.

11.3.4 Current Farming Enterprises

Table 11-3 and Table 11-4 present the category of farm size and crop type in the affected E.D.'s and how they compare with the national percentages for each category. The distribution of farm sizes within the affected E.D.'s in comparison with national averages is presented in Table 11-3**.**

Table 11-3: The number of farms classified by farm size

Farm Size	No. of Farmers [2]	% of Farmers	National %
<10 Hectares	59	15.8	18.2
10 -<20 Hectares	107	28.6	24
20 - <30 Hectares	86	23.1	17.6
30 - <50 Hectares	86	23.1	21.9
50 - <100 Hectares	32	8.6	14.8
>=100 Hectares	3	0.8	3.5
Total	373	100	100

The figures show that the average farm size in these areas is somewhat less than the farm size on a national level. Of all farms, 67.5% are less than 30 hectares in size in contrast with the national average of 59.98 % for the same category. There is a smaller level of farms between 50 –100 hectares in comparison with the national average.

Table 11-4 illustrates the breakdown of the agricultural land use and the comparison with the national averages

Table 11-4 Crop types and the area devoted to Crops and Grassland[56]

Crop Types	Area within E.D.'s (ha)	% of Area	% of National Area under Crops and Pasture
Total Crops, Cereals, Fruit, Horticulture	0	0	7.75%
Total Pasture	6505	66.17	54.88%
Total Hay	306	3.11	4.24%
Total Silage	2233	22.71	23.56%
Rough Grazing in use	788	8.01	9.57%
Total	9832	100%	100%

The high level of grass-based farm enterprises is reflected in the higher level of grassland crop types than the national average. There is a higher level of pasture than the national average. There is a lower level of rough grazing than the national average and a very low level under tillage or crops in the area. The route chosen will not cause a severe reduction in area of any particular crop type.

11.4 Description of Likely Impacts

11.4.1 Operational

The alignment of the *Proposed Road Development* is predominately through drumlin hills with extensive wetlands and small lakes dispersed throughout the area. The land consists of moderate agricultural range and usage. The main enterprises are beef, dairying and mixed livestock. The impact on agriculture of the new road construction will be limited to the farms directly traversed by the *Proposed Road Development*.

11.4.1.1 Loss of Agricultural Land

Nationally there are approximately 4,568,938 hectares of agricultural land (excluding commonage) of which 3,777,734 ha are in grassland based enterprises excluding rough grazing and 353,927 ha of cereal and non-cereal crop production. Approximately 170 of land will be lost to agricultural production as a result of this *Proposed Road Development*. This loss, while significant to individual farmers, is not significant on a county or national level.

11.4.1.2 Individual Farm Impact

There are ninety one farms directly affected by the construction of the new road. An agricultural consultant from Philip Farrelly & Company contacted most of these landowners, in order to carry out the following tasks:

- to conduct an appraisal of the farm facilities and layout, and;
- to gather data via a questionnaire to enable an assessment of the impact and mitigation measures required as a result of the *Proposed Road Development*..
- Farms were categorised according to the following criteria:
    - Total area of farm holding (hectares, ha);
    - Enterprise type(s);
    - Degree of overall impact;
    - Under major/severe overall impact;
    - Degree of land sub-division
    - Buildings/facilities to be acquired;
- New access facilities requiring provision;

[56] CSO Agricultural Statistics 2010 Census of Agriculture 2010.

Table 11-5 shows the summary details of the individual farm assessments and the anticipated impact of the new road on each farm.

Table 11-5: Summary on Individual Farm Assessments (of 92 farms)

Category	No. of Farms	% of Farms
Farm Size (ha): -		
<10	33	35.9
10 – <20	24	26.1
20 – <30	10	10.9
30 – <50	16	17.3
50 – <100	9	9.8
>=100	0	0.0
Farm Enterprises: -		
Dairy	1	1.1
Equestrian Enterprises	4	4.3
Beef	31	33.7
Sheep	4	4.3
Tillage	0	0
Mixed Livestock*	11	12.0
Mixed Tillage & Livestock**	0	0
Leased Forestry	25 1	27.2 1.1
Other***	15	16.3
Overall Impact on Farm		
Not Significant	15	16.3
Minor	19	20.7
Moderate	36	39.1
Major	22	23.9
Severe	0	0
Of those 22 farms with Severe/Major Impact		
Beef	11	12
Mixed Livestock	3	3.3
Equestrian Enterprises	2	2.2
Leased	5	5.4
Sheep	1	1.1
Land Sub- division - (on 106 land parcels)		
Not Significant	78	73.6
Minor	2	1.9
Moderate	14	13.2

Category	No. of Farms	% of Farms
Major	11	10.4
Severe	1	0.9
Facilities to be acquired*****	14	15
Access required to sub-divided area /retained area	39	42
Access points to be restored	51	55

* Mixed Livestock includes any combination of cows, cattle, horses or sheep enterprises. It consists of two farms primarily involved in dairying and nine primarily involved in beef.

** Mixed Tillage & Livestock includes any combination of cows, cattle, horses or sheep with tillage enterprises. .

*** Includes three land parcels where the land is not farmed, and one parcel involved in hay production, one parcel where the land is partly in forestry and partly leased, one land parcel partly leased, partly in forestry and involved in a beef enterprise, and nine grassland farms where the farm visit has not taken place and details of farm enterprise are not known

**** Includes one beef & equine farm and two mixed beef and dairy farms

***** Facilities include farmyards, fodder storage facilities, animal handling and housing facilities, etc.

(i) Access is deemed to be required where it has to be provided to a severed portion of land or a parcel where the access along the entire road frontage is removed. It does not refer to cases where the access point or gates have to be replaced or restored on a land parcel.

(ii) In the case of access required or facilities required, the figure refers to the number of land parcels in each case. It does not relate to the number of farms. In some cases access may be required on more than one land parcel on a holding.

Of all affected farms, 27.2% are in the farm size category of greater than 30ha. This compares with 40.2% on a national level. This reflects a higher incidence of smaller farm holdings in the area.

There is one specialist dairy farm and two mixed livestock farms that have dairying as the primary farm enterprise on the route. There are thirty one specialist beef farms along the route representing 33.7% of the farms affected. There are nine mixed livestock farms that have beef as the primary farm enterprise on the route. There is a significant level of less intensive farm enterprises along the route of the proposed road.

11.4.1.3 Overall Impact on Individual Farms

Prior to any mitigation measures being put in place, there are no farms on which the agricultural impact would be severe. (See Appendix 11.2 contained within Volume 4 of this EIS). There are 22 farms, which would have a major degree of impact, which represents 23.9% of all farms.

Without mitigation measures, these farm enterprise(s) cannot be continued due to the combination of the level of sub-division created, the type of enterprise, farm size, land take and the effects on farm buildings and facilities.

There are thirty six farms, which would have a moderate degree of impact representing 39.1% of all farms. There are nineteen farms, which would have a minor impact representing 20.7% of overall farms. There are fifteen farms, which would not have a significant degree of impact representing 16.3% of overall farms.

Appendix 11.2 (volume 4 of this EIS) shows the details of the individual farm assessments and the anticipated impact of the new road on each farm.

11.4.1.4 Impact on Individual Farm Parcels

Where the road has affected more than one land parcel on a farm the degree of land sub-division on each land parcel is assessed separately. There are 106 individual land parcels directly affected along the proposed route.

Without mitigation, severe land sub-division will occur on one land parcel (0.9% of all land parcels) major land sub-division will occur on eleven land parcels (10.4% of all land parcels), moderate land sub-division will occur on fourteen land parcels (13.2 % of all land parcels), minor land sub-division will occur on two land parcels (1.9% of all land parcels) and not significant sub-division will occur on seventy-eight land parcels (73.6% of the land parcels).

On fourteen land parcels, facilities will be removed. Facilities affected range from farm buildings and yards to animal handling facilities and pens.

Appendix 11.2 (Volume 4) shows the details of the individual farms and land parcel assessments and the anticipated impact of the new road on each.

11.4.2 Construction Impacts

11.4.2.1 Construction Noise

Construction traffic such as transport and other ancillary vehicles including earth moving machinery will generate additional noise emissions in the immediate vicinity of the *Proposed Road Development* during construction. Noise can be of significance for farm animals (i.e. when noise becomes excessively loud). In general, animals become accustomed to regular noises and sounds. Intermittent noises can cause fright and distress. Blasting activity can be of particular concern with certain farm enterprises such as breeding and training of horses. Intermittent noises close to farm buildings, particularly milking parlours, can distress livestock. The impact of noise is expected to be short term and intermittent during construction. The equine assessment concludes that horses on one of the equine facilities may have to be moved out of the stables most adjacent to the N4 to alternative stables during blasting/rock breaking activities.

11.4.2.2 Dust

Dust generated from the exposure of soil to the atmosphere during construction may cause annoyance or nuisance to the farmer and farm animals. The proliferation of dust during construction has a nuisance effect and, if produced in high volumes near milking parlours or on-farm bulk milk storage tanks, may constitute a risk as a source of contamination to the milk.

Livestock are at risk of eye irritations from high levels of windblown dust particles. This stress may reduce productivity and increase management difficulties, especially on dairy and equestrian farms. The impact of dust is expected to short term and occasional during construction.

11.4.2.3 Restricted Access to Sub-divided Land Parcels

Access to sub-divided land parcels will still be required during the road construction process (i.e. following the commencement of construction but before the accommodation works have been completed). It is to be expected that there will be increased difficulties in providing such access during the construction phase due to the need to allow machinery and equipment continual movement along the construction corridor. This will conflict with the farmer's requirements to move livestock from one part of the farm to another in order to utilise the grazing area properly.

11.4.2.4 Disturbance of Field Drainage Works

It is to be expected that field drainage systems currently in situ will be disturbed and in places destroyed by the construction of the new road. These systems will be restored as part of the completed road works, but there may be impaired drainage in the period of time between initial disturbance and final reinstatement of such drainage works.

11.4.2.5 Soil Disturbance

The construction works together with the use of heavy earth moving machinery and equipment will result in disturbance of the soil structure along the construction route corridor.

11.4.2.6 Provision of Ducting.

Ducting for piped watering systems on some farms are being severed. Access to either piped water or drinking points on watercourses will be removed through sub-division on other farms.

In some cases ducting will be required for the purposes of installing electric fencing to stock-proof non-roadside boundaries on newly severed land.

11.5 Mitigation Measures & Environmental Commitments

11.5.1 Operational

Mitigation measures detailed in this section relate to engineering accommodation works alone. Further measures to compensate farmers due to land acquisition, drainage works and loss of facilities can be agreed by the valuer at a later stage.

A total of twenty eight land parcels, out of the 106 assessed land parcels, have areas of lands, which have been severed. New access will be required on 39 land parcels. Access is deemed to be required where it has to be provided to a sub-divided area or to a retained area of land where the entire road frontage is removed. There are fifty land parcels on which the existing access point(s) will be affected or a new access point off an existing road may be required. The access points will have to be reinstated on these land parcels.

The extent and complexity of such access provisions vary with each farm depending on the nature of the impact and the type of enterprise being carried out. In some cases simple gateways will suffice, while in other cases new accommodation roads and bridges may have to be constructed.

Timber post and rail fencing with stock proofing as appropriate will be provided along the main line, regional, local and accommodation roads. The Local Authority will maintain the fence along the National road. It will be the responsibility of the landowners to maintain the fence along regional, local and accommodation roads.

Appendix 11.2 (Volume 4) summarises the level and nature of the impact the route will have on each individual farm and proposed mitigation measures relating to accommodation works.

11.5.2 Construction

11.5.2.1 Construction Noise

Good communication between the contractor and the landowners during the construction phase will prevent undue disturbance due to noise. Good communication with farmers will facilitate the organisation of farm enterprises, so that vulnerable livestock are kept as far away as feasible from the construction work during critical times. The contractor shall minimise impacts on agricultural lands due to construction noise by way of a programme of mitigation measures for noise and vibration control as described in the Noise and Vibration impact assessment chapter of this EIS Chapter 8.

11.5.2.2 Dust

The contractor will employ measures to prevent the spread of dust onto adjoining lands. These measures are set out in the Air Quality chapter 9 of the EIS. Good communication between the contractor and the farmers in the proximity of construction activities will facilitate on-going farm enterprises so that valuable livestock are kept as far away as possible from the construction work during critical times.

11.5.2.3 Restricted Access to Sub- divided Land Parcels

As in the case of mitigating noise and dust pollution, good communication between individual farmers and the construction authorities will minimize difficulties caused by the restriction of access to severed land parcels. Such communication should produce a workable arrangement, which will allow all parties to continue their work in return for some compromise to other parties. There also should be proper termination of existing boundaries. Maintenance of open access to all landholdings and properties is required.

Temporary fencing will be erected as required to delineate the site boundary and to minimize disturbance to adjacent lands. Farmers may need to move animals across the construction site while they await more permanent measures to be put in place and this will be facilitated by providing gates where needed until such time as the access arrangements are in place for these farmers when these gateways should be replaced by permanent stock-proof fencing.

11.5.2.4 Disturbance of Field Drainage Works

In cases where impeded drainage during construction will cause obvious difficulty to a particular landowner, temporary measures will be taken to allow waters to drain to less critical areas and so minimise the impact.

11.5.2.5 Soil Disturbance

Areas if so required on a temporary basis for road construction purposes will be returned to agricultural use following the completion of the *Proposed Road Development*.

11.5.2.6 Provision of Ducting.

Where required, separate ducting will be given to take water supply and electric fencing across the proposed road to the land on the other side. The location of these will be agreed in advance of road construction on an individual farm basis and put in place during the construction phase. Again some temporary measures may be needed, such as water tanks and battery power electric fencing to ensure that disruption to farming is minimized.

11.6 Residual Impacts

Following recommended mitigation works relating to sub-division no farm will have a residual impact of severe.

Eight farms will have a residual impact of major degree of residual impact representing 8.7 % of all farms. This represents a 15.2 % reduction in the level of farms with a major impact.

Forty seven farms would have a moderate degree of residual impact representing 51.1% of all farms. This represents a 12.0 % increase in the level of moderately impacted farms on the route.

Twenty two farms will receive a minor impact representing 23.9% of overall farms. This represents a 3.3% increase in the level of farms on the route with a minor impact.

Fifteen farms will not have a significant degree of impact, which represents 16.3% of the overall farms.

Table 11-6 shows the details of the individual farm assessments and a comparison of the overall impact with the anticipated residual impact of the new road on each farm following recommended mitigation works being carried out.

Table 11-6: Residual Impacts on the Individual Farms

Category	Overall Impact No of Farms	Residual Impact No. Of Farms	Residual Impact % of Farms
Overall Impact on Farm (of 92 farms)			
Not Significant	15	15	16.3
Minor	19	22	23.9
Moderate	36	47	51.1
Major	22	8	8.7
Severe	0	0	0.0
Of those 22 farms with Major Impact			
Beef	11	4	4.3
Mixed Livestock ****	3	2	2.2
Leased	5	1	1.1
Equine	2	1	1.1
Sheep	1	0	0

Appendix 11.2 shows the details of the individual farms and the anticipated residual impact of the new road on each farm.

11.7 Relevant Figures and Appendices

11.7.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 11.1.1-11.1.8: Agriculture and Material Assets;

11.7.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 11.1.: Soil Associations;

Appendix 11.2.: Farm Assessments.

Section B; Natural Environment

This section of the Environmental Impact Statement deals with the potential impacts of the *Proposed Road Development* on the Natural Environment. The effects have been grouped as follows:

- Impacts on **Flora, Fauna and Fisheries**;
- Impacts on **Soils and Geology;**
- Impacts on **Hydrology and Hydrogeology;**

12 Flora, Fauna and Fisheries

12.1 Introduction

This ecology report is part of the Environmental Impact Statement (EIS) for the proposed N4 Collooney to Castlebaldwin Realignment in Co. Sligo and provides a description of the existing terrestrial and aquatic flora and fauna (ecology) of the area and assesses impacts of the *Proposed Road Development* from an ecological perspective. The overall aim of the study was to identify areas of ecological interest that may present constraints to the *Proposed Road Development* or where special mitigation is necessary. An evaluation is made of the scientific and/or conservation value of the sites identified.

The Project Description (Chapter 4) provides a comprehensive narrative of the *Proposed Road Development*. In preparing this Flora and Fauna section of the EIS, all tasks were carried out with reference to:

- *Guidelines for the Assessment of Ecological Impacts of National Road Schemes* (Rev.2, NRA 2009);
- *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (NRA, 2009a);
- *Environmental Impact Assessment of National Realignments – A practical guide* (NRA Re. 2 2008);
- *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* (NRA 2006b);
- *Guidelines for the Treatment of Badgers Prior to the Construction of a National Road Schemes* (NRA 2006);
- *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (NRA 2005b);
- *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (NRA 2008);
- *Guidelines for the Treatment of Otters during the Construction of National Road Schemes* (NRA, 2008);
- *Institute of Ecology and Environmental Management Guidelines for Ecological Impact Assessment* (IEEM 2006);

The findings of specialist surveys and associated impact assessments set out in the Hydrological and Hydro-Geological Chapter (Chapter 14) and the Landscape and Visual Chapter (Chapter 10) of the current EIS were also referred to in relation to potential ecological effects and associated mitigation measures.

Designated conservation sites including Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs) in the vicinity of the proposed route corridor were identified. This information was supplied by the National Parks & Wildlife Service of the Department of the Arts, Heritage and the Gaeltacht. The route corridor was surveyed systematically during the period October 2005 to June 2006. The extensive information obtained during the initial baseline surveys was further supplemented by additional targeted fieldwork undertaken during November 2009 and September 2010. Follow-up surveys were undertaken between September and December 2012 and during the summer of 2013 to provide up-to-date verification of baseline conditions.

12.1.1 Legislative context

Under Section 40 of the 1976 Wildlife Act, as amended by Section 46 of the Wildlife Amendment Act (2000), it is prohibited to cut or remove trees or other semi-natural vegetation during the bird nesting season, from the 1st of March to the 31st of August. This includes riparian vegetation along river channels (i.e. reeds and marginal vegetation) which could be used by water birds. However, there is the provision for the clearance of vegetation during the course of road developments during this period.

Under the Fisheries (Consolidation) Act, 1959, it is an offence to disturb the bed of a river; therefore it will be necessary to get written permission from Inland Fisheries Ireland to proceed with the works, as disturbance to the spawning and nursery areas of both salmonids and lampreys will occur as a result of the scheduled works. Salmon, all lamprey species and their habitat are further protected under the EU Habitats Directive, 1992.

Otters are also protected under the provisions of the Wildlife Act (1976), Wildlife (Amendment) Act (2000) and the EU Habitats Directive (1992), transposed into Irish legislation as the European Communities (Birds and Natural Habitats) Regulations 2011.

Under Section 3 of the Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act) it is an offence to cause or permit any polluting matter to enter waters; where suspended solids

would be a key parameter with regard to construction phase impacts. Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter is defined as *'not only any substance that is liable to injure fish but is also liable to damage their spawning grounds or the food of any fish or to injure fish in their value as human food or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish'*.

12.2 Methodology

12.2.1 Desktop Review

A desktop review was carried out to identify features of ecological importance within the study area and surrounding region. The ecological assessment included designated and sensitive areas in the vicinity of the study area, to enable sufficient assessment to identify and quantify any significant impacts on the habitats, flora and fauna likely to arise from the construction and operation of the proposed road. Potential sites of conservation interest were identified prior to the field survey by an examination of Ordnance Survey (OS) aerial photography and OS maps (1:50,000, 1:10,560 or 6" and 1:2500 scales).

The digital database of the New Atlas of the British and Irish Flora (Preston et *al*, 2002) was consulted to assess the presence of rare plant species recorded from the 10 km square in which the site is located. Likewise, '*Exploring Irish Mammals*' (Hayden and Harrington, 2000) was used to assess the importance of the study area for mammals. A desk study of bat records from the study area was undertaken. Sources accessed included the Bat Conservation Trust's report '*Distribution atlas of bats in Britain and Ireland 1980-1999'* (Richardson, 2000) and the Heritage Council publication '*Bridge Usage By Bats In County Leitrim And County Sligo'* (Shiel, 1999).

The results of the '*Irish Wetland Bird Survey (I-WeBS)*' (Crowe, 2005) were also reviewed. The '*New Atlas of Breeding Birds in Britain and Ireland: 1988-1991'*, (Gibbons *et al*, 1993) was also consulted to assess breeding birds of conservation importance using areas within a 10km radius of the site. A preliminary ecological report (Cotton, 2000) and a summary of ecological constraints (Cotton, 2002) for the *Proposed Road Development* were also reviewed.

The 'Sligo County Development Plan (2011-2017)' (Sligo County Council, 2011) was reviewed in the preparation of this Chapter, taking account of the 'mini plan' for Castlebaldwin Village. The *'County Sligo Biodiversity Action Plan'* (Sligo County Council, 2010) was also reviewed.

12.2.2 Field Survey Work

The corridor of the *Proposed Road Development* and the wider study area including the zone of influence was surveyed systematically during the period October 2005 to June 2006. Additional fieldwork was undertaken during November 2009, September 2010, autumn 2012 and the summer period of 2013. The field survey elements and evaluation of ecological significance followed guidelines set out by the NRA including:

- *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (NRA, 2008);
- *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* (NRA 2006b);
- *Guidelines for the Treatment of Badgers Prior to the Construction of National Road Schemes* (NRA 2006);
- *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (NRA 2005b);
- *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (NRA 2008);
- *Guidelines for the Treatment of Otters during the Construction of National Road Schemes* (NRA, 2008);

Information was recorded in relation to the primary habitats and land take to be directly affected by the *Proposed Road Development*, at a level corresponding with the Heritage Council publication '*Best Practice Guidance for Habitat Surveying and Mapping*' (Smith *et al.,* 2011). Habitat mapping was aided by aerial photography and habitats recorded were classified according to Fossitt '*A Guide to Habitats in Ireland*' (2000). Where relevant the '*Interpretation Manual of European Union Habitats – EUR28*' (EC, 2013) was utilised with regard to Annex I habitats identified within the study area. A list of the dominant and notable plant species was taken for each habitat type. Plant species nomenclature follows Stace (1997) '*New Flora of the British Isles'*. Hedgerow survey methodology followed the NRA Guidance '*Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Realignments*' (NRA, 2009a) which proposes that the 'National Hedgerow Survey Methodology' be utilised in surveying hedgerows within the study area of

national realignments, after Foulkes & Murray (2006). While emphasis was placed on the habitats within the land take of the *Proposed Road Development* route, the terrestrial habitats occurring within the zone of influence either side of the *Proposed Road Development* were also considered. Sensitive habitat features in the study area including watercourses and wetlands connected via surface water or groundwater pathways were assessed; where potential for adverse effects were identified as informed by the hydrological and hydrogeological impact assessment (Chapter 14).

Detailed surveys for non-volant mammals, bats and fisheries were also undertaken as part of the current assessment. The full extent and results of these surveys are detailed in separate reports presented as Appendices to the current chapter.

The presence of particular faunal species was based on the (1) direct identification, (2) indirect identification i.e. observation of dwellings, signs of feeding and droppings (3) the nature and type of habitat present. Bat detectors, roost surveys and habitat surveys were used in assessing the importance of the area for bats, following the NRA's '*Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes*' (NRA 2006b). The badger and otter surveys were carried out according to NRA guidelines with further reference to Harris et al. (1989) and Macdonald et al. (1998), respectively. Breeding and wintering bird surveys were undertaken within the appropriate seasonal timeframe and survey results are presented in separate reports included as appendices to the current chapter. The main rivers and streams in the study area were subjected to detailed ecological assessment including a River Corridor Habitat appraisal (incorporating the Environment Agency (UK) methodology, 2003). Kick sampling assessments were undertaken on all the main watercourses following the EPA methodology (Toner *et al.*, 2005), while kick sampling from smaller streams followed the Small Streams Risk Score (Walsh, 2005) evaluation assessment.

A screening assessment for the presence of protected terrestrial invertebrates listed on Annex II of the EU Habitats Directive (1992) was carried out during 2010; with a follow-up targeted molluscan survey undertaken during November 2012. Protected terrestrial invertebrate surveys specifically focussed on surveying suitable habitats for the Marsh fritillary butterfly (*Euphydryas aurinia*) and Whorl snail species (*Vertigo* spp.); both listed on Annex II of the EU Habitats Directive (1992).

All fauna identified was assessed in relation to the EU Habitats Directive (92/43/EEC), Bird Directive (79/409/EEC), the Wildlife Act (1976), the Wildlife Amendment Act (2000) and the '*Irish Red Data Book 2: Vertebrates - Threatened Mammals, Birds, Amphibians and Fish in Ireland*' (Whilde 1993). The '*Red Data List (No. 3) Terrestrial Mammals*' (Marnell, 2009) was also referenced, as was the '*Red Data List (No. 2) Non-Marine Molluscs*' (Byrne *et al*., 2009).

12.2.3 Consultations

Preparation of this Chapter included consultation, either directly or through publicly-available information, with:

- The National Parks and Wildlife Service (NPWS) within the Department of Arts, Heritage and the Gaeltacht (DAHG);
- Sligo County Council;
- Botanical Society of the British Isles (BSBI);
- Birdwatch Ireland;
- Bat Conservation Ireland;
- British Trust for Ornithology (BTO);
- Environmental Protection Agency (EPA);
- Butterfly Ireland;
- Irish Wildlife Trust;
- Department of Communications, Energy and Natural Resources (DCMNR);

During the preparation of this Chapter, direct consultations with the regional staff of the National Parks and Wildlife Service (NPWS):

- A field meeting to discuss the treatment of mammals during the proposed construction and operation of the realignment was undertaken on 12th June 2006;
- An additional consultation meeting and site visit focussing on the wetland habitats within the study area was carried out with regional NPWS staff including the Divisional Ecologist and Regional Management on the 30th of October, 2012; and

- A further meeting was held with the NPWS Divisional Ecologist on the 28th of June 2013 to discuss the key ecological receptors identified within the study area and zone of influence of the *Proposed Road Development* and the appropriateness of mitigation measures proposed.

Consultation with Inland Fisheries Ireland (previously the North western Regional Fisheries Board) during the preparation of this impact assessment resulted in two written responses (29th March 2010 and 27th April 2012); both of which outlined the Board's requirements in relation to water quality protection, fish passage and reinstatement. A series of site meetings with the District Environmental Officer and local IFI staff were undertaken, including meetings on the 30th May 2013 and on the 23rd of October 2013 to further inform the impact assessment and mitigation measures required with regard to watercourse crossings and fisheries protection.

12.2.4 Evaluation

The ecological assessment within the study area was carried out with reference to with the '*Guidelines for the Assessment of Ecological Impacts of National Realignments – Revision 2*' (NRA 2009). The evaluation of impact significance is a combined function of the value of the affected feature (its ecological importance), the type of impact and the magnitude of the impact. It is therefore necessary to identify the value of ecological features within the study area in order to evaluate the significance and magnitude of possible impacts. Following the guidance set out by the NRA (2009) the study area for the *Proposed Road Development* has been evaluated based on an identified zone of influence with regard to the potential for pathways for impacts affecting ecological features of interest (habitats, flora and fauna).

Ecological features are assessed on a scale ranging from international-national-county-local. Following the guidance set out by the IEEM (2006) the local scale is taken as corresponding to the zone of influence of the development and extending to a parish area. The NRA (2009) evaluation criteria are presented in Table 12-1 below. Watercourses, evaluated following the NRA (2009) criteria were evaluated on the basis of a number of characteristics and features defined as follows:

- Aquatic habitat refers to the in-water conditions of any watercourse; including substrate and stream structure (i.e. proportion of riffles, runs and pools).
- The fisheries value of a watercourse refers to its suitability for fish, primarily salmonids (salmon and trout), and to the associated value for recreational angling purposes.
- Annex II species are those that are listed under the EU Habitats Directive (92/43/EEC).
- Annex I habitats are those that are listed under the EU Habitats Directive, including Priority Habitats.
- The evaluation of water quality uses a five-point biotic index (Q-value) based on the presence and relative abundance of various invertebrates using the Environmental Protection Agency's (EPA) standard technique.

Table 12-1: Criteria used to determine the value of ecological resources (NRA 2009)

Importance	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 (SPA). 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 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) 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

Importance	Criteria
	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).
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) of the following: Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing 'viable areas' of the habitat types listed in Annex I of the Habitats Directive.
County Importance	Area of Special Amenity. 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) 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 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) 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.

*SAC = Special Area of Conservation; SPA = Special Protection Area; NHA = Natural Heritage Area.

12.3 Description of the Existing Environment

12.3.1 Designated areas

The first large-scale effort to identify native flora, fauna, and habitats throughout Ireland was the survey of Areas of Scientific Interest in the 1970s. The sites identified by the initial survey were subsequently renamed as 'Natural Heritage Areas' (NHAs) in 1992. The passing of the Wildlife (Amendment) Act 2000 began the process that has led to proposed NHAs being legally protected. NHAs are an Irish designation protected under Irish law, as are sites proposed as NHAs. The EU 'Habitats Directive' (92/43/EEC) has been transposed into Irish law by The European Community (Natural Habitats) Regulations 1997 (S.I. No. 94/1997) and most recently consolidated with the European Communities (Birds and Natural Habitats) Regulations (SI No. 477/2011). These regulations seek to protect natural habitats and flora and fauna of European importance. Ireland has been obliged to designate sites, which contain sufficiently intact semi-natural habitats and/or important species of wild flora and fauna in order to ensure that these habitats and species survive. The Habitats Directive established the Natura 2000 network which includes designated conservation sites entitled Special Areas of Conservation (SACs) for protected habitats and species listed in Annex I and Annex II of the directive, together with 'Special Protection Areas' (SPAs) which are designated under the Birds Directive (2009) for the protection of birds and important bird habitats.

12.3.1.1 Natura 2000 sites

A Natura Impact Statement has been prepared to inform an Appropriate Assessment for the proposed N4 Collooney to Castlebaldwin Realignment. The reporting to inform the Appropriate Assessment sets out the implications of the plan or project, alone and in combination with other plans and projects, on the integrity of a Natura 2000 site in view of its conservation objectives. Effects upon the conservation objectives and qualifying interests (including habitats and species) within the affected designated areas are considered. Taking account of the NPWS (2009) guidance for Appropriate Assessment, designated Natura 2000 sites within a 15km radius were identified. Of these sites, four designated Natura 2000 sites are found in close proximity to the *Proposed Road Development*, i.e. within 1 km; three of which are identified within the zone of influence of the *Proposed Road Development* including the Unshin River cSAC, the Lough Arrow cSAC and the Lough Arrow SPA. The locations of these Natura 2000 sites with respect to the *Proposed Road Development* are presented in Table 12.2. A map showing the location of designated conservation sites is provided in the Natura Impact Statement (NIS), included as Appendix 12.1 in Volume 4 and in Figure 12.1 of the current EIS.

Table 12-2: Natura 2000 sites in proximity to the Proposed Road Development which are designated for nature conservation

Site name and code	Designation	Distance from site	Reasons for designation
Unshin River (1898)	cSAC	0.04km at closest point	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) Rivers with floating vegetation often dominated by Water-crowfoot Atlantic salmon (*Salmo salar*) Otter (*Lutra lutra*)
Lough Arrow (1673)	cSAC	0.5km	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
Lough Arrow (4050)	SPA	0.7km	Little grebe (*Tachybaptus ruficollis*) Tufted duck (*Aythya fuligula*) Wetlands & Waterbirds
Bricklieve Mountains and Keishcorran (1656)	cSAC	1.03km	Turloughs [3180]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6210]; Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) [6510];

Site name and code	Designation	Distance from site	Reasons for designation
			Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) [8120]. Marsh fritillary (*Euphydryas aurinia*) [1065] White-clawed crayfish (*Austropotamobius pallipes*) [1092].
Union Wood (00638)	cSAC	1.9km	Old sessile oak woods with *Ilex* and *Blechnum* in British Isles [91A0]
Knockmullin Fen (1904)	pNHA	1km	Fen vegetation

12.3.1.1.1 *Unshin River cSAC*

This cSAC runs parallel and to the east of the existing N4, from Lough Arrow to Ballysadare Bay. It is notable as an example of a pristine river corridor that has not been drained and retains natural habitats along its margins. The Unshin River cSAC is designated for its Annex I habitats floating river vegetation [3260] and alluvial wet woodlands [91E0]. The site is also selected for the Annex II species Atlantic salmon (*Salmo salar*) [1106] and Otter (*Lutra lutra*) [1355]. Bird species listed on Annex I of the EU Birds Directive (2009) recorded along the river corridor include Whooper swan and Kingfisher. The cSAC boundary is in close proximity to the east side of the existing N4 where the *Proposed Road Development* rejoins it at Doorly. A number of link roads also adjoin this cSAC:

- At Knocknagroagh (the tie in of the L-55016-0 to the existing N4 at Knocknagroagh Td. is approximately 40m from the cSAC boundary; however the main road corridor (national primary element) is approximately 190m away from the cSAC boundary at this location.
- At Drumfin the proposed upgrade and tie-in of the local road (L-1502-32) between the Proposed Road Development and the existing N4 is located approximately 30m from the cSAC site boundary.

The cSAC is also indirectly connected to the Proposed Road Development by the crossing of the Drumfin River approximately 2km upstream of its confluence with the Unshin River. Potential impacts on the cSAC downstream will need to be carefully mitigated.

12.3.1.1.2 *Lough Arrow cSAC*

Lough Arrow SAC is a spring-fed lake designated for the Annex I habitat 'Hard oligo-mesotrophic waters' (EU habitat code 3140), with the Annex II species otter occurring in addition to a variety of lakeshore habitats. The cSAC site boundary lies approximately 350m from the proposed route at its closest point, due south of Castlebaldwin village. This designation is hydrologically connected to the *Proposed Road Development* via the Drumderry Stream which flows south from Castlebaldwin; a tributary of this watercourse is also crossed by the *Proposed Road Development*.

12.3.1.1.3 *Lough Arrow SPA*

Lough Arrow SPA is located approximately 700m to the south of the *Proposed Road Development*, due east of Castlebaldwin village. This site is designated as a SPA for the conservation of Little grebe (*Tachybaptus ruficollis*) [A004], Tufted duck (*Aythya fuligula*) [A061] and wetlands & waterbirds [A999]; the Whooper swan [A038] which is also listed on Annex I of the EU Birds Directive (2009) occurs on the lake and is listed in the Natura 2000 Standard Data Form for this site.

12.3.1.1.4 *Bricklieve Mountains and Keishcorran cSAC*

Bricklieve Mountains and Keishcorran cSAC (site code: 001656) is located approximately 1.05km south-west from the proposed route at Cloghoge Lower. It covers an upland area of limestone outcrop with a wide variety of habitats and high floral diversity. This cSAC is designated for the conservation of Annex I habitats: Turloughs [3180]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6210]; Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [6510]; Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) [8120]. Annex II species listed as qualifying interests of the site include Marsh fritillary (*Euphydryas aurinia*) [1065] and White-clawed crayfish (*Austropotamobius pallipes*) [1092]. This Natura 2000 site is not connected via hydrological or hydrogeological pathways to the proposed N4 realignment. There are no pathways for direct, indirect or cumulative impacts affecting this designated site with regard to the habitats or species listed

as conservation interests of this site. There is no aspect of the proposed works which may result in adverse affects on this designated site.

12.3.1.1.5 *Union Wood cSAC*

Union Wood cSAC is located approximately 1.9km due north of the *Proposed Road Development* at its closest point. This woodland is designated as a cSAC for the presence of 'Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles', an Annex I habitat. There is no aspect of the proposed works which may result in adverse affects on this designated site, where there are no pathways for direct, indirect or cumulative impacts arising from the proposal which could potentially affect the oak woodland habitats for which this site is designated.

12.3.1.2 Natural Heritage Areas

There are no designated Natural Heritage Areas (NHAs) within, directly adjacent to or within the zone of influence of the *Proposed Road Development*. Proposed Natural Heritage Areas (pNHAs) within the study area have been, in the main, included within Special Areas of Conservation; where the ecological conservation interests comprise habitats and species of conservation concern with respect to the Habitats Directive (1992) and the pNHA designation is superseded by the Natura 2000 designation. The Knockmullin Fen pNHA is an exception, as this habitat complex remains designated as a pNHA, to the west of the *Proposed Road Development*.

12.3.1.2.1 *Knockmullin Fen pNHA*

The boundary of the Knockmullin Fen pNHA is located approximately 1km northwest of the *Proposed Road Development* and is not hydrologically connected to the development. Knockmullin Fen lies in a wide valley that drains east into the Toberscanavan Loughs, which subsequently flow under the existing N4 and into the Unshin River to the east. As well as calcareous flushes with fen vegetation, the site contains areas of peat with acidic vegetation. There are no pathways for impacts or ecological effects on this designated site identified with regard to the *Proposed Road Development*.

12.3.2 Habitats and Flora

The general landscape of the study area is characterised by low drumlin hills, dominated by agricultural grassland pasture with hedgerows; which overlie the limestone of the Bricklieve Formation. Small areas of limestone bedrock are found as outcrops along the route. As drainage is concentrated into the inter-drumlin hollows, wetland habitats have formed in the low-lying areas. Gleys, interdrumlin peats/peaty gleys and brown earth soils derived from limestone glacial till and alluvium dominate. Habitats along the proposed road corridor were classified following Fossitt (2000) '*A Guide to Habitats in Ireland*'. These habitats are discussed below, and a species list is provided in Appendix 12.2, Volume 4 of the EIS. A summary of the wetland sites identified within the study area of the *Proposed Road Development* is presented in Table 12-3. The Sligo County Development Plan (2011-2017) (Sligo Co. Co., 2011) outlines the following objective in relation to nature conservation outside of designated sites:

'*O-NH-9: Identify and protect, in co-operation with the relevant statutory agencies and other relevant groups, County Biodiversity Sites which are not otherwise protected by legislation*.'

A summary of habitats identified as being of local importance (higher value) or greater occurring within the study area of the *Proposed Road Development* is presented in Table 12.4. Habitat mapping for the study area has been prepared and is presented in Figures 12.2.1 to 12.2.8 of Volume 3. No habitat areas designated as Natura 2000 sites or Natural Heritage Areas (including pNHAs) are crossed by the proposed route.

The habitat survey undertaken for the *Proposed Road Development* identified wetland features corresponding to Annex I habitats that occurred within the study area of the proposed road corridor. The Annex I habitat types and habitat areas evaluated as being of 'Local Importance (higher value)' within the study area were identified as such based on the botanical communities present, with reference to the '*Interpretation Manual of European Union Habitats*' (EC, 2007). A number of the wetland habitat sites within the zone of influence and wider study area are evaluated as being of county to national importance; taking account of their location outside of any conservation designation. These important habitat areas were surveyed initially during the constraints study and route selection (Cotton, 2000 & 2002) and the follow-up survey carried out as part of the EIS stage during 2005 / 2006. Further ecological survey work was undertaken during field surveys carried out in 2010, 2012 and 2013 which included additional habitat assessment and specialist botanical surveys at these sites. Cognisance was also taken of the findings of the '*County Sligo Wetland Survey*' (Wilson *et al*.; 2008 -

2011) published by Sligo County Council which had also undertaken a botanical assessment of the majority of the wetland sites and follow-up site surveys were carried out with Faith Wilson, consultant botanist, from this wetlands team.

Table 12-3: Sligo County Biodiversity Sites and their ecological interests within the study area of the Proposed Road Development, taken from the Sligo County Development Plan (2011-2017) and the 'County Sligo Wetland Survey' reports (Wilson et al., 2008, 2009, 2011a and 2011b).

Biodiversity Site	General Description	Receptor Importance / Evaluation
Toberscanavan Lough	Lake, transition mire and fen	National Importance
Lackagh Fen	Fen	National Importance
Boathole Lough and Lough Corran	Lake and raised bog	County Importance
Cuileencroobagh Lough	Transition mire and quaking bog	County Importance
Ardloy and Aghalenane Loughs Complex	Lake and Fen	International Importance*
Tawnagh	Turlough	National Importance
Swallow Hole near Riverstown[57]	Turlough	National Importance
Loughymeenaghan	Lake with alkaline fen and transition mire	International Importance
Drumderry Marsh	Raised bog, Cutaway	Local importance (higher value)
Cleavry Lough	Lake with transition mire and fen	National Importance

* Taking account of the evaluation from Moorkens (2012) which recorded the Annex II *Vertigo geyeri* at this site; in addition to the priority Annex I habitat 'Tufa forming springs' also present.

The evaluation of the importance of habitat features within the study area follows the guidance set out by the NRA (2009) '*Guidelines for Assessment of Ecological Impacts of National Road Schemes*'. Habitat areas identified as being of national importance were evaluated taking account of the presence of Annex I habitats and priority Annex I habitats within these areas; while the county importance evaluation includes small areas of Annex I habitats occurring within the study area. One wetland site, at Aghalenane and Ardloy Loughs Complex, has been evaluated as being of international importance taking account of the Annex I habitats present, but with particular reference to the Annex II listed *Vertigo geyeri* recorded at this site. Further direction in reaching the evaluations for the ecologically significant habitat resources within the study area was obtained following direct consultation with the NPWS; taking account of the absence of any Natura 2000 designation at these locations which would warrant international status and with reference to the habitat evaluations presented in the County Sligo Wetlands Survey reports (Wilson *et al*.; 2008-2011). An on-site meeting with the NPWS to view the individual wetland sites containing Annex I habitats and to discuss the evaluation of these areas with respect to the *Proposed Road Development* was facilitated by regional NPWS staff on the 30th of October, 2012. During the course of this meeting the 'international importance' evaluation attributed to the wetland complex at Loughymeenaghan by Wilson *et al*. (2011) was discussed and, as this wetland lies outside of the zone of influence of the *Proposed Road Development*, it was considered that this rating would remain.

In addition to the ecologically important wetland habitats above, additional habitats identified as being of 'local importance (higher value)' are identified within the zone of influence of the *Proposed Road Development*. Ecologically sensitive sites within the zone of influence are summarised in Table 12-4 below.

Table 12-4: Evaluation of ecologically sensitive habitats within the study area of the proposed N4 Collooney to Castlebaldwin Realignment

Site/habitat	Description	Rating
Toberscanavan Lough	Wetland complex with mesotrophic lake, reed swamp, Annex I alkaline fen and priority Annex I Alluvial woodland	National importance; derived from consultation with the NPWS

[57] Corresponds to Swallow Holes Complex at Tawnagh as referred to in this Chapter.

Site/habitat	Description	Rating
Lackagh Fen Complex	Fen complex with Annex I Alkaline fen and transition mire with priority Annex I Tufa forming springs and high diversity marsh habitats.	National importance; derived from consultation with the NPWS
Boathole Lough & Lough Corran	Mesotrophic lakes with reed swamp and cutover raised bog and transition mire habitats to the southeast.	County importance
Ardloy & Aghalenane Loughs Complex	Mesotrophic lake network with Annex I transition mire, alkaline fen and priority Annex I Tufa forming springs.	National importance (*with regard to habitats and flora*); derived from consultation with the NPWS
Cuileencroobagh Lough Complex	Small lake with Annex I transition mire within a complex of cutover raised bog.	County importance; derived from consultation with the NPWS
Swallow Holes Complex	Small groundwater connected waterbodies corresponding to priority Annex I Turlough habitat. Reed swamp vegetation and wet grassland.	National importance; derived from consultation with the NPWS
Marsh (GM1)	Species-rich marsh	Local Importance (higher value)
Wet willow/alder/ash woodland (WN6)	Wet willow/alder/ash woodland along the Drumfin River corridor and at the margins of Toberscanavan Lough	Local importance (higher value)
Oak/ash/hazel woodland (WN2)	Occurring in isolated pockets on dry and elevated ground within the study area	Local importance (higher value)
Scrub (WS2)	Semi-natural hawthorn, blackthorn, gorse and hazel scrub within the context of an agricultural landscape	Local Importance (higher value)
Hedgerows (WL1) and treelines (WL2)	Well connected hedgerows and treelines with fair-good structure, providing a wildlife corridor function within the study area.	Local Importance (higher value)
Exposed calcareous rock (ER2) at Carrownagark.	Species-poor limestone outcrop, significantly degraded.	Local Importance (higher value)

12.3.2.1 Description of habitats occurring within the study area

A summary of the habitats recorded from the study area of the proposed N4 Collooney to Castlebaldwin Realignment is presented in Table 12.5, with a description of each habitat type following the classification system set out by Fossitt (2000) and whether it occurs within the proposed alignment provided separately. Habitat mapping for the study area is presented in Figures 12.2.1 to 12.2.8, included in Volume 3 of the EIS.

Table 12-5: Summary of the habitat types recorded from the N4 Collooney to Castlebaldwin Realignment study area following Fossitt (2000).

Habitat within the study area	Habitat code	Occurring within the footprint of the *Proposed Road Development*	Occurring within the wider study area
Mesotrophic Lakes	FL4	No mesotrophic lake features occur within the footprint of the *Proposed Road Development*	✓
Dystrophic Lakes	FL1	Only one small lake classified as dystrophic occurs within the study area, this lies adjacent to, but not within, the footprint of the *Proposed Road Development*	✓
Turloughs	FL6	No turlough habitats occur within the footprint of the *Proposed Road Development*; although potential groundwater connectivity to turlough systems at Springfield, downstream of the *Proposed Road Development* is noted.	✓
Eroding / depositing watercourses	FW1 / FW2	Both eroding and depositing sections of watercourses are crossed by the *Proposed Road Development*	✓
Drainage ditches	FW4	Drainage ditches are crossed by the *Proposed Road*	✓

Habitat within the study area	Habitat code	Occurring within the footprint of the *Proposed Road Development*	Occurring within the wider study area
		Development	
Improved agricultural grassland	GA1	Improved agricultural grassland occurs within the *Proposed Road Development*	✓
Amenity grassland	GA2	Amenity grassland occurs within the *Proposed Road Development*	✓
Wet grassland	GS4	Wet grassland occurs within the *Proposed Road Development*	✓
Dry meadows and grassy verges	GS2	Grassy verges along existing road corridors occur within the *Proposed Road Development*	✓
Marsh	GM1	Marsh occurs within the *Proposed Road Development*	✓
Reed and large sedge swamp	FS1	Reed and large sedge swamp does not occur within the footprint of the *Proposed Road Development*	✓
Raised bog / Cutover bog	PB1 / PB4	Raised bog which has been cutover occurs within the *Proposed Road Development* at Drumfin, due south of Lough Corran.	✓
Rich fen and flush	PF1	Rich fen and flush occurs within the *Proposed Road Development*, where the road corridor includes a small portion of the southern boundary of Lackagh Fen.	✓
Poor fen and flush	PF2	A small area of poor fen and flush occurs in close proximity to the *Proposed Road Development* at Aghalenane Lough	✓
Transition mire and quaking bog	PF3	Transition mire and quaking bog occurs within the Aghalenane / Ardloy wetland complex to the north of the *Proposed Road Development*. This habitat also occurs within the Toberscanavan Lough complex, the Lackagh Fen complex, the Boathole and Lough Corran complex and the Cuileencroobagh Complex, associated with cutover peat at Drumfin.	✓
Calcareous springs	FP1	Calcareous springs are associated with fen habitats at Lackagh Fen and the Aghalenane and Ardloy wetland complex and do not occur within the footprint of the *Proposed Road Development*	✓
Wet willow/alder/ash woodland	WN6	Wet willow/alder/ash woodland occurs within the footprint of the *Proposed Road Development* along the eastern margin of Toberscanavan Lough and at the Drumfin River crossing.	✓
Oak/ash/hazel woodland	WN2	Oak/ash/hazel woodland occurs within the *Proposed Road Development*	✓
Conifer Plantation	WD4	Conifer plantation occurs within the *Proposed Road Development*	✓
Immature woodland	WS2	Immature woodland occurs within the *Proposed Road Development*	✓
Scrub	WS1	Scrub occurs within the *Proposed Road Development*	✓
Hedgerows / treelines	WL1 / WL2	Hedgerows and treelines occur within the *Proposed Road Development*	✓
Exposed calcareous rock	ER2	Exposed calcareous rock occurs within the *Proposed Road Development*	✓
Stone walls	BL1	Stone walls occur within the *Proposed Road Development*	✓
Tilled land	BC3	Tilled land does not occur within the *Proposed Road Development*	✓

Habitat within the study area	Habitat code	Occurring within the footprint of the *Proposed Road Development*	Occurring within the wider study area
Spoil and bare ground	ED2	Spoil and bare ground occurs within the *Proposed Road Development*	✓
Buildings and artificial surfaces	BL3	Buildings and artificial surfaces occur within the *Proposed Road Development*	✓

12.3.2.1.1 *Mesotrophic lakes (FL4)*

The *Proposed Road Development* passes close to a number of small mesotrophic lakes including Toberscanavan Lough, Boathole Lough & Lough Corran, Aghalenane Lough and Ardloy Loughs. These sites have been the subject of detailed survey as part of the preparation of the current Ecology chapter; in addition to surveys undertaken by Cotton (2000, 2002) and as part of the County Sligo Wetlands Survey (Wilson *et al*., 2011). These wetland sites are evaluated as being of significant importance with regard to the complex of Annex I wetland habitats they support. With regard to the lakes themselves, open water in Ardloy & Aghalenane Loughs supports species such as yellow water-lily *Nuphar lutea* and white water-lily *Nymphaea alba*, with mare's-tail *Hippuris vulgaris*, bogbean *Menyanthes trifoliata* and water horsetail *Equisetum fluviatile* near the lake margin. All lakes in the study area were found to contain a reed fringe, with *Phragmites australis* dominating and *Cladium mariscus* occurring at Aghalenane Lough. Loughymeenaghan is a mesotrophic lake located to the west of the proposed road corridor, and due to the fact that there are no surface water pathways to this waterbody, where the lake is upstream of any potential impacts, it is determined to be outside of the zone of influence of the *Proposed Road Development*. Loughymeenaghan is identified as being of significant ecological importance and the outflow stream has been evaluated in terms of its importance in relation to fisheries and aquatic ecology, downstream within the study area.

Evaluation: Mesotrophic lakes within the study area are evaluated as being of county to national importance, with regard to the complex of wetland habitats integrally associated with these waterbodies.

12.3.2.1.2 *Dystrophic lakes and ponds (FL1)*

Cuileencroobagh Lough due south of the townland of Carrownagark was identified as a dystrophic lake by Wilson *et al*. (2011), broadly corresponding to the Annex I habitat 'Natural dystrophic lakes and ponds'. This small pond occurs within a complex of cutover bog, transition mire and reedbed habitats, surrounded by wet agricultural grassland and immature forestry plantation. It is considered that this particular example is degraded due to drainage with evidence of eutrophication in the land drains associated with the lake. Significant poaching and nutrient inputs from agriculture and forestry are likely factors in the current status of this waterbody.

Evaluation: Cuileencroobagh Lough is evaluated as being of county importance as it broadly corresponds to an Annex I habitat, this evaluation is directly related to the Annex I wetland habitats associated with the margins of this small lake.

12.3.2.1.3 *Turloughs (FL6)*

The Swallow Holes Complex which is located in the townland of Tawnagh, to the west of Ardloy, is an example of a Turlough system, with further, surface-water derived flooding also occurring. This habitat area is located at a distance to the north of the *Proposed Road Development*; however, as it is connected hydrologically, and potentially hydro-geologically, to the study area it is evaluated as a key ecological receptor.

Evaluation: The restricted distribution of turloughs has lead to their designation as a priority habitat under Annex 1 of the EU Habitats Directive (92/43/EEC) and are also protected under the EU Water Framework Directive (2000/60/EC) designated as Groundwater Dependent Terrestrial Ecosystems. Following direct consultation with the NPWS in October 2012 it was agreed that turlough habitats corresponding to the priority Annex I habitat type, which includes the Swallow Holes Complex wetland site, should be evaluated as being nationally important where they occur outside of designated Natura 2000 sites. The NPWS guidance on this issue takes account of the International importance of designated Natura 2000 sites at a European level, in line with the NRA (2009) guidance. Therefore a reduced evaluation of national importance for Annex I habitat types occurring outside of these sites of European importance was determined to be appropriate and applicable. The relative importance of these sites with regard to Co. Sligo, and indeed at a national level was further corroborated by the evaluations presented in the County Sligo Wetland Survey reports (Wilson *et al*., 2008-2011), with reference to the guidance provided by the NPWS.

12.3.2.1.4 *Eroding rivers (FW1) / depositing rivers (FW2)*

The proposed alignment requires the crossing of a number of watercourses within the study area. These watercourses contain both eroding and depositing conditions, taking account of their predominantly drained and channelised character within the agricultural landscape of the *Proposed Road Development*. Watercourses in the study area are described in detail in Section 12.3.3.5.

Evaluation: Rivers and watercourses within the study area are evaluated with regard to their function in supporting important aquatic and water-dependant ecological communities. Individual evaluations for each watercourse are provided in Section 12.3.3.5.

12.3.2.1.5 *Drainage ditches (FW4)*

Drainage ditches are found along field boundaries, draining low-lying areas of the study area. These linear habitats support a flora dominated by a small number of nutrient-loving species, mainly fool's water-cress *Apium nodiflorum*, water-cress *Roripppa nasturtium-aquaticum* and floating sweet-grass *Glyceria fluitans*. Duckweed *Lemna minor* and water mint *Mentha aquatica* are frequent. Emergent reeds and sedges were found to be common including *Typha* spp*., Phragmites australis, Sparganium erectum, Iris pseudacorus and Phalaris arundinacea.*

Evaluation: Drainage ditches are evaluated as being of local importance (lower value) within the study area. In instances where drainage ditches support important water dependant ecological communities, these are evaluated separately on their own merit.

12.3.2.1.6 *Improved agricultural grassland (GA1)*

For most of its length, the proposed route traverses improved and semi-improved agricultural pasture. A small number of fields comprise improved gleys which had been reseeded and are dominated by perennial rye-grass *Lolium perenne* (GA1-type). The greater proportion of permanent pasture is semi-improved, containing a diversity of grass species, and is closer to wet grassland (GS4), with wet soil conditions common and low levels of management. Perennial rye-grass is often present in low-moderate abundance, and the sward is generally dominated by a mixture of common and creeping bent-grasses *Agrostis capillaris*, *A. stolonifera*, meadow-grasses *Poa* spp., crested dog's-tail *Cynosuros cristatus* and Yorkshire fog *Holcus lanatus*; with white clover *Trifolium repens*. Soft rush *Juncus effusus* is locally abundant in many semi-improved pastures. Nutrient-loving agricultural weeds are present in most fields, varying from rare/occasional to locally abundant. These include species such as creeping and spear thistle *Cirsium arvense, C. vulgare*, nettles *Urtica dioica*, ragwort *Senecio jacobaea*, dandelion *Taraxacum* sp. and docks *Rumex* sp. Other weedy species which are found frequently to abundantly include common mouse-ear chickweed *Cerastium fontanum*, common sorrel *Rumex acetosa* and lesser stitchwort *Stellaria graminea*.

In drier areas the agricultural grassland habitat contains elements of the species-rich dry calcareous grassland (GS1) habitat type; however this is limited in extent comprising common calcareous grassland species associated with grazed hedgerow banks along the route, where it is dominated by red fescue *Festuca rubra* with species such as knapweed *Centaurea nigra*, selfheal *Prunella vulgaris*, lady's bedstraw *Galium verum*, ox-eye daisy *Leucanthemum vulgare*, fairy flax *Linum catharticum*, mouse-ear hawkweed *Pilosella officinarum*, spring sedge *Carex caryophyllea* and glaucous sedge *Carex flacca*, with abundant mosses.

Evaluation: Improved agricultural grassland within the study area is evaluated as being of local importance (lower value), as it is characterised by species-poor, managed habitat. Where greater botanical diversity occurs within the agricultural grassland, it is not considered such that it is of greater ecological value.

12.3.2.1.7 *Amenity grassland (GA2)*

Amenity grassland habitat within the study area is limited, associated with open lawns, recreational space and managed open ground. This habitat is generally species poor.

Evaluation: Amenity grassland is evaluated as being of local importance (lower value) within the study area.

12.3.2.1.8 *Wet grassland (GS4)*

Wet grassland is an abundant habitat type in this area of County Sligo, particularly in inter-drumlin hollows or on poorly-draining slopes. It forms mosaics with marsh, fen, bog and dry grassland habitats. Species diversity varies. The most frequently-found type is a species poor wet grassland in semi-improved pasture, dominated by soft rush *Juncus effusus*, with creeping bent *Agrostis stolonifera* and Yorkshire fog *Holcus lanatus* grasses.

The most common broad-leaved herbaceous species are creeping buttercup *Ranunculus repens*, lady's smock *Cardamine pratensis* and marsh thistle *Cirsium palustre*. Purple moor-grass *Molinia caerulea* is locally common, with Tufted hair-grass *Deschampsia cespitosa* also occurring within this habitat type. More diverse areas also support sharp-flowered rush *Juncus acutiflorus*, common sedge *Carex nigra*, glaucous sedge *Carex flacca*, devil's-bit scabious *Succisa pratensis*, common marsh bedstraw *Galium palustre*, horsetail species *Equisetum* spp., water avens *Geum rivale*, yellow flag *Iris pseudacorus*, meadowsweet *Filipendula ulmaria*, water mint *Mentha aquatica*, marsh ragwort *Senecio aquaticus* and lesser spearwort *Ranunculus flammula*.

Evaluation: Wet grassland habitat within the study area is evaluated as being of local importance (lower value) with regard to the species diversity recorded from this habitat type generally, being common in the wider countryside. Where this habitat supports important faunal communities such as the Marsh fritillary, it is these species that are evaluated as being of higher value. Wet grassland habitats supporting high densities of Devil's bit scabious were identified and surveyed during the dedicated Marsh fritillary surveys undertaken during the baseline ecological surveys.

12.3.2.1.9 *Dry meadows and grassy verges (GS2)*

Roadside verges within the study area were also characterised within the above botanical communities, which generally present a eutrophic flora dominated by tussocky grasses such as cock's-foot *Dactylis glomerata* and false oat grass *Arrhenatherum elatius*, with Yorkshire fog, nettles, cow parsley *Anthriscus sylvestris*, bush vetch *Vicia sepium* and tufted vetch *V. cracca*.

Evaluation: This habitat is evaluated as being of local importance (lower value) as it contains a diversity of species abundant and common in the wider countryside.

12.3.2.1.10 *Marsh (GM1)*

Usually found in association with low-lying wet grassland and lakeshore/fen habitats, marsh habitat within the study area is generally species-rich with yellow iris, lesser spearwort, marsh pennywort *Hydrocotyle vulgaris*, common valerian *Valeriana officinalis*, ragged robin *Lychnis flos-cuculi*, water avens *Geum rivale* and marsh cinquefoil *Potentilla palustris* some of the more common species.

Evaluation: Marsh habitat is evaluated as being of local importance (higher value) where it contains a high botanical diversity. Within the current study area it is often associated with Annex I fen habitat and included within wetland complexes.

12.3.2.1.11 *Reed and large sedge swamp (FS1)*

This habitat is primarily represented as a reed bed around the margins of lakes along the route. The reed beds are dominated by common reed *Phragmites australis* with *Sparganium erectum, Iris pseudacorus, Phalaris arundinacea* and *Typha* spp. also common. This marginal habitat represents a graduation from open water to wet grassland/marsh and fen habitat common on the landward side. Botanical diversity was found to be particularly high at the Aghalenane/Ardloy Loughs complex, with *Cladium mariscus* also recorded; corresponding to the priority Annex I habitat 'Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*'.

Evaluation: Reed and large sedge swamps within the study area are generally associated with wetland habitats of significant ecological importance. Reedbeds dominated by *Phragmites australis* occurring in isolation are evaluated as being of local importance (lower value), while those occurring within wetland complexes such as at Aghalenane and Ardloy Loughs are evaluated within the context of the wetland.

12.3.2.1.12 *Raised bog (PB1) / Cutover bog (PB4)*

A topography dominated by drumlins, in a region of high rainfall, typically leads to development of peaty soils in wet inter-drumlin hollows and low-lying, poorly draining areas, as well as on lake margins where fen peat can accumulate. Sufficient accumulation raises the upper layers of peat above the water-table, whereupon it becomes a primarily rain-fed raised bog system. Areas which would correspond to a raised bog habitat are found to the south of Boathole Lough and Lough Corran and their outfall stream, and under coniferous woodland at the minor road (L1502-32) in the townland of Cloonlurg. Raised bog also occurs at Carrownagark associated with the Cuileencroobagh Lough wetland. All raised bog areas within the road alignment have been found to have been cut or harvested and are classified as cutover bog. This habitat is also recorded from the margins of Lackagh Fen. Elements of cutover bog are found at Drumderry/Cloonymeenaghan in mosaic with wet and dry grasslands and basin peats.

Evaluation: Cutover raised bog occurring within the study area of the *Proposed Road Development* is evaluated as being of local importance (higher value) to county importance, taking cognisance of the variance in species diversity, current levels of degradation and recovery. Peatland habitats associated with cutover bog, where they occur in the context of wetland habitat complexes are evaluated taking account of the importance of the overall complex.

12.3.2.1.13 *Rich fen and flush (PF1)*

Fens are peat-forming systems fed by ground/surface waters; rich fens are at least mildly base-rich. Lackagh Fen and Ardloy & Aghalenane Loughs are two areas of good quality Annex I Alkaline fen habitat within the study area. In addition to surveys undertaken for the current Ecology chapter, both areas were also surveyed as part of the County Sligo Wetlands Survey (Wilson *et al*., 2011) and are listed as Co. Sligo Biodiversity Sites comprising good examples of these habitats. Alkaline fen habitat also occurs around the shoreline of Toberscanavan Lough and the Lough Corran / Boathole Lough complex. Loughymeenaghan was also surveyed as part of the County Sligo Wetlands Survey (Wilson, 2011) and as a wetland complex was evaluated as being internationally important with regard to the presence of Annex I habitats including Alkaline fen and Transition mire, in addition to priority Annex I Tufa forming springs which occur within the wetland complex.

Evaluation: Taking account of the quality of the Annex I fen habitat at Lackagh and Aghalenane and Ardloy Loughs, occurring in mosaic with other Annex I habitat types; these fen habitats within the study area are evaluated as being of national importance. This evaluation is further informed by the evaluation presented in the County Sligo Wetlands Survey Reports (Wilson *et al*.; 2008-2011) and taking account of consultation with the NPWS.

12.3.2.1.14 *Poor fen and flush (PF2)*

Poor fen habitat occurs as part of the alkaline fen and transition mire complex at the south-western side of Aghalenane Lough. This habitat lies adjacent to an area of infill dominated by wet agricultural grassland.

Evaluation: Poor fen habitat at this location is evaluated as being of local importance (higher value) and it is associated with the wider fen/wetland complex at Aghalenane.

12.3.2.1.15 *Transition mire and quaking bog (PF3)*

Transition mire and quaking bog habitat corresponding to the Annex I habitat 'transition mires and quaking bogs' was recorded at the following wetland sites: Toberscanavan Lough, Lackagh Fen, Aghalenane and Ardloy Loughs, Boathole Lough and Lough Corran and also at Cuileencroobagh Lough. This habitat occurs in the above areas within small pockets or depressions within historical cutover raised bog and also as developing alkaline fen with a calcareous groundwater influence, along lakeshore margins.

Evaluation: Good examples of this habitat occurring within the study area, in association with wetland complexes of other Annex I and priority Annex I habitats are evaluated as being of national importance, at Toberscanavan Lough, Lackagh Fen and Aghalenane and Ardloy Loughs. This evaluation is further informed by the County Sligo Wetlands Survey Reports (Wilson *et al*.; 2008-2011) and taking account of consultation with the NPWS. Transition mire (quaking bog) habitat, within the context of cutover raised bog due south of Boathole Lough at Drumfin is evaluated within the context of this wetland habitat complex, as is the case for Cuileencroobagh Lough.

12.3.2.1.16 *Calcareous springs (FP1)*

The limestone geological influences in the study area result in a calcareous hydrogeological character. Groundwater seeps and springs occurring in the study area were found to be associated with peaty soils, predominantly within transition mire / alkaline fen areas and tufa formation was found to be common. Calcareous precipitation was found to be very common within the study area, occurring within depressions caused by tractor tyres and animal trails in wet grassland habitats, as well as in areas of fen / peat with a good bryophyte flora. Well developed tufa formations were recorded at Lackagh Fen, with more diffuse Tufa forming springs recorded within the Aghalenane and Ardloy Loughs Complex. Following a detailed bryological survey of these two areas, it was confirmed that the calcareous springs in these areas corresponded to the priority Annex I habitat 'Petrifying springs with tufa formation (*Cratoneurion*)'. The results of this spring survey (Denyer, 2012) are detailed in a separate report, presented in Appendix 12.8, Volume 4 of the EIS.

Evaluation: Tufa forming calcareous springs within the study area are identified as priority Annex I habitats and are evaluated as being of national importance, in the context of the complex of Annex I habitats occurring at the Lackagh Fen and Aghalenane and Ardloy Loughs areas.

12.3.2.1.17 *Wet willow/alder/ash woodland (WN6)*

Where this habitat type occurs along the margins of Toberscanavan Lough and the banks of the Drumfin River adjacent to an area of coniferous woodland, this semi-natural habitat type corresponds to the priority Annex I habitat 'Alluvial forests with alder (*Alnus glutinosa*) and ash (*Fraxinus excelsior*)(*Alno-Padion, Alnion incanae, Salicion albae*)'. The alluvial woodland at Toberscanavan Lough is bounded to the east by the existing N4 corridor and to the west by the lakeshore. Alder dominates this habitat, with ash and willow species occurring with some sycamore. The Drumfin River crossing location includes a small stand of willow carr habitat (approximately 0.5ha.) dominated by eared and grey willow *Salix aurita, S. cinerea*, with occasional ash *Fraxinus excelsior*. Beech and mature conifers occur at the southern perimeter of this woodland where elevated ground is drier. Greater tussock sedge *Carex paniculata* is locally abundant. Small areas of wet willow scrub and willow carr woodland with some alder or birch occurs associated with the wet transition mire and peatland habitats within the study area. This habitat is evaluated as WN6 where it is located within a predominantly wetland habitat.

Evaluation: Wet willow/alder/ash woodland is evaluated as being of local importance (higher value) within the study area of the *Proposed Road Development*, taking account of its limited extent within the study area, outside of the habitat area associated with the Toberscanavan Lough wetland complex.

12.3.2.1.18 *Oak/ash/hazel woodland (WN2)*

Stands of broadleaved woodland on dry or elevated ground within the study area were found to be dominated by ash *Fraxinus excelsior*, with hazel *Corylus avellana* and the non-native sycamore *Acer pseudoplatanus* occurring frequently. No large or significant oak/ash/hazel woodland occurs within the route corridor of the *Proposed Road Development*.

Evaluation: Woodland habitat within the study area is not extensive but where it occurs it is evaluated as being of local importance (higher value).

12.3.2.1.19 *Conifer plantation (WD4)*

A large, mature coniferous plantation dominated by Sitka spruce *Picea sitchensis* with pines *Pinus* sp. occurs in the townland of Cloonlurg, planted on cutover bog habitat. This habitat area is crossed by the route of the *Proposed Road Development*. Ground flora within the plantation is poor, due to dense shading. Elements of the peatland flora are found in the more open areas with young trees. The area is crossed by numerous deep, peaty drains.

Evaluation: Conifer plantation within the study area is evaluated as being of local importance (lower value) with regard to its botanical diversity and habitat value. The importance of this area for fauna is evaluated separately.

12.3.2.1.20 *Immature woodland (WS2)*

Immature woodland plantation occurs within the realignment corridor at Kingsbrook, due south of Carrownagark on an elevated, south facing slope. This immature plantation is dominated by beech and larch with some bramble and willow scrub occurring and is approximately 6 years old.

Evaluation: Immature woodland is evaluated as being of local importance (lower value) with regard to its botanical diversity.

12.3.2.1.21 *Scrub (WS1)*

A few small areas of scrub are found on or adjacent to the proposed road corridor. Three main types were found: Scrub associated with improved agricultural grassland and dominated by blackthorn *Prunus spinosa*, gorse *Ulex europaeus* and bramble *Rubus fruiticosus* spp. agg.; hazel *Corylus avellana* dominated scrub on steep ground; and willow dominated scrub occurring either in association with wet grassland or wet peatland habitats. Additional species recorded in scrub habitats included hawthorn *Crataegus monogyna*, ivy *Hedera helix* and wild rose *Rosa canina*. Grey willow was the most abundant species in wet scrub areas. Ground flora abundance and diversity in scrub depends on factors such as light availability and grazing pressure. The ground

flora in dense scrub in this survey was found to be poor in species diversity, though some notable species were found.

Evaluation: Scrub habitat within the study areas was found to represent pockets of semi-natural habitat within a broadly agricultural landscape and is evaluated as being of local importance (higher value).

12.3.2.1.22 *Hedgerows (WL1) and treelines (WL2)*

Hedgerows along the alignment tend to have been planted on vegetated banks, which in some cases have been built up over loose stones. In some instances where the banks are eroded revealing their structure, it appears that a dry stone wall or loose assemblage of stones from the adjacent fields has first been built, then covered with earth and planted with the hedgerow. Where the hedgerows are open or with a thin base, and grazed, the banks support a dry grassy flora. The hedgerows along the route are dominated by hawthorn, with occasional blackthorn and gorse. Earth banks (BL2) feature within many of the field boundaries on the route. In most cases they are dominated by hedgerow which has been planted on top or to one side of the bank. Bramble and ivy *Hedera helix* are abundant, and ground flora comprises species such as hart's-tongue fern *Phyllitis scolopendrium*, barren strawberry *Potentilla sterilis*, wood avens *Geum urbanum*, herb robert *Geranium robertianum*, violets *Viola* sp. and primrose *Primula* sp.Treelines (WL2) dominated by ash were most frequently recorded within treeline and hedgerow habitats. Non-native conifer treelines and/or broadleaves were recorded from the route associated with dwellings and residential land boundaries.

Evaluation: Hedgerows and treelines within the study area comprise a well connected network of semi-natural habitats within the context of the agricultural landscape and are of importance as wildlife corridors. They are therefore evaluated as being of local importance (higher value).

12.3.2.1.23 *Exposed calcareous rock (ER2)*

A very small area of exposed limestone was found at Carrownagark, at the northern side of the existing local road, overgrown by hazel scrub and with a poor ground flora dominated by mosses. This limestone area was found to have been significantly degraded during the period of the current study (2006-2012). Limestone outcrop is also found at a few other locations on the route, where it supports elements of calcareous grassland flora.

Evaluation: Exposed calcareous rock is evaluated as being of local importance (higher value) as it has the potential to support a specific, calcareous flora.

12.3.2.1.24 *Stone walls (BL1)*

A small number of dry stone walls are found along the route. These support a low diversity of typical wall species, mainly ferns. In some cases these form a boundary with hedgerows and have become overgrown by the hedgerows.

Evaluation: Stone walls within the study area are evaluated as being of local importance (lower value) in terms of their habitat and botanical value.

12.3.2.1.25 *Tilled land (BC3)*

The agricultural land within the study area is dominated by grassland pasture; however one area of tilled land was recorded during the 2012 survey to the north of the existing local road L1502-32 at Cloonlurg.

Evaluation: Tilled and disturbed ground is evaluated as being of local importance (lower value).

12.3.2.1.26 *Spoil and bare ground (ED2)*

Areas of spoil, disposed construction and demolition waste and fill and bare ground within the study area were recorded along the line of the proposed road corridor, associated with human disturbance impacts.

Evaluation: Spoil and bare ground areas are evaluated as being of local importance (lower value).

12.3.2.1.27 *Buildings and artificial surfaces (BL3)*

Built structures within the study area including houses, agricultural buildings and paved surfaces are included within this habitat category.

Evaluation: Buildings and artificial surfaces are evaluated as being of local importance (lower value) within the study area with regard to their habitat value.

12.3.2.2 Rare and Protected Plant Species

The *N4 Realignment Cloonamahan to Castlebaldwin Constraints Study Ecological Report* was compiled by Dr. Don Cotton, the county botanical recorder for Sligo, who has compiled a database of species in the county over a number of years, and who has noted the presence of any rare species in the area surveyed for that study. The current widely available database for plant records in Ireland is found on the searchable CD-ROM of the *New Atlas of the British and Irish Flora* (Preston *et al.,* 2002), which contains records up to 2000. Data for Ireland is currently recorded in 10 km squares. By searching the database it is possible to extract a list of notable plants recorded from any 10 km square, or a number of 10 km squares. The likelihood of their occurrence in habitats in that square can then be assessed in addition to their occurrence on the proposed alignment; as well as their listing in the Red Data Book for vascular plants (Curtis & McGough 1988) and the Flora (Protection) Order (1999). The National Biodiversity Data Centre records (www.biodiversityireland.ie) for protected flora, which includes the rare and protected flora database managed by the NPWS, were also searched. The only record of note was the occurrence of the Small white orchid (*Pseudorchis albida*), a species listed on the Flora Protection Order (1999). This species has been recorded from the Bricklieve Mountains and also from Ballysadare Bay; at a distance from the footprint of the *Proposed Road Development*. According to the Biodiversity Ireland database, there are no records of rare or protected flora from within the study area of the *Proposed Road Development*. It is considered that of the habitats occurring within the study area, the most likely areas to support protected flora would be within the high diversity alkaline fen habitats such as at Lackagh or Aghalenane/Ardloy Loughs; botanical surveys at these locations were therefore carried out. The Red Data listed (Curtis & McGough, 1988) Round-leaved Wintergreen *Pyrola rotundifolia* was recorded from the transition mire habitat at Aghalenane Lough, to the south of and outside the *Proposed Road Development.* Additional bryophyte species *Rhizomnium pseudopunctatum* and *Campyliadelphus elodes* were recorded associated with calcareous Tufa forming springs at Lackagh Fen Complex, with the former also recorded at Aghalenane Lough Complex; both species are listed as 'Near Threatened' in the Irish bryophyte Red Data Book (Lockhart *et al*., 2012).

12.3.3 Fauna

The Wildlife Acts 1976 and 2000 protect most of our native fauna, while the Birds and Natural Habitats Regulations (2011) seeks to protect the most sensitive and threatened species. In addition the EU Water Framework Directive (2000/60/EC) provides additional protection to both water quality and aquatic habitats. This section provides a summary of the findings of the ecological surveys undertaken during the period 2005 to 2013 for the *Proposed Road Development*. Important features identified within the study area with regard to individual faunal groups are presented in separate Figures referred to in each section. Mapping showing locations of importance with regard to mammal species is presented in Figures 12.3.1 to 12.3.8, Volume 3 of the EIS.

12.3.3.1 Non-volant Mammals

Table 12.6 presents a list of mammals recorded previously or expected to occur within the study area of the proposed N4 Collooney to Castlebaldwin Realignment; adapted from data held by the Irish Biodiversity Data Centre (www.biodiversityireland.ie, accessed August 2013) and from Hayden & Harrington (2001). Overall, a total of 15 non-volant mammal species have been recorded, or can be expected to be present, within the study area.

12.3.3.1.1 *Badger (Meles meles)*

Badger *Meles meles* is present throughout the survey area and a small number of badger setts are affected by the *Proposed Road Development*. Badger populations in Ireland have been reviewed in the report '*Conservation and management of the European badger*' edited by Griffiths & Thomas (1997). Badgers occur throughout the Republic of Ireland and are most common in areas such as Kilkenny and Louth, but much less so in areas such as Counties Longford, Galway and Sligo. In the mid-1990s it was estimated that around 200,500 adult badgers comprising of approximately 34,000 social groups were present in the country. This equated to an overall density of 0.46 badger setts/km^2. Badger sett densities in County Sligo are generally in the range of 0.2-0.39 setts/km^2; among the lowest in Ireland.

The badger is protected in Ireland under the Wildlife Acts 1976 and 2000. Despite protection, the illegal killing of badgers is widespread and common. Badger death due to vehicle road collisions are also thought to be significant. Badgers have been identified as a reservoir of bovine TB, and the law permits the culling of c. 900 badgers each year in the Republic. A breakdown of numbers of badger setts by category recorded, and directly affected, by the proposed N4 realignment is given in Table 12.7. Up to nine separate territorial social groups were identified as being potentially active within the study area. The location and brief description of each community is provided in Table 12.8. The mammal surveys undertaken for the *Proposed Road Development* over the period 2006-2013 have identified a significant decrease in badger activity within the study area, specifically in relation to setts and territories identified during the initial and follow-up non-volant mammal surveys of 2006, 2009, 2010, 2012 and most recently in 2013. It was found that a number of previously active and inactive dwellings forming communities along the *Proposed Road Development* were no longer in existence with a significant reduction in the number of dwellings. This is considered to be attributed to a number of factors observed in the study area including management of hedgerows by landowners and poaching of suitable hedgerow corridors by cattle, direct persecution of badgers and also the combined effect of successive wet summers between 2006 and 2012, leading to wet ground conditions in low-lying areas within the study area. The general habitats within the study area, dominated by wet grassland and heavy, wet agricultural grassland are evaluated as being of sub-optimal potential for badger; however, where communities occur, these dwellings are assessed as being of local importance (higher value).

Table 12-6: List of non-volant mammals recorded or expected to occur within the study area of the Proposed Road Development; protection status (Marnell, 2009) and preferred habitat types are included.

Common name	Scientific name	EU HD	RDB	WA	Bern	Preferred habitat type(s)	Geographic distribution
Otter	*Lutra lutra*	II, IV	NT	P	II	Watercourses, coast	Widespread
Badger	*Meles meles*	-	LC	P	III	Woodland, agricultural landscapes, diverse.	Widespread
Fox	*Vulpes vulpes*	-	LC	-	-	Diverse	Widespread
Irish Hare	*Lepus timidus hibernicus*	V	LC	P	III	Grassland, heathland, bog	Widespread
Rabbit	*Oryctolagus cuniculus*	-	-	-	-	Diverse	Widespread
Hedgehog	*Erinaceus europaeus*	-	LC	P	III	Woodland, scrub, hedgerow	Widespread
Pine Marten	*Martes martes*	V	LC	P	III	Woodland, scrub	Mainly west and midlands
Pygmy Shrew	*Sorex minutus*	-	LC	P	-	Diverse	Widespread
Red Squirrel	*Sciurus vulgaris*	-	NT	P	-	Woodland	Widespread
Irish Stoat	*Mustela erminea hibernica*	-	LC	P	-	Diverse	Widespread
Fallow Deer	*Dama dama*	-	LC	P	-	Woodland	Widespread
Wood mouse	*Apodemus sylvaticus,*	-	LC	-	-	Diverse	Widespread
House mouse	*Mus (musculus) domesticus*	-	LC	-	-	Diverse	Widespread
Brown rat	*Rattus norvegicus.*	-	-	-	-	Diverse	Widespread
American mink	*Mustela vison*	-	-	-	-	Diverse	Widespread

- *EU HD - EU Habitats Directive (Council Directive 92/43/EEC)* II - Annex II animal and plant species, IV – Annex IV animal and plant species, V – Annex V animal and plant species.
- *RDB - Red Data Book Category*: NT – Near Threatened, LC – Least Concern.
- WA - Wildlife Act (1976) & Wildlife (Amendment) Act (2000): P - Protected species
- *Bern* – Bern Convention (1979) *'Convention on the Conservation of European Wildlife and Natural Habitats'.*

Table 12-7: Breakdown of badger setts by category recorded along the corridor of the Proposed Road Development. Satellite setts include both subsidiary and outlier setts.

Sett category	Number in surveyed area	Number in direct line of realignment
Active main setts	3	1
Active annexe / satellite setts	6	2
Inactive setts	6	3
Total	15	6

Table 12-8: Description and location of badger setts recorded historically during 2006-2013; along and near the corridor of the Proposed Road Development.

Badger Community	Location	Description
Cloonamahan	Located 50m west of existing N4 in agricultural grassland.	No longer exists
	Located to the west of the existing N4 corridor, due south of Cloonamahan	No longer exists
	Located west of the existing N4, to the north of the access road to the HSE centre	Active outlier sett.
	Located to the south of the access road to the HSE centre, on the west side of the existing N4	Active outlier sett. Signs of recent activity
Drumfin	Located in scrub at the corner of the peatland complex.	Active outlier sett with single entrance.
	Located along hedgerow boundary, to the north of the local road (L-5502-0).	Inactive, single entrance outlier sett.
Cloonlurg	Located to the north of the Ballymote Road (L-1502-32). Within the footprint of the *Proposed Road Development*.	Inactive badger sett with two entrances. Signs of recent activity.
	Located at the western side of the coniferous plantation at Cloonlurg	Active main sett with nine entrances in a raised area of peat within the coniferous plantation. Extensive activity within this area.
	Located at the western side of the coniferous plantation at Cloonlurg	Active annexe sett with three entrances to the south of the main sett.
Carrownagark	A number of setts north of Carrownagark and to the east of the Drumfin River.	Active and inactive setts recorded during 2006-2010, now found to no longer exist.
	Located in line of proposed N4 on southern side of Carrownagark hill. In the line of the proposed road corridor.	Active outlier sett, two entrances.
	Located to the south of Carrownagark, along the hedgerow. In the line of the proposed road corridor.	Inactive, single entrance outlier sett. Recently used.
Kingsbrook	Located in hedgerow to the west of Lough Aghalenane.	Inactive sett recorded during 2006-2010 now no longer exists. Extensive badger activity recorded due northwest on elevated ground within the immature plantation.
Ardloy	A number of setts due north of the existing N4 alignment at Ardloy. Located within the proposed alignment and the SR/BP Type 01-No.1 spoil repository site.	Active and inactive setts recorded during 2006-2010 now found to no longer exist.
Tawnagh	Hill to the north of the proposed structure at Ardloy, immediately north of the proposed alignment.	Active sett. Three entrances.
	Located to the south of the above sett in the line of the proposed road corridor.	Active sett. One entrance.

Badger Community	Location	Description
	Annex sett recorded in 2010. Located on elevated ground, south of the farmhouse; due south of the main sett listed above.	Now no longer present.
Drumderry	Located in scrub at corner of field boundary	Active main sett. Three entrances.
	Located along same hedgerow, due southwest.	Inactive, single entrance sett in the line of the road corridor.
	Annexe sett recorded at the southwestern corner of the ringfort, adjacent to a recently constructed house.	Active annexe sett. One entrance.
Castlebaldwin	Due east of Castlebaldwin, within the CPO line of the local road realignment (L-1403-0).	Inactive single entrance dwelling, not recently used.
	Elevated ground to the south east and southwest of Castlebaldwin village contained badger dwellings during the 2006-2010 surveys Hill to the west of Castlebaldwin village (hedgerow south of school).	Three badger dwellings previously recorded due south of Castlebaldwin were found to no longer exist during the 2012 survey.

12.3.3.1.2 *Otter (Lutra lutra)*

The otter is listed in Annex II and Annex IV of the EU Habitats Directive and is protected under the Irish Wildlife Acts 1976 and 2000 and is evaluated as being Near Threatened in the most recent Red Data list for mammals (Marnell *et al*., 2009). A widespread Irish species, otters are frequently found along rivers and lakes within the study area. During species-specific surveys for otter within the study area, footprints and spraints were found along the Drumfin River and the Turnalaydan Stream during the 2013 survey, confirming findings from the previous surveys undertaken between 2005 and 2012. Otter activity including trails and sprainting were also recorded along the southern margin of Aghalenane Lough. These findings suggest that otters use the loughs in the study area to some degree. Habitats for otter in the study area are rated locally important (higher value).

12.3.3.1.3 *Pine Marten (Martes martes)*

Pine marten has been recorded from the general study area, but no evidence of the species was recorded during the survey period and habitat for this species is sub-optimal along most of the route. Unsubstantiated, anecdotal records of sightings of these species were recorded during the survey period and were confirmed by the NPWS Regional Ecologist. Suitable habitat for this species does occur within the wider study area. In general, the study area is deemed to be of local importance (higher low value) for pine marten.

12.3.3.1.4 *Irish Stoat (Mustela erminea hibernica)*

Irish stoat, a protected species under the Wildlife Acts 1976 and 2000, is likely to occur within the study area, with suitable habitat and an abundance of prey species; however, none were recorded during the survey period. This species is evaluated as being of local importance (higher value).

12.3.3.1.5 *Hare (Lepus timidus hibernicus)*

The Irish hare *Lepus timidus hibernicus* is present within the survey area and was recorded throughout the study area during the fieldwork period. The Irish hare is protected under the Wildlife Acts 1976 and 2000. The study area contains some optimal habitat for the Irish hare and this species is evaluated as being of local importance (higher value) within the study area.

12.3.3.1.6 *Additional mammal species*

The fallow deer *Dama dama* is present in the wider study area, particularly in the Markree Demesne to the north of the *Proposed Road Development* corridor. No signs of the deer were recorded along the corridor during the survey period. The red squirrel (*Sciurus vulgaris*) is listed as Near Threatened on the updated Irish Red Data List (Marnell *et al.,* 2009). This species is protected under the Wildlife Acts (1976 and 2000). No red squirrels were recorded during the field survey element of the current study. Other species present along the corridor are thought to include pygmy shrew *Sorex minutus*, hedgehog *Erinaceous europaeus*, wood mouse *Apodemus sylvaticus*, house mouse *Mus (musculus) domesticus* and brown rat *Rattus norvegicus*. Hedgehogs and shrews are protected under the Wildlife Acts (1976, Amendment 2000). Fox *Vulpes vulpes* is widespread

and common. Fox dens were found at a number of locations throughout the proposed route corridor and foxes were seen occasionally during the survey. Rabbits *Oryctolagus cuniculus* are present throughout the survey area. The American Mink *Mustela vison* is common within the study area. The study area of the *Proposed Road Development* is of local importance (lower value) for the above species.

12.3.3.2 Bats

All Irish Bats are internationally protected by the Bonn Convention 1992 (Agreement on the Conservation of Bats), the Bern Convention 1982 and the Habitats Directive (92/43/EEC of 21 May 1992). In Ireland these species are protected under the Birds and Natural Habitats Regulations (2011) and the Wildlife (Amendment) Act 2000. All potential bat roosts recorded in the study area were noted. Bats are typically associated with bridges, older buildings, waterbodies and hedgerows. Suitable waterbodies are present near the proposed route, but few suitable roosting locations were observed. Potential roosts include older dwellings along local roads and mature trees within the agricultural landscape. The following species have been previously recorded in the OS 10 km grid squares where the *Proposed Road Development* is located:

- Common pipistrelle (*Pipistrellus pipistrellus*): This is an abundant and widely distributed species known to forage along hedgerows, woodland edges, gardens and urban areas near streetlamps.
- Soprano pipistrelle (*P. pygamaeus*): This pipistrelle is also abundant and widespread in Ireland and has similar habitat requirements. This species favours woodland and hedges along the edges of water bodies.
- Natterer's bat (*Myotis nattereri*): This is a rare species and likes woodland and mature hedgerow habitats. This species has been previously recorded roosting in Behy Bridge on the Drumfin River.
- Brown long-eared bat (*Plecotus auritus*): This is a woodland species and the general lack of deciduous woodland in the study area makes it unsuitable for use by this species.
- Daubenton's bat (*Myotis daubentonii*): This bat has been recorded previously along the Unshin River and has been found roosting in bridges along the Drumfin River. It is likely to use the river corridors and lakes in the study area for foraging
- Leisler's Bat (*Nyctalus leisleri*): This bat species is known to forage over open deciduous and coniferous woodland and in areas of scrub. They are also known to forage in parkland and suburban areas. Some suitable, albeit sub-optimal, habitat for this species occurs along the route corridor. Leisler's bat populations in Ireland are of international importance.

A number of detailed bat surveys have been carried out for the *Proposed Road Development*, with the most recent survey conducted in June 2013. A comprehensive survey was also carried out from October 2005 to June 2006 to establish the value and significance of the corridor of the *Proposed Road Development* and its surroundings for bats. These surveys incorporated preparatory desk research, roost and habitat surveys, and the use of bat detectors to record and count bats. A further bat survey was conducted during early September 2010 to confirm the status of bat activity and roost sites within the study area. An Anabat bat detector was used for the 2010 and 2013 surveys, in conjunction with heterodyne bat detectors. A detailed account of the bat survey methodology and results is presented in the 'Flora and Fauna: Bat Report', Appendix 12.4, in Volume 4 of the EIS.

A car-based survey following Roche *et al.* (2005) was also undertaken during 2010 and again in 2013 along the existing N4 road corridor and local roads crossed by the proposed route. In general, a relatively low diversity and abundance of bats was recorded in the study area. Bats recorded in the survey include soprano pipistrelle, common pipistrelle, Natterer's bat, and Daubenton's bat. Soprano pipistrelle was the most common species recorded during the current survey, followed by the Common pipistrelle. Natterer's and Daubenton's bats were recorded in small numbers in limited areas; principally along wooded river corridors away from the proposed road corridor, while records of Leisler's bats were restricted to the northern end of the *Proposed Road Development*. In general, a low level of activity was recorded along the entire length of the road corridor. Possible and confirmed roost sites were recorded at individual buildings at the northern end of the route, within and adjacent to the realignment. Additionally, individual mature trees within the study area were identified as having roosting potential. Foraging activity was recorded to be concentrated around the mature trees and hedgerows at the above locations. Soprano pipistrelles were observed flying overhead and/or foraging in and around trees/hedgerows surrounding the complex of farmhouses (Cloonlurg House) on the Ballymote Road (L-1502-32). These buildings will not be directly affected by the *Proposed Road Development*, as they are over 300m west of the road corridor. The habitats in the areas surveyed are, in many cases, quite suitable for this species. Previous bat surveys have noted the dominance of this species over its close relative, the Common Pipistrelle, in the North West (Roche *et al.*, 2005).

It is likely that the Markree Demesne to the north of the study area is used by Long-eared bats, but only pipistrelle species were recorded from this locality during the survey period (2005/06 - 2013). Moderate activity was observed along the Drumfin River corridor, and bats recorded included Soprano pipistrelles and Daubenton's bats. High levels of activity of soprano pipistrelle and Daubenton's bats were previously observed at Lisconny Bridge, on the Unshin River, to the east of the *Proposed Road Development*, outside of the zone of influence of the development.

The bat survey confirmed that the corridor of the *Proposed Road Development* is not a particularly important area for bats, in fact the results of the 2013 survey determined that bat activity has declined across the study area when compared to previous years' results. This is mainly due to the absence of high quality bat habitats in this area of County Sligo; in addition to the successive poor summer weather prior to 2013; and possibly also due to the ongoing loss of hedgerow habitat in the wider landscape. The *Proposed Road Development*, in the main, does not significantly impact on commuting, foraging or roosting sites for bats. The majority of the proposed route corridor is located in areas currently occupied by agricultural and wet grassland. These areas are of low value to the bat populations present both in terms of habitat and insect prey production. No hibernation roosts were recorded during the current survey; however a number of dwellings and farm buildings will be affected by the *Proposed Road Development*. Some of these buildings are locally important summer/night roosts for bats and mitigation measures will be required.

12.3.3.3 Birds

The status of birds in Ireland has been classified by Birdwatch Ireland and the Royal Society for the Protection of Birds (RSPB) as detailed in '*The status of birds in Ireland: an analysis of conservation concern, 2008-2013*' (Lynas *et al.*, 2007). Birds on the Red List are of high conservation interest in Ireland and are priority species for conservation action; while amber listed birds are of medium conservation concern. A wintering bird survey was commissioned for the current assessment (October 2011 to March 2012); taking account of the proximity of the *Proposed Road Development* to the designated Lough Arrow SPA to the south of the realignment. The results of this survey are presented in the 'Flora and Fauna: Winter Bird Survey' Appendix 12.5, in Volume 4 of the EIS. In Table 12.9 a list of bird species on the amber or red lists recorded in the study area are provided. Only one species on Annex I of the EU Birds Directive (2009/147/EC) was recorded previously in the study area - Whooper Swan *Cygnus cygnus.* This record was from Boathole Lough and Lough Corran. There are no Special Protection Areas (SPAs) as designated under the EU Birds Directive (2009/147/EC) as transposed into Irish law directly affected by the proposed route corridor. The current bird survey data builds on the findings of previous bird surveys in the vicinity of the proposed road corridor undertaken by Cotton (2000).A breeding bird survey within the study area of the *Proposed Road Development* was carried out during June 2013. The lands within the proposed alignment and the wider zone of influence were found to be characterised by improved agricultural grassland of local importance (lower value) with regard to breeding birds. No curlew or lapwing were recorded, where the managed and rank grassland habitats were evaluated as being broadly unsuitable for these species. Species recorded from within this agricultural grassland environment included linnet, chaffinch, meadow pipit and lesser redpoll (associated with pockets of woodland).

The wetland habitats within the study area were surveyed over two days with the Boathole/Lough Corran area identified as supporting the greatest diversity of breeding birds. All wetland habitats, including the marginal habitats, contained broadly similar species with Mallard, Coot, Moorhen, Little grebe, Mute swan, Reed bunting, Whitethroat, Blackcap, Sedge warbler, Willow warbler and Lesser redpoll recorded at all locations. Four pairs of Tufted duck and Grasshopper warbler were also recorded at Boathole Lough, with water rail recorded at Boathole Lough and at Loughymeenaghan.

Birds of prey were found to be scarce within the study area during the current breeding bird survey. A single Sparrowhawk was recorded, as was a Long-eared owl on a post adjacent to the minor road south of Boathole Lough. It is considered that the owl may range within a 1km territory and that its nest site may be in any old crow's nest in a mature tree of which there are many. Nest sites move around from year to year.

The only Red listed species recorded in the study area, Black-headed gull, was feeding in the area but almost certainly came from breeding colonies on Lough Allen. The majority of Amber listed species were associated with the small lakes in the area, the most important of which is Boathole Lake.

Table 12-9: Bird species and their conservation status recorded in the study area during the breeding bird survey.

Species	Conservation Status	Hedgerow/Scrub	Lakes	Open fields
Mute Swan	Amber		*	
Mallard	Green		*	
Tufted Duck	Green		*	
Grey Heron	Green		*	
Little Grebe	Amber		*	
Sparrowhawk	Green	*		
Kestrel	Amber	*		*
Pheasant	Green			*
Moorhen	Green		*	
Water Rail	Amber		*	
Coot	Amber		*	
Common Snipe	Amber			*
Black-headed Gull	Red			*
Common Gull	Amber			*
Lesser Black-backed Gull	Amber			*
Wood Pigeon	Green	*		*
Collared Dove	Green	*		*
Long-eared Owl	Green	*		
Sand Martin	Amber		*	*
House Martin	Amber		*	*
Swallow	Amber		*	*
Meadow Pipit	Green			*
Pied Wagtail	Green		*	*
Wren	Green	*		
Dunnock	Green	*		
Robin	Green	*		
Stonechat	Green			*
Blackbird	Green	*		
Song Thrush	Green	*		
Mistle Thrush	Green	*		
Chiffchaff	Green	*		
Willow Warbler	Green	*		
Blackcap	Green	*		
Whitethroat	Green	*		
Grasshopper Warbler	Amber	*	*	

Species	Conservation Status	Hedgerow/Scrub	Lakes	Open fields
Sedge Warbler	Green	*	*	
Common Starling	Amber			*
Coal Tit	Green	*		
Blue Tit	Green	*		
Great Tit	Green	*		
Skylark	Amber			*
Magpie	Green	*		*
Jackdaw	Green			*
Rook	Green	*		*
Hooded Crow	Green	*		*
House Sparrow	Amber	*		
Chaffinch	Green	*		*
Linnet	Amber	*		*
Goldfinch	Green	*		*
Lesser Redpoll	Green	*		
Siskin	Green	*		*
Bullfinch	Green	*		
Reed Bunting	Green	*	*	*

Table 12-10: Bird species and their conservation status recorded in the study area during the wintering bird survey.

Species		Conservation Status
Coot	*Fulica atra*	Amber List
Cormorant	*Phalacrocorax carbo*	Amber List
Cuckoo	*Cuculus canorus*	Amber List
Great Crested Grebe	*Podiceps cristatus*	Amber List
Lapwing	*Vanellus vanellus*	Red List
Redpoll	*Acanthis flammea*	Amber List
Sand Martin	*Riparia riparia*	Amber List
Snipe	*Gallinago gallinago*	Amber List
Stonechat	*Saxicola torquata*	Amber List
Swallow	*Hirundo rustica*	Amber List
Teal	*Anas crecca*	Amber List
Tufted Duck	*Aythya fuligula*	Amber List
Whinchat	*Saxicola rubetra*	Amber List
Whooper Swan	*Cygnus cygnus*	Amber List / Bird's Directive (Annex I)
Wigeon	*Anas penelope*	Amber List

Species		Conservation Status
Pochard	*Aythya farina*	Amber List
Sand Martin	*Riparia riparia*	Amber List
Snipe	*Gallinago gallinago*	Amber List
Stonechat	*Saxicola torquata*	Amber List
Teal	*Anas crecca*	Amber List
Wigeon	*Anas penelope*	Amber List
Curlew	*Numenius arquata*	Red List
Red-breasted Merganser	*Mergus serrator*	Amber List

12.3.3.4 Reptiles and Amphibians

The common frog (*Rana temporaria*) occurs throughout the proposed route and is likely to breed in the many drains and wetland habitats in the study area. Frogs were regularly encountered during the fieldwork surveys. The Smooth newt (*Triturus vulgaris*) was recorded from the land drain at the northern end of Lackagh Fen during surveys in 2010 and it is considered likely that this species is more widespread within suitable habitats in the study area. The breeding sites of both frogs and newts are protected under the Wildlife Act (1976, Amendment 2000) and the common frog is also listed on Annex V of the EU Habitats Directive (1992). It is considered unlikely that the viviparous lizard (*Lacerta vivipera*) occurs.

12.3.3.5 Aquatic ecology and fisheries

This section provides the results and evaluation of the aquatic ecology and fish surveys undertaken for the *Proposed Road Development*. A detailed assessment of these ecological features are presented in the '*Flora and Fauna: Aquatic Ecology and Fish Report*' Appendix 12.6, in Volume 4 of the EIS. The survey site locations and aquatic ecological feature maps are presented in Figures 12.4.1 to 12.4.8 of Volume 3 of the EIS.

12.3.3.5.1 *Protected Aquatic Fauna (Annex II species)*

The status and occurrence of aquatic fauna listed on Annex II of the EU Habitats Directive (1992) in the study area are discussed as follows:

12.3.3.5.1.1 *White-clawed crayfish*

The white-clawed crayfish is the only freshwater crayfish recorded in Ireland. Populations of the species in the rest of Europe have declined dramatically and Ireland is seen as a unique stronghold for this species in a European context (Reynolds 1998). It is classified as vulnerable and rare in the IUCN Red List and is protected in Ireland under the schedules of the Wildlife Act 1976. It is also listed in Annexes II and V of the Habitats Directive (1992). It is generally considered to be widespread in lakes and rivers which are underlain by Carboniferous limestone, or its derivative - glacial drift (Reynolds, 1998). According to Reynolds (1998) crayfish occur in Hydrometric Area 35, which includes the Ballysadare catchment. White-clawed crayfish were recorded from the Unshin River within suitable habitat downstream of the study area of the *Proposed Road Development*. A single white-clawed crayfish was recorded on the Turnalaydan Stream (Lough Corran outflow) during the baseline aquatic survey in 2006. This species was recorded at only one location, the Markree Demesne Stream during detailed crayfish sampling surveys undertaken in 2013.

12.3.3.5.1.2 *Brook lamprey*

The brook lamprey is the smallest of the three lamprey species native to Ireland and it is the only one of the three species present within the study area. This species is non-parasitic and spends all its life in freshwater (Maitland & Campbell 1992). The brook lamprey is listed both in Appendix II of the Habitats Directive and Appendix III of the Bern Convention. Kurz and Costello (1999) reported Brook lamprey ammocoetes in a tributary of the Unshin River. Electrical fishing surveys conducted during 2006 and most recently in 2013 recorded juvenile lamprey populations at the Turnalaydan Stream (Lough Corran outflow) site and also in the Markree Demesne Stream.

12.3.3.5.1.3 *Atlantic salmon*

The Atlantic salmon is listed under Annexes II and V of the EU Habitats Directive and Appendix III of the Bern Convention. It an economically important species and the Ballysadare catchment is of international importance for salmon. Salmon spawning and nursery areas are present within the study area. Juvenile salmon were present at both sites investigated on the Drumfin River and also on the site surveyed on the Turnalaydan Stream during the June 2013 electrical fishing survey, confirming the findings of the 2006 baseline survey. Juvenile Atlantic salmon were also recorded in the Markree Demesne Stream during the June 2013 electrical fishing survey.

12.3.3.5.2 *Overview of affected catchments*

The study area of the *Proposed Road Development* lies within the Unshin River Catchment and its source Lough Arrow at the upstream end. This catchment is located in EPA hydrometric Area 35. General aspects of this catchment and its fisheries are discussed below. The Unshin River lies within the Ballysadare Catchment (OS Catchment No: 116) which includes the Ballysadare River and its tributaries the Owenmore and the Unshin. The overall Ballysadare catchment drains a catchment of 652 Km^2, which includes Lough Arrow and Templehouse Lake. The Ballysadare River itself is 3.5km long and flows down from Collooney into Ballysadare Bay. The Unshin River drains Lough Arrow and flows for 23km to join the Ballysadare River at Collooney. The Office of Public Works (OPW) estimates the Unshin River catchment area to be 202km^2, inclusive of Lough Arrow and the Unshin River. A detailed assessment of the hydrological character of the study area is set out in the Hydrological and Hydrogeological Assessment, Chapter 14 of the EIS. The following assessment relates to the ecological features of interest within the aquatic environment of the study area.

Water quality in the Unshin River is generally good, rated as 'Good Status' (Q4) throughout the study area, with the exception of the most upstream section, at the Lough Arrow outflow which was rated 'Moderate Status' (Q3-4) by the EPA during the 2012 monitoring survey. The downstream stations on the Unshin, below the study area of the *Proposed Road Development*, and the lower reaches of the Ballysadare River were rated 'High Status' (Q4-5) during the EPA's monitoring in 2012. The Drumfin River was rated as 'Good Status' (Q4) during the 2012 EPA monitoring at Closkeybeg Bridge (St. 0800), this site is approximately 1.5 kilometres downstream of Behy Bridge, where biological sampling was undertaken for the current report. The upstream monitoring station on the Drumfin River at Kilmorgan Bridge was most recently surveyed by the EPA in 2006 and was found to be 'Moderate Status' (Q3-4). None of the additional minor watercourses within the study area are monitored by the EPA.

According to McGinnity *et al.* (2003) the Ballysadare catchment has a total of 3.326m m^2 of fluvial habitat of which 2.215m m^2 is used by salmon. Most of the fluvial habitat in the catchment is located in low gradient areas, with over 1.980 m^2 of habitat classified in the lowest gradient class (Rosgen 4) and 0.019 m^2 in the highest gradient class (Rosgen 1). The fishing rights for the migratory fish (salmon, sea trout and eels) of the Ballysadare catchment were vested by an Act of Parliament to the Cooper family of Markree Castle in 1837 (O'Reilly, 2004). The Coopers then built fish passes at the impassable Ballysadare Falls and introduced salmon to the system. Despite this, most of the fishing in the river system still takes place below the 'Butt' of the falls at Ballysadare.

There is a small run of spring salmon in the river from April, while the peak grilse run comes in June-July. Sea trout fishing in the catchment is generally limited to the estuary of the river below Ballysadare. There are several noted angling pools between Ballysadare and Collooney Bridge. This section of the river provides the best of the salmon fishing on the area of the river upstream of the falls (O'Reilly, 2004). Brown trout angling is also important on the Ballysadare River with trout up to 1.5 kg occasionally caught. The Unshin is a limestone river and provides good brown trout fishing, in parts, all the way up to Lough Arrow (O'Reilly, 2004). It is overgrown downstream of Lough Arrow, with deep water. Down at Markree Castle the banks are more open and it holds good stocks of trout from 300g to 1 kg and sometime larger. According to O'Reilly (2004) the best of the fishing is from the end of April to mid-June, after which it becomes weeded.

12.3.3.5.3 *Results of the fish stock assessment on affected watercourses*

The fish species recorded at each site investigated during the June 2013 electrical fishing survey of rivers affected by the *Proposed Road Development* are listed by site in Table 12.11. These watercourses have been subject to previous baseline surveys during 2006 and 2010. Based on the findings of the 2013 survey, it is evaluated that the aquatic environment, with regard to fish and fisheries has not significantly altered, with reference to the previous electrical fishing results from 2006. Overall, a total of seven species of fish were recorded; Atlantic salmon *Salmo salar*, Brook lamprey *Lampetra planeri*, Eel *Anguilla anguilla*, Brown trout

Salmo trutta, Three-spined stickleback *Gasterosteus aculeatus*, Rudd *Scardinius erythropthalmus* and Perch *Perca fluviatilis*. The Annex II listed White-clawed crayfish *Austropotamobius pallipes* was present in the Turnalaydan Stream and also in the Markree Demesne Stream. White-clawed crayfish were not recorded elsewhere within the study area, following specific surveys for the species in Lough Corran and Toberscanavan Lough. It is considered however that small numbers of White-clawed crayfish could occur in these loughs as well as their efferent streams. The results of the fish stock assessment carried out by Ecofact Environmental Consultants are provided in the '*Flora and Fauna: Aquatic Ecology and Fish Report*', included in Appendix 12.6 of Volume 4 of the EIS.

Table 12-11: Fish species recorded at each site investigated during the June 2013 electrical fishing survey of rivers affected by the proposed N4 Collooney to Castlebaldwin Realignment.

Site	Waterbody	Fish species
1	Markree Demesne Stream / Toberscanavan Lough outflow	Atlantic salmon *Salmo salar* Brown trout *Salmo trutta* Three spined stickleback *Gasterosteus aculeatus* Eel *Anguilla anguilla* Rudd *Scardinius erythropthalmus* Perch *Perca fluviatilis* Brook lamprey *Lampetra fluviatilis*
2	Toberscanavan Lough	Perch
3	Turnalaydan Stream, downstream of N4 crossing	Brook lamprey *Lampetra planeri* Atlantic salmon *Salmo salar* Brown trout *salmo trutta* Three spined stickleback *Gasterosteus aculeatus* Eel *Anguilla anguilla*
5	Turnalaydan Stream / Lough Corran inflow	Brown trout *Salmo trutta*
6	Drumfin River at Behy Bridge	Atlantic salmon *Salmo salar* Brown trout *Salmo trutta* Three spined stickleback *Gasterosteus aculeatus* Eel *Anguilla anguilla*
7	Drumfin River downstream of Kilmorgan Bridge.	Atlantic salmon *Salmo salar* Brown trout *Salmo trutta* Three spined stickleback *Gasterosteus aculeatus* Eel *Anguilla anguilla*
8	Springfield Stream/Loughymeenaghan outflow south of Swallow Hole	Three spined stickleback *Gasterosteus aculeatus*
9	Lissycoyne Stream ca. 1km east of Loughymeenaghan	Brown trout *Salmo trutta* Three spined stickleback *Gasterosteus aculeatus*
10	Drumderry Stream	Brown trout *Salmo trutta* Three spined stickleback *Gasterosteus aculeatus*
11	Tributary of the Drumderry Stream	Brown trout *Salmo trutta*

Both Atlantic salmon and Brook lamprey are also listed under Annex II of the EU Habitats Directive (1992). Juvenile salmon abundances are usually presented as numbers of fish per smolt rearing unit (100 per m^2). Salmon densities recorded at the quantitative sites investigated in the current study were 0.41 fish per m^2 (Drumfin River at Kilmorgan Bridge), 0.78 fish per m^2 (Drumfin River at Behy Bridge) and 1.27 fish per m^2 (Turnalaydan Stream).

The relative abundance of fish species recorded during the five site survey is presented in detail in the '*Flora and Fauna: Aquatic Ecology and Fish Report*', included in Appendix 12.6 of Volume 4 of the EIS. Overall a total of 402 fish were intercepted during the 2013 surveys, of which trout (n=198) and Atlantic salmon (n=136) were the most common. Salmon were present at both sites investigated on the Drumfin River and also on the sites surveyed on the Turnalaydan Stream (the Lough Corran outflow) and the Toberscanavan Lough outflow. Trout were present at all watercourse sites with the exception of the Lissycoyne Stream and Springfield Stream.

12.3.3.5.4 *Existing environment at individual aquatic areas*

The main waterbodies and watercourses that would be affected by the *Proposed Road Development* are described and evaluated on the basis of aquatic and riparian habitats, fisheries value and aquatic ecology. The presence of protected aquatic fauna species is also considered. The main rivers directly affected are the Drumfin River and the Turnalaydan Stream, the latter being the Lough Corran outflow stream. A number of other minor streams/drains would also be crossed. The affected rivers / streams are described below and a summary description and evaluation of these aquatic habitats is provided in Table 12.12. Total macroinvertebrate groups and aquatic macrophyte plants recorded at the selected aquatic areas are presented as species lists in Appendix 12.6, Volume 4 of the EIS.

The Unshin River will not be crossed by the *Proposed Road Development*, but could be indirectly affected, as the main line of the road would run within 300 m of this river and run-off from the road, or link roads adjacent to the watercourse, could enter this river via affected minor watercourses. No aquatic areas designated as Natura 2000 sites under the EU Habitats Directive (1992) would be directly affected by the proposal. All rivers affected by the proposal are currently crossed by the existing N4 road.

Habitat considerations for juvenile salmonids in streams and rivers include stream size and flow (Hatfield & Bruce, 2000), depth and gradient (Kennedy & Strange, 1986), substrate (Greenberg & Dahl, 1998), canopy (O'Grady, 1993) and engineering history of the river (O'Grady and Curtin, 1993). Habitat class at each site was rated using a habitat rating index (HRI). The index and descriptions used to represent habitat quality during the aquatic habitat survey are presented in Table 12.13. The index works on a scale of 1-5 where 1=Unsuitable, 2=Poor, 3=Satisfactory, 4=Good and 5=Excellent. A rating of "1" indicates that the ecologist carrying out the assessment regarded it as impossible that the stream could support salmonid fish in the relevant life stage. A rating of "1-2" indicates that it was regarded as possible but unlikely that the stream could support salmonid fish in the relevant life stage. In addition to habitat quality, the presence of salmonids at each site would also depend on present and historical water quality and accessibility of a given site to fish. For this reason the presence of obstacles to migration (i.e. weirs) downstream of each site were also considered.

Table 12-12: Description and evaluation of aquatic habitats within the zone of influence of the N4 Collooney to Castlebaldwin Realignment.

Waterbody	Aquatic habitat and evaluation	Fisheries value and evaluation	Presence of protected aquatic fauna	Overall evaluation of aquatic habitats
Markree Demesne Stream / Toberscanavan Lough outflow	Small modified stream with generalised aquatic flora community	Spawning nursery area and tributary of the Unshin River cSAC	Salmon, Brook lamprey, White clawed crayfish, Otter may also occur	*Local importance (higher value)*
Toberscanavan Lough	Important habitats with a high botanical diversity	Maybe of local fisheries value	Otters likely to occur, White clawed crayfish may occur	*County importance*
Boathole and Lough Corran	Ecologically sensitive areas with a diverse array of habitats.	Maybe of local fisheries value	Otters likely to occur, White clawed crayfish may occur	*County importance*
Turnalaydan Stream (Lough Corran Outflow)	Small drained river with gravel substrate and moderate naturalness	Spawning nursery area and tributary of Unshin River SAC.	Salmon, Otter, Brook lamprey, White clawed crayfish	*County Importance*

Waterbody	Aquatic habitat and evaluation	Fisheries value and evaluation	Presence of protected aquatic fauna	Overall evaluation of aquatic habitats
Unshin River	Important aquatic habitat supporting Annex I habitats and Annex II species, designated as a cSAC.	Important salmon and salmonid fishery and designated as a cSAC for aquatic ecological interests, therefore internationally important.	Salmon, Otter, Lamprey species, White clawed crayfish	*Internationally important*
Drumfin River (Behy Bridge)	Small river with cobble/gravel bottom and a high degree of naturalness. Good water quality.	Spawning nursery area and tributary of Unshin River SAC.	Salmon, Otter, Brook lamprey	*County Importance*
Drumfin River tributary	Small stream with generalised aquatic flora community.	No fisheries value.	None.	*Local importance (lower value)*
Aghalenane and Ardloy Loughs	Important habitats with a high floral diversity.	No fisheries value.	None	*Local importance (higher value)*
Lissycoyne Stream (Cleavry Lough outflow)	Minor drain with generalised flora community	No fisheries value.	None	*Local importance (lower value)*
Springfield Stream	Small stream with impoverished aquatic flora.	No fisheries value.	None	*Local importance (lower value)*
Drumderry Stream	Minor drain with generalised flora community	High fisheries value in its lower reaches. Spawning tributary for trout in Lough Arrow SAC.	Otter and maybe Brook lamprey	*Local importance (higher value)*
Drumderry tributary	Small stream with cobble/gravel substrates and semi-natural character. Good water quality.	Identified by IFI as a spawning tributary for trout in Lough Arrow SAC.	Possibly Otter and Brook lamprey	*Local importance (higher value)*
Lough Arrow	Large limestone lake with important aquatic flora community; lake habitat corresponds to Annex I 'Hard oligo-mesotrophic waters'	High fisheries value as a brown trout fishery	Otter, possibly Brook lamprey within the afferent streams.	*International importance (designated cSAC)*

Table 12-13: Habitat rating index (HRI) evaluations referred to during the aquatic habitat survey.

HRI	Value Habitat Description
1	Unsuitable
2	Poor
3	Satisfactory
4	Good
5	Excellent

Habitat has a key influence on the macroinvertebrate communities, which occur in rivers and streams. Also, individual macroinverterate species such as the Annex II listed white-clawed crayfish have specific habitat requirements. The habitats of aquatic areas within the study area were assessed in relation to macroinvertebrates and rated as being suitable or unsuitable for individual protected aquatic macroinvertebrates. General habitat quality for macroinvertebrate communities was rated as being Optimal, Suboptimal, Marginal or Poor with reference to a scheme developed by Barbour & Stribling (1991). This scheme is presented in Table 12.14.

Table 12-14: Physical habitat assessment of streams for their suitability for macroinvertebrate production (adapted from Barbour and Stribling, 1991).

Score	Optimal	Suboptimal	Marginal	Poor
	20	15	10	5
Bottom substrate	More than 60% of bottom is gravel, cobble, and boulders. Even mix of substratum size classes.	30-60% of bottom is cobble or boulder, may be dominated by one size class.	10-30% of substrata consists of large materials. Silt or sand accounts for 70-90%	Substrate dominated by silt and sand. Gravel, cobble and larger substrate sizes <10%.
Habitat complexity	A variety of types and sizes of material form a diverse habitat.	Structural type/size of material less than optimum, adequate cover still provided.	Habitat dominated by one or two structural components. Amount of cover is limited.	Monotonous habitat with little diversity. Silt and sand dominate reducing habitat complexity.
Pool quality	25% of the pools are as wide or wider than the mean stream width and area >1m deep.	<5% of the pools are >1m deep and wider than the mean stream width.	<1% of the pools are >1m deep and wider than the mean stream width. Pools present range very deep or very shallow.	Majority of pools are small and shallow. Pools may be absent.
Bank stability	Little evidence of past bank failure and little potential for future mass wasting into channel.	Infrequent or very small slides. Low future potential of slides.	Mass wasting moderate in frequency and size. Raw spots eroded during high floods.	Frequent or large slides. Banks unstable and contributing sediment.
Bank protection	Over 80% of stream bank surfaces are covered by vegetation, boulders, bedrock, or other stable materials.	50-80% of the stream banks covered with vegetation, cobble, or larger material.	25-50% of the stream bank is covered by vegetation.	<25% of the stream bank is covered by vegetation or stable materials.
Canopy	Vegetation of various heights provides a mix of shade and filtering light to water surface.	Discontinuous vegetation provides full shade to full exposure. Filtering shade occurs <6h/day.	Shading is complete and dense. Or filtering shade occurs <3h/day.	Water surface is exposed to full sun nearly all day long.

The habitat rating of the watercourses within the study area as habitats for aquatic invertebrates and salmonids (salmon and trout), following the evaluations above, is given in Tables 12.15 and 12.16 below.

Table 12-15: The rating of rivers and streams within the study area as habitat for aquatic invertebrates (from Barbour & Stribling, 1991).

Watercourse	Bottom substrate	Habitat complexity	Pool quality	Bank stability	Bank protection	Canopy	Overall	
Markree Demesne Stream	15	15	5	15	15	15	80	(Marginal)
Turnalaydan Stream	15	15	15	20	20	10	90	(Suboptimal)
Drumfin River (Behy Br.)	20	15	15	20	20	10	100	(Suboptimal)
Drumfin Tributary	5	10	5	20	20	10	70	(Marginal)
Lissycoyne Stream	10		5	20	20	10	75	(Marginal)
Springfield Stream	20	15	15	20	20	15	105	(Suboptimal)
Drumderry Stream	15	10	5	20	20	10	80	(Marginal)

Watercourse	Bottom substrate	Habitat complexity	Pool quality	Bank stability	Bank protection	Canopy	Overall	
Drumderry tributary	20	15	5	10	10	15	75	(Marginal)

Table 12-16: HRI rating of rivers and streams within the study area as habitats for salmonids (salmon and trout).

Watercourse	Spawning	Nursery	Rearing	Foraging
Markree Demesne Stream	2-3	3	3	3
Turnalaydan Stream	3	3	3	3
Drumfin River (Behy Br.)	3-4	3	3	3
Drumfin Tributary	1	1	1	1
Springfield Stream	2	2	2	1
Lissycoyne Stream	1	1	1	1
Drumderry Stream	1	1	1	1
Drumderry tributary	3	3	2	3

1=Unsuitable, 2=Poor, 3=Satisfactory, 4=Good and 5=Excellent

12.3.3.5.4.1 *Markree Demesne Stream, Toberscanavan Lough outflow*

Toberscanavan Lough is located in the townland of Cloonamahan, at the northern end of the *Proposed Road Development*. The proposed road runs on-line with the existing N4 corridor at this location and crosses the outflow from Toberscanavan Lough, known as the Markree Demesne Stream. Fish species recorded from this outflow stream during the 2013 fisheries survey included Atlantic salmon, brook lamprey, European eel, brown trout, three-spined stickleback, rudd and perch. Larvae of Ephemerellidae and Limnephilidae were present in fair numbers at the site examined on the Markree Demesne Stream while Pollution tolerant *Gammarus deubeni* was dominant. The *Proposed Road Development* requires widening of the existing N4 corridor and culvert replacement works at the Markree Demesne Stream crossing and directly adjacent to Toberscanavan Lough, giving rise to the potential for water quality impacts and downstream pollution in the absence of mitigation.

12.3.3.5.4.2 *Lough Arrow*

Lough Arrow is a large, limestone lake located at the head of the Unshin River system. It is a candidate SAC (Site Code 001673) and is one of the most important brown trout fisheries in Ireland. It is a spring-fed lake designated for the Annex I habitat 'Hard oligo-mesotrophic waters' (EU habitat code 3140); supporting the Annex II listed otter and a diversity of lakeshore habitats. It is listed as an SPA for the nationally important populations of wintering birds recorded within this site. Lough Arrow is located in the catchment of the *Proposed Road Development*, with a surface water connection between the proposed road route and the lake via the Drumderry Stream, but would not be directly affected by the proposal. At its nearest point the lake is over 1 km from the proposed road. It receives some drainage from the Drumderry Stream discussed below and would therefore be at risk from pollution via contaminated run-off/accidental spills. However, the distance of the lake from the road corridor coupled with the mitigation measures proposed will effectively avoid adverse affects on this internationally important waterbody.

12.3.3.5.4.3 *Unshin River*

The Unshin River, discussed previously, runs from Lough Arrow north to Ballysadare Bay, Co. Sligo. It is a candidate SAC and is one of the last undrained limestone rivers in Ireland. It contains important aquatic macrophyte communities, as well as populations of Annex II listed salmon, brook lamprey, white-clawed crayfish and otter. At its nearest point (at Doorly) the river is approximately 300 m from the proposed road corridor; however at this point it is at a greater distance than the existing N4. Along most of the route, the *Proposed Road Development* is more than 1 km away from the river. The Unshin River does however have a number of tributaries, which would be directly affected by crossings required by the proposed road. The Drumfin River is the largest tributary of the Unshin River directly affected by the *Proposed Road Development*.

This watercourse has poor instream physical diversity, probably due to the drainage history of the river and suffers from low summer flows. Some gravel has been placed in this river as part of rehabilitation works undertaken by IFI. Stocks of trout and salmon in downstream areas may be higher than those at Behy Bridge, taking account of the poor salmonid habitat recorded within the study area. The *Proposed Road Development* has the potential to give rise to indirect pollution affecting the Unshin River, via the influent tributaries (Turnalaydan Stream and Drumfin River) during both the construction and operation phases.

12.3.3.5.4.4 *Turnalaydan Stream*

This is the second largest watercourse directly affected by the *Proposed Road Development.* It flows from Lough Corran to meet the Unshin River at Lackagh. It is crossed via a bridge by the existing N4 at the townland boundary of Lackagh/Knocknagroagh. This watercourse is identified as an important spawning stream for salmon and trout downstream of the aforementioned bridge and the proposed crossing point. This river has been drained and channelised in the past and the banks are steep in many areas. The riparian vegetation is generally not very diverse. Willowherb (*Epilobium* sp.) and *common re*ed are common riparian plants along this channel while the aquatic vegetation consists primarily of *Glyceria fluitans, Apium nodiflorum and Sparganium erectum*. Enriched conditions near the existing N4 crossing at Lackagh/Knocknagroagh were noted by the presence of filamentous algae. The Turnalaydan Stream contains a rich macroinvertebrate community, with 17 families found. Pollution sensitive mayfly larvae of *Heptagenia sulphurea were recorded but w*ere greatly outnumbered by pollution tolerant larvae of mayflies such as *Baetis rhodani* and *Ephemerella ignita*. It is noted that White-clawed crayfish were recorded in this watercourse during the 2006 baseline survey; however, these were not observed during the detailed crayfish survey undertaken in June 2013.

12.3.3.5.4.5 *Boathole and Lough Corran*

These loughs are located to the west of Drumfin, they are connected to the Unshin River by the Turnalaydan Stream and this is large enough to facilitate movements of fish into the lakes. Boathole and Corran Loughs would not be directly affected by the *Proposed Road Development*. However, the proposed road passes within 50 m of this wetland complex. This would make this sub-catchment susceptible to pollution in the absence of mitigation measures.

12.3.3.5.4.6 *Drumfin River*

This Drumfin River rises on Bricklieve Hill, approximately 1.5 km west of Castlebaldwin, and flows in a south-easterly direction to join the Unshin River immediately below Coolbock Bridge. It is 7.5 km long and is classified as a second order stream. There is evidence of some drainage works in the past and the channel is entrenched. It is crossed by the existing N4 at Behy Bridge. Water quality in the watercourse was evaluated as Q3-4, Moderately Polluted equivalent to WFD moderate status during the 2013 survey. This stream is considered to be an important salmonid spawning and nursery river. It also has habitat potentially important for brook lampreys but this species was not recorded during electrical fishing in depositing areas deemed suitable for the species. Brown trout and Three spined-stickleback were recorded during the current survey assessment. The Drumfin River contains a diverse macroinvertebrate community, with pollution sensitive mayflies *Ephemera danica* and *Ecdyonurus dispar* among the benthic fauna recorded.

12.3.3.5.4.7 *Drumfin Tributary*

This is a minor tributary drain of the Drumfin River, which drains the forestry area upstream of Behy Bridge. This drain also has a connection to the afferent watercourses of Lough Corran. It is of no fisheries importance due to its small size and drained character, but may provide habitat for amphibians. A macroinvertebrate family diversity of 21 was recorded at this location. The assemblage included three species of mayfly at larval stage: *Ecdyonurus* sp., *Rhithrogena semicolorata* and *Baetis rhodani*. Stonefly larvae of *N. cinerea* and *Leuctra hippopus* were present. A wide range of Trichopterans were recorded with 5 families of cased and three families of caseless caddisfly larvae recorded. Less pollution sensitive cased species included *Halesus* sp. and *Potamophylax* sp. (Limnephilidae), *Agapetus fuscipes* of family Glossosomatidae and *Phryganea* sp. (family Phryganeidae). Pollution tolerant caseless species were *Hydropsyche siltalai, Rhyacophila dorsalis* and *Polycentropus kingi*. Molluscs recorded at this location included *Pisidium* sp. and *Bithynia tentaculata*. True fly larvae of *Dicronata sp.* was present and fair numbers of green chironomids were recorded.

12.3.3.5.4.8 *Aghalenane and Ardloy Loughs*

These loughs are connected to the Unshin River by a small stream that goes underground. This stream is approximately 0.5 m wide and has a mean depth of 0.3 m. It contains both riffle and glide habitat and the

aquatic vegetation are dominated by *Apium nodiflorum*. This stream has a poor macroinvertebrate fauna dominated by freshwater shrimps. Mayflies of the genus *Baetis* were common, while two species of caseless caddis fly larvae were recorded (*Polycentropus kingi* and *Wormaldia subnigra*). The Aghalenane and Ardloy Loughs and their efferent stream would not be directly affected by the *Proposed Road Development*. However, the proposed road passes within close proximity of these wetland habitats, making this sub-catchment susceptible to pollution in the absence of mitigation measures.

12.3.3.5.4.9 *Lissycoyne Stream*

This is another minor stream/drain due north of Castlebaldwin. From the results of the 2013 aquatic ecological surveys it is not of fisheries importance but may provide habitat for amphibians. It drains out of Cleavry Lough – a minor lake located to the west of Castlebaldwin.

12.3.3.5.4.10 *Springfield Stream*

This is a small stream which flows from Loughymeenaghan Lough to the 'Swallow Holes' at Tawnagh. It is crossed by the existing N4 at Ardloy Bridge and would be crossed by the *Proposed Road Development* 300m downstream of the existing crossing. This stream is a partially manmade watercourse, which extends back into Loughymeenaghan through a rock cut. Below the rock cut the stream is approximately 0.8 m wide with a mean depth of 20 cm. It is fast flowing and has not been drained or channelised, characterised by a gravel substrate. The aquatic vegetation is dominated by *Apium nodiflorum,* with some mosses also present. The Swallow Holes complex is a pond/marsh complex which provides inputs into local groundwater systems. Its principal input is the Ardloy Bridge stream. Vegetation on the margins of the complex includes Flag Iris, Bulrush and common reed. This watercourse is not of fisheries importance and it may partially dry up in the summer.

12.3.3.5.4.11 *Drumderry Stream (and its tributary)*

The Drumderry Stream is a minor watercourse located south of Castlebaldwin. It is crossed by the existing N4 in this area. The upper reaches of this watercourse directly south of Castlebaldwin are not of fisheries importance i.e. at the proposed crossing location. However, the channelised and drained nature of the watercourse at this location provides suitable habitat for Common frog *Rana temporaria*. This watercourse is evaluated as being of local importance (higher value) with particular reference to is character downstream of the Proposed Road Development and the value placed on this watercourse by IFI. To the south of Castlebaldwin minor first order tributary meets the Drumderry Stream; this watercourse is identified by IFI as an important spawning stream for Brown trout from Lough Arrow. This minor watercourse is evaluated as being of local importance (higher value). Mitigation measures to avoid significant impacts within these watercourses will be employed, particularly with regard to connectivity to Lough Arrow downstream.

12.3.3.6 Terrestrial invertebrates

A total of 33 species of butterfly have been recorded from Ireland. Of these, 26 species have been recorded from Co. Sligo. The majority of these species are common throughout Co. Sligo and there is no threat to their conservation status. However, according to survey results produced by Butterfly Ireland between 2000 and 2004, eight of these species could be classed as rare in Co. Sligo. The *Proposed Road Development* passes through a wide variety of habitat types, including improved grassland, wet grassland, fen, marsh, bog and forest. There is also an extensive network of hedgerows with reasonably well developed native shrubs and ground flora. These factors mean that the planned route corridor will disturb the natural habitats of some butterflies. In 2000, a survey of the area in the vicinity of the *Proposed Road Development* was undertaken by Cotton (2002). The eight species classified as rare in Co. Sligo are: the Dingy Skipper *Erynnis tages*, the Green Hairstreak *Callophrys rubi*, the Purple Hairstreak *Quercusia quercus*, the Small Blue *Cupido minimus*, the Holly Blue *Celastrina argiolus*, the Dark Green Fritillary *Mesoacidalia aglaja*, the Grayling *Hipparchia semele* and the Marsh Fritillary *Eurodryas aurinia.* Of these eight rare species, the only one that is afforded any protection under Irish or EU law is the Marsh Fritillary. This butterfly is a listed species in Annex II of the EU Habitats Directive due to its rapid decline throughout Europe and so it is of high conservation concern. Although it is widely recorded in Ireland, it generally exists in extremely localised colonies. It can be found in rough grassy meadows, damp wood edges, unimproved wet grassland, eskers and bogs. The larval food plant of the Marsh Fritillary is the Devil's bit scabious *Succisa pratensis,* and it will only be found in areas where this plant grows. The eggs of the Marsh Fritillary are laid in batches on the underside of leaves and after emergence the larvae spin a large web on the ground and dozens of them will hibernate together until the spring. The butterfly is on the wing during late May and June and it is single brooded.

During the ecological survey of the study area the larval plant food of the Marsh Fritillary, Devil's bit scabious (*Succisa pratensis*), was recorded from the following locations:

- Drumderry Bog
- Lough Corran
- Ardloy & Aghalenane Lough
- Lackagh Fen
- Kingsbrook and Kilmorgan Stream
- Cuilleencroobagh Lough

During the 2010 field survey, Marsh Fritillary butterfly larvae were recorded from wet grassland/fen habitats in the southern portion of Lackagh Fen and also on the western and southern sides of Aghalenane Lough. It is considered that populations of this butterfly within the study area are generally transitory and may potentially occur within any of the above wetland habitats, where Devil's bit scabious has been recorded as common. However, the NPWS have been monitoring regular populations of Marsh fritillary at Lackagh Fen Complex between 2010 and 2012. The majority of the study sites for this species at Lackagh Fen occur outside of the footprint of the alignment; however, the proposed access road at c. Ch. 4,000m does cross one of the identified breeding areas. This area has been identified as becoming less favourable for Marsh fritillary over the period 2010 to 2012, due to the development of rank, tall herb communities (dominated by Meadowsweet), which reduce the breeding potential at this site. The habitat for Marsh fritillary at Lackagh Fen is evaluated as 'Good Condition' to 'Good Condition (Rank).' This butterfly was also recorded from Cleavry Lough, which lies southwest of the existing N4, outside of the zone of influence of the *Proposed Road Development*. Specific mitigation for the protection of Marsh fritillary has been provided.

Three species of whorl snail occurring in Ireland are listed on Annex II of the EU Habitats Directive (1992); these are *Vertigo moulinsiana, Vertigo geyeri* and *Vertigo angustior*. There are records of *Vertigo geyeri* and *Vertigo angustior* from the 10km grid square to the north of the study area. Potential habitat for whorl snail species was identified within the study area, particularly within the wetland habitats identified as containing Annex I fen, transition mire and tufa spring formations.

A targeted molluscan survey was undertaken in November 2012, focussing on the calcareous spring habitats recorded at Lackagh Fen and at the Aghalenane and Ardloy Loughs Complex. The Annex II listed *Vertigo geyeri* was recorded from calcareous, Tufa forming springs within the transition mire/alkaline fen habitat mosaic at the south-western side of Aghalenane Lough. The results and conclusions of this survey are presented in Appendix 12.7, Volume 4 of the EIS. The *Vertigo geyeri* population at this location is of good quality, corresponding to populations designated within existing cSAC sites. Taking account of the Annex II status of this species, the Aghalenane population has been attributed an A rating, i.e. internationally important. It is noted that the survey was undertaken during November 2012 and provides a 'snap-shot' of the *Vertigo geyeri* population at this location. The evaluation of the population importance is based on what information is known about this species within County Sligo and nationally, with cognisance of the single site visit data available for the Aghalenane and Ardloy Loughs Complex site. During a spot-check site visit to the Aghalenane site in June 2013, it was evaluated that the Aghalenane Lough site remained suitable for *V. geyeri*; furthermore a single record of this species was identified from samples collected from fen habitat at the northern end of Loughymeenaghan. During field survey work undertaken during September 2010 two species of whorl snail, *Vertigo antivertigo* and *V. substriata*, were recorded from the northern end of Lackagh Fen, the Aghalenane / Ardloy Loughs Complex and also from land drains within Drumderry Bog. Both species are listed on the Red Data List of Non-marine molluscs as 'Vulnerable' and 'Near-Threatened' respectively.

12.3.4 Key ecological receptors

Following the methodology outlined in the NRA guidelines for ecological impact assessment (2009), the key ecological receptors identified within the zone of influence (i.e. within the affected areas of the current study area) are presented in Table 12.17 below.

Table 12-17: Identification of key ecological receptors within the zone of influence; based on the 'Guidelines for the Assessment of Ecological Impacts of National Road Schemes' (Rev.2, NRA 2009);

Key Ecological Receptor	Summary description of the ecological receptors	Evaluation of the ecological receptors
Designated sites	There are no designated sites within the corridor of the *Proposed Road Development*. The Unshin River cSAC and the Lough Arrow cSAC / SPA complex are identified as being within the zone of influence of the *Proposed Road Development*, due to surface	International importance

Key Ecological Receptor	Summary description of the ecological receptors	Evaluation of the ecological receptors
	water connections.	
Toberscanavan Loughs Complex	Mesotrophic lake with alder/ash wet woodland corresponding to priority Annex I 'Alluvial woodland', Annex I alkaline fen and reed fringe habitats.	National importance
Lackagh Fen Complex	Fen complex with Annex I Alkaline fen and transition mire habitats, priority Annex I Tufa-forming springs and high diversity marsh habitats also occur. Annex II listed Marsh fritillary butterfly also recorded.	National importance
Boathole Lough & Lough Corran	Mesotrophic lakes with associated alkaline fen and transition mire habitats, reed swamp and cutover raised bog habitats occur within the wetland complex to the southeast.	County importance
Ardloy & Aghalenane Loughs	Mesotrophic lakes with Annex I Alkaline fen and Transition mire habitats; priority Annex I Tufa-forming springs supporting Annex II *Vertigo geyeri*. Annex II listed Marsh fritillary butterfly also recorded.	International importance
Cuileencroobagh Lough	Small, degraded dystrophic lake with Annex I transition mire within a complex of cutover raised bog.	County importance
Swallow Holes Complex	Small groundwater connected wetlands corresponding to priority Annex I Turlough habitat. Reed swamp vegetation and wet grassland.	National importance
Marsh (GM1)	Species-rich marsh	Local Importance (higher value)
Wet willow/alder/ ash woodland (WN6)	Wet willow/alder/ash woodland corresponding to priority Annex I 'Alluvial woodland habitat' at the margin of Toberscanavan Lough and along the Drumfin River corridor; also occurring in isolated pockets on wet ground as willow scrub.	Local importance (higher value)
Oak/ash/hazel woodland (WN2)	Occurring in isolated pockets on dry and elevated ground within the study area	Local importance (higher value)
Scrub (WS1)	Semi-natural hawthorn, blackthorn, gorse and hazel scrub within the context of an agricultural landscape	Local Importance (higher value)
Hedgerows (WL1) / Treelines (WL2)	Well connected hedgerows and treelines with fair-good structure, providing a wildlife corridor function within the study area.	Local Importance (higher value)
Exposed calcareous rock (ER2) at Carrownagark.	Species-poor limestone outcrop, significantly degraded.	Local Importance (higher value)
Badger	Badger groups and active territories identified along the entire length of the proposed route.	Local Importance (higher value)
Otter	Otter activity associated with the Drumfin River, with commuting habitat within other watercourses and some foraging habitat within the lakes outside of the zone of influence.	Local Importance (higher value)
Pine marten, Stoat and Irish Hare	Potential Pine marten and Irish stoat populations and confirmed Irish hare occurring within the zone of influence	Local Importance (higher value)
Bats	Six bat species recorded associated with woodlands, treelines and buildings within the study area	Local Importance (higher value)
Atlantic salmon	Salmon (Annex II listed species) recorded from the Drumfin River and other watercourses where juvenile habitat available	Local Importance (higher value)
White-clawed crayfish	This Annex II species was recorded from the Drumfin River and is present within the study area	Local Importance (higher value)
Brook lamprey	Annex II listed species, present in the Drumfin River and likely to occur within other watercourses in the study area	Local Importance (higher value)
Marsh fritillary	This Annex II listed butterfly occurs within Alkaline fen and marsh habitat within the study area, associated with its food plant	County Importance

Key Ecological Receptor	Summary description of the ecological receptors	Evaluation of the ecological receptors
	Devil's bit scabious (*Succisa pratensis)*.	
Vertigo geyeri	This is an Annex II species recorded from the transition mire/alkaline fen habitat mosaic at the Aghalenane and Ardloy Loughs wetland complex.	International Importance.

12.4 Description of Likely Impacts

12.4.1 Assessment of Impact Type and Magnitude

When characterising impacts, wherever possible reference is made to the following parameters:

- Magnitude relates to the quantum of an impact, for example the number of individuals affected by an activity;
- Extent should also be predicted in a quantified manner and relates to the area over which the impact occurs;
- Duration is intended to refer to the time during which the impact is predicted to continue, until recovery or re-instatement;
- Reversibility should be addressed by identifying whether an impact is ecologically reversible either spontaneously or through specific action;
- Timing/Frequency of impacts in relation to important seasonal and/or life-cycle constraints should be evaluated. Similarly, the frequency with which activities (and concomitant impacts) would take place can be an important determinant of the impact on receptors.

It is necessary to ensure that any assessment of impact takes account of impacts associated with construction and operation; direct, indirect and synergistic impacts; and those that are temporary, reversible and irreversible. The criteria for assessment impact magnitude, impact type and impact significance are provided in Tables 12.18 and 12.19.

The following terms are defined when quantifying duration: based on the '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes*' (Rev.2, NRA 2009)

- Temporary: up to 1 year;
- Short-term: from 1-7 years;
- Medium-term: 7-15 years;
- Long-term: 15-60 years;
- Permanent: over 60 years.

Table 12-18: Criteria for assessing impact significance; based on the 'Guidelines for the Assessment of Ecological Impacts of National Road Schemes' (Rev.2, NRA 2009)

Impact magnitude	Definition
No change:	No discernible change in the ecology of the affected feature.
Imperceptible Impact:	An impact capable of measurement but without noticeable consequences.
Slight Impact:	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate Impact:	An impact that alters the character of the environment that is consistent with existing and emerging trends.
Significant Impact:	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound Impact:	An impact which obliterates sensitive characteristics.

Table 12-19: Criteria for assessing impact quality; based on the 'Guidelines for the Assessment of Ecological Impacts of National Road Schemes' (Rev.2, NRA 2009)

Impact type	Criteria
Positive impact:	A change which improves the quality of the environment (for example by increasing species diversity; or

Impact type	Criteria
	improving the reproductive capacity of an ecosystem; or removing nuisances; or improving amenities).
Neutral	A change which does not affect the quality of the environment.
Negative impact:	A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem, or damaging health or property or by causing nuisance).

12.4.2 'Do nothing' impact

In the absence of the current proposal the integrity of the existing environment within the zone of influence of the *Proposed Road Development* would be considered to continue in line with existing trends. The fen habitats within the study area are surrounded by improved and semi-improved pasture, some of which has been reclaimed through drainage and fertilization. They are not designated for nature conservation and so are vulnerable to changes in land management, particularly drainage.

While it is difficult to predict the ecological succession or human interference at these areas in the future; it is likely that the fen habitats will continue to infill in natural succession, eventually becoming peatland systems, unless they are reclaimed or otherwise interfered with. Wet woodland may be felled for timber, though this is unlikely given the very wet nature of the terrain in which it is found.

In the event that the N4 Collooney to Castlebaldwin realignment is not progressed, traffic levels would continue to increase above and beyond the capacity of the road. Traffic build-ups and increasing use of other local roads and alternative routes would also be expected. This would increase disturbance of adjacent habitats and increase the risk of animal collisions on this and other roads, evaluated as potentially leading to significant impacts in the local context.

12.4.3 Construction Phase Impacts

12.4.3.1 Designated areas

As the *Proposed Road Development* is not located within any area designated for nature conservation, there will be no direct impacts on any such site as a result of the construction and operation of the *Proposed Road Development*. However the *Proposed Road Development* is located within close proximity to a number of designated areas giving rise to the potential for indirect impacts. Elements of the *Proposed Road Development* (i.e. link roads) also lie in close proximity to the boundary of the Unshin River cSAC. Hydrological connections via the tributaries of the Unshin River and Lough Arrow gives rise to the potential for water quality impacts and a deterioration in the aquatic environment potentially affecting the water-dependant qualifying interests of these designated Natura 2000 sites. The potential for effects on designated sites are evaluated as being certain in the absence of mitigation. Impacts at a scale that would have an adverse effect on the conservation status of the relevant qualifying interests are considered as likely, in the absence of mitigation.

12.4.3.2 Habitats and flora

Ecologically sensitive habitats i.e. habitats corresponding to those listed on Annex I of the EU Habitats Directive (1992) lie within the footprint and directly adjacent to the *Proposed Road Development*. Direct impacts affecting limited areas of these habitats will arise during the construction of the *Proposed Road Development* with potential indirect effects on Annex I habitats identified as requiring targeted design stage mitigation.

12.4.3.2.1 *Lackagh Fen Complex*

The *Proposed Road Development* has been designed to minimise effects on Annex I habitats existing without designated conservation sites. No Annex I habitats occurring within designated SAC sites lie within the zone of influence of the *Proposed Road Development*. Further amendments to the route have been undertaken to minimise landtake within the Lackagh Fen complex, where the road route predominantly follows the line of improved agricultural grassland and wet grassland to the west of the Lackagh Fen complex. The proposed alignment will result in the direct loss of two small sections of Rich Fen and Flush (PF2) along the western edge of Lackagh Fen and an additional area at the southern end of the fen adjacent to the local access road. The total area of Rich Fen and Flush (PF2) habitat within the footprint of the proposed road is approximately 0.0029km^2. Transition mire habitat lies directly adjacent to but not within the footprint of the *Proposed Road Development* at Lackagh. Three areas of tufa forming springs were recorded within the Lackagh Fen complex;

these springs are located at a distance of 86m, 110m and 160m from the *Proposed Road Development*, from north to south and would not be subject to direct impacts. It is important to note that the small area of tufa formation at the southern end of the site lies approximately 20m from an existing infill / hardstanding area which will be affected by the realignment of the local road junction. Construction works associated within the *Proposed Road Development* will therefore be within 10-15m of this spring area. The area of Annex I habitat within the alignment has been reduced to the minimum direct impact possible taking account of the sensitivity of this wetland complex, with regard to its ecological evaluation and with cognisance of the fact that it is in private ownership and is not a designated conservation site.

The construction of the proposed road will give rise to the potential for indirect impacts affecting the hydrology and hydrogeology of the Lackagh Fen Complex with particular cognisance of the presence of calcareous springs within the transition mire and fen habitat, corresponding to the priority Annex I habitat Tufa forming springs. Specific and targeted design stage mitigation measures have been developed, as outlined in section 4.8.5 of Chapter 4, to reduce indirect construction phase impacts on these habitats.

12.4.3.2.2 *Boathole Lough & Lough Corran Complex*

The *Proposed Road Development* crosses the southeastern corner of this site within cutover raised bog habitat at Drumfin at a distance from the Lough Corran. Localised pockets of transition mire were recorded forming within the depressions of this cutover peat. Wet grassland habitat, at the south-eastern extremity of this habitat complex will also be crossed. Drainage ditches that are hydrologically connected to Lough Corran will be crossed by the *Proposed Road Development.* The potential for disruption of flow or water quality impacts with regard to release of pollutants into the lake system as a result of construction are evaluated as likely and may potentially be significant in the local context; however with the implementation of design stage mitigation as set out in Chapter 4 of the EIS, such impacts will not occur.

12.4.3.2.3 *Aghalenane and Ardloy Loughs Complex*

The *Proposed Road Development* follows an arc from the north west of Aghalenane Lough, around the south-western side of the lake along the southern boundary of the Alkaline fen/transition mire habitats present within the wetland complex at this location. The realignment has been selected and further amended to avoid landtake within this wetland complex to the greatest degree possible. An area of transition mire extends to the west of Aghalenane Lough and lies adjacent to but outside of the boundary of the *Proposed Road Development*. The proposed alignment bears east around the southern side of the wetland complex, it follows the boundary of the wetland, predominantly on elevated agricultural and wet grassland. Tufa forming springs within the Aghalenane and Ardloy Loughs Complex are calculated as being at distances of 80-90m due north of the proposed road line and will not be directly affected by the construction of the road.

During the construction phase of the works there is the potential for indirect impacts affecting the hydrological and hydrogeological regime due to excavation and fill works in proximity to the wetland complex. Run-off and discharges also give rise to the potential for water quality impacts affecting the hydrologically dependant botanical communities at this site. Specific and targeted design stage mitigation measures have been developed as outlined in Section 4.8.5 of Chapter 4 to reduce indirect construction phase impacts on these habitats.

12.4.3.2.4 *Cuileencroobagh Lough Complex*

The route passes approximately 60m to 70m to the west of this wetland site at its nearest point, on elevated agricultural grassland. The *Proposed Road Development* includes a constructed wetland attenuation pond to the north of the Cuileencroobagh Lough which will be located on degraded cutover bog and wet grassland habitats, not directly associated with the wetland complex. This area is affected by significant poaching by cattle and the development of gorse scrub. The transition mire and peatland habitats within Cuileencroobagh Lough Complex will not be affected by the *Proposed Road Development*.

12.4.3.2.5 *Swallow Holes complex*

The turlough habitat at the Swallow holes complex in the townland of Tawnagh will not be directly affected by the *Proposed Road Development*, as they are located at a distance from the works. There is the potential for indirect construction phase impacts arising due to the required crossing of the Loughymeenaghan outflow stream which is hydrologically connected to the turlough complex. Mitigation measures for the protection of water quality are specified in order to protect the water-dependant ecological interests within this sensitive site; project-specific water quality protection measures are set out in Chapter 14 Hydrology and Hydrogeology.

12.4.3.2.6 *Local importance (higher value) habitats*

Several habitats identified as being species-rich or representing important botanical communities in the local context are evaluated as being of local importance (higher value) and are therefore identified as being key ecological receptors with regard to the proposed alignment.

Marsh (GM1) habitat within the study area, particularly at Lackagh Fen is identified as being species rich and dominated by a calcareous botanical community. The proposed alignment does not give rise to the loss of any significant area of marsh within the road route and impacts affecting this habitat are evaluated as being moderate to significant negative in the local context. High diversity marsh in mosaic with wet grassland (GS4) habitat within the study area was found to support Devil's bit scabious, the food plant of the Annex II listed Marsh fritillary butterfly. Where this habitat mosaic occurs it is evaluated as being of local importance (higher value).

Wet willow/alder/ash woodland (WN6) corresponding to the priority Annex I habitat 'Alluvial woodland' occurs at the crossing point of the *Proposed Road Development* at the Drumfin River. The habitat at this location is more accurately described as willow carr. Additional Annex I 'Alluvial woodland' habitat occurs along the margins of Toberscanavan Lough, directly adjacent to the *Proposed Road Development*. The habitat at this location is dominated by alder and ash, with willow at the water's edge. WN6 habitat where it occurs is evaluated as being of local importance (higher value). Individual stands of semi-natural wet willow woodland also occur within some of the peatland/wetland complexes within the study area. Construction of the *Proposed Road Development* will require the removal of areas of this habitat along the proposed road corridor; this impact is evaluated as certain, with regard to the localised loss of this habitat and would be significant in the local context in the absence of mitigation. Mitigation in the form of replanting to avoid net loss of this habitat is proposed.

Semi-natural oak/ash/hazel woodland (WN2) occurs in small pockets within the alignment and where it occurs is evaluated as being of local importance (higher value). No significant area of semi-natural, broadleaved woodland will be affected by the *Proposed Road Development* and no woodland areas corresponding to Annex I 'Old oak woodland' will be affected. It is evaluated that the loss of discrete areas of this habitat would be certain to occur, limited to the local context and would not be significant; taking account of replanting of High canopy woodland and riparian woodland included in Chapter 10 of the EIS (Landscape and Visual Impact).

Scrub habitat in the study area is dominated by willow on the lower, wetter ground and hawthorn and hazel on drier ground. Small areas of scrub will be directly affected by the *Proposed Road Development* and localised impacts affecting this habitat are certain, limited to the local context and would not be significant; taking account of replanting proposals included as mitigation.

The realignment requires the crossing of both hedgerow and treeline habitats which are evaluated as comprising important wildlife corridors, giving rise to the potential for significant negative impacts affecting this habitat in the local context, with reference to the ongoing cumulative loss of these habitats in the study area. The potential for localised impacts on this habitat during the construction stage are evaluated as being certain. The significance of negative effects, with regard to the conservation status of these habitats, will be offset by replanting and reinstatement included as mitigation measures.

A small area of exposed calcareous rock occurs in the townland of Carrownagark. This habitat lies outside of the footprint of the *Proposed Road Development* and it is evaluated that no impacts affecting this habitat will occur.

12.4.3.3 Fauna

12.4.3.3.1 *Non-volant Mammals*

Non-volant mammal species identified within the study area of the *Proposed Road Development* will be affected to varying degrees by the construction phase of the works. The potential significance, duration and extent of these impacts with regard to each species has been set out. Effective and attainable mitigation measures are provided to minimise the significance of these impacts.

12.4.3.3.1.1 *Impacts on Badgers*

According to the National Road Authority publication '*Guidelines for the treatment of badgers prior to the construction of National realignments*' (NRA, 2006), road projects can potentially cause significant direct and indirect impacts on badgers. Construction may result in death or injury to badgers within setts; as well as the

destruction of setts, loss of foraging habitat or dissection of their foraging areas. Construction works close to breeding setts can cause serious disturbance to badgers and mortality of cubs. Where loss of habitat is likely to be greater than 25%, the impact may be considered as significant on the affected social group. Badgers may be killed or injured by road traffic as they attempt to access their feeding areas. This can significantly affect the viability of badger groups in an area. There is also a risk of road collisions, as badgers attempt to cross roads to and from foraging areas. Many of the general potential impacts on badgers outlined above apply for the *Proposed Road Development*. Impacts potentially affecting badgers are evaluated as being certain, with direct impacts identified affecting local communities of this species. The most significant impacts brought about during the construction phase would be destruction of active and inactive setts, division of social groups and division of territories. Although the overall density of badger setts along the proposed route is low, the territories of eight social groups are affected to some degree. The *Proposed Road Development* directly impacts on the habitats used by six badger communities. Badger communities identified within the study area are evaluated as being of local importance (higher value).

One active main sett and two active annex setts are in the direct line of the *Proposed Road Development*, with three inactive dwellings also in the proposed road line. Other active sets are located in close proximity to the *Proposed Road Development* and could potentially be impacted on by disturbance. The loss of active badger setts due to the construction of the proposed road are evaluated as being certain, and would directly impact on the badger social groups affected in the immediate locality. Effective mitigation prescriptions are required to avoid significant impacts on badger dwellings that will be directly affected. Badger territories would be disrupted during the construction phase and during the operational phase of the road badgers may find that the corridor of the proposed alignment, in addition to the existing N4 comprises a barrier to mobility. A summary of the potential impacts on badgers of the *Proposed Road Development* is provided in Table 12.20.

Table 12-20: Summary of impacts of the proposed N4 Collooney to Castlebaldwin Realignment on badgers. All impacts are evaluated in the local context for this species.

Badger Community	Construction Phase Impacts	Operational Phase Impacts
Cloonamahan	Disturbance due to construction of online section of road and will be at a distance from any dwelling.	New road will run online; design stage mitigation will avoid any change in the local context.
Drumfin	Loss of single entrance annex sett will occur.	Foraging habitat will be lost and access to foraging areas will be prevented.
Cloonlurg	Loss of annex sett to the north of the main sett. Construction phase disturbance may affect the main sett at a distance from the road corridor.	Foraging habitat will be lost and access to foraging areas will be prevented in the absence of mitigation. Suitable foraging habitat will remain to the north, west and south.
Carrownagark	Disturbance to foraging areas and loss of single active sett.	Minor loss of foraging habitat will occur.
Kingsbrook	CPO area will result in loss of territory and may cause disturbance impacts.	Foraging habitat will be lost and access to foraging areas will be prevented in the absence of mitigation. However, more suitable habitat to the west, north and south will not be affected.
Ardloy	If disturbance during construction is minimised no impacts will occur.	Foraging habitat will be lost and access to foraging areas between the existing and proposed road corridors will be prevented in the absence of mitigation.
Tawnagh	A single entrance active sett will require removal. The proposed route crosses an active territory at this location.	Foraging habitat will be lost and access to foraging areas between the existing and proposed road corridors will be prevented in the absence of mitigation.
Drumderry	A single entrance inactive sett will require removal. The proposed route crosses an active territory at this location.	Foraging habitat will be lost and access to foraging areas will be prevented in the absence of mitigation.
Castlebaldwin	A single entrance inactive sett will require removal. The proposed route crosses a historical territory at this location.	Foraging habitat will be lost and access to foraging areas will be prevented in the absence of mitigation.

12.4.3.3.1.2 *Impacts on Otters*

No otter holts were recorded during the current survey. Otter footprints and spraints were recorded along the Turnalaydan Stream, the Drumfin River and along the southern margins of Aghalenane Lough. Construction work in the vicinity of watercourses and aquatic habitats can result in noise disturbances affecting otters. Otters and other mammals are known to utilize culverts to pass under roads (Clevenger *et al*, 2001; Philcox, 1999) and further mitigation proposals, including design stage mitigations, are set out in the appropriate sections. Culverts and bridges over the rivers and streams along the subject road corridor could, if not adequately designed, prevent movements of otters or encourage them to leave the river channel and cross the road itself which can lead to mortalities.

12.4.3.3.1.3 *Impacts on Pine martens, Stoats and Red squirrels*

It is likely that stoats are common in the area due to the abundance of rabbits. Stoats are extremely adaptable animals that should cope well with the changes in the local landscape that would occur as a result of the construction and operation of the realignment. Impacts affecting the stoat population within the study area are evaluated as being slight to imperceptible negative.

Pine marten and red squirrel activity is closely correlated, as both species require extensively connected woodland habitat. Both species are extremely elusive mammals that avoid anthropogenic activity. The *Proposed Road Development* crosses coniferous plantation and some limited scrub habitat giving rise to the potential for a moderate negative, long term impact on pine martens at a local level in the affected areas. Red squirrel requires smaller territories within woodland habitats and would not be as significantly affected by the *Proposed Road Development*. However, as the proposed route will require the crossing of coniferous plantation in the area of Cloonlurg it is expected that there is the potential for limited impacts affecting Red squirrel at this location, which would not be significant in the local context.

12.4.3.3.1.4 *Impacts on Irish hares*

Hares were recorded in a number of areas along the proposed road corridor. The main impact of the *Proposed Road Development* on hares would be habitat loss, habitat fragmentation, disturbance and potential road mortality. Many of the impacts can be mitigated. Disturbance during the construction phase would be minimised and the provision of badger/mammal fencing would serve to keep hares off the road.

12.4.3.3.1.5 *Other mammals*

No evidence of deer was recorded within the study area of the *Proposed Road Development* and none of the landowners spoken to were aware of deer on their lands; however Fallow deer are known to occur in the Markree Demesne to the north of the alignment. There are no impacts potentially affecting deer identified with regard to the *Proposed Road Development*. Rabbits are not a protected species and are considered to be a pest by many landowners. Many of the hedgerows along the proposed road corridor are used by rabbits and these areas would be lost, loss of rabbit foraging areas would also occur. Rabbits are an adaptable and fast breeding species and the overall impact on rabbits is likely to be neutral. Foxes are widespread along the road corridor. This species is not protected and is regularly controlled by shooting; however, no fox dens will be directly affected. Foxes will benefit from the mitigation measures proposed for badgers. The impact of the development on this adaptable species will be minor negative at most.

12.4.3.3.2 *Bats*

The corridor of the *Proposed Road Development* is evaluated as being of low local importance for bats as it generally runs through agricultural grassland and wet grassland areas – habitats which are of low importance to bats. Consultation with the NPWS during the preparation of this report also confirmed that NPWS does not consider that affected areas to be particularly important to bats. NPWS and Bat Conservation Ireland also have no records of any roosts occurring in the areas directly affected by the *Proposed Road Development*. No hibernation roosts were recorded during the bat surveys undertaken to inform the assessment; however a number of old farmhouses/farm buildings will be affected by the *Proposed Road Development*. A number of these buildings in the northern portion of the study area are locally important summer/night roosts for bats and mitigation measures will be required during the construction phase.

12.4.3.3.2.1 *Damage to commuting routes*

New roads interfere with a bat's ability to commute across an agricultural landscape; where links between roosts or between feeding sites and roosts may be severed, preventing access to alternative roosts. Bat

species undergo localised or long-distance migration between roost sites in different seasons. Impacts will be greatest where a road project severs well developed hedgerows and treelines or causes the loss of mature trees. However, the potential for adverse effects on commuting corridors will be offset through mitigation measures.

The *Proposed Road Development* runs online and in parallel with the existing N4 road so the road would affect regional bat movements in combination with the existing road. The main mature hedgerow networks affected by the *Proposed Road Development* are those located immediately south west of the Drumfin River crossing and along the southern 3km section of the *Proposed Road Development*.

Mature trees and hedgerows are also present near the farmhouses to the north of Aghalenane/Ardloy Loughs and the loss of these would disrupt local commuting routes and foraging areas. However, the baseline bat assessments concluded that affected areas are only used by relatively small numbers of Soprano Pipistrelle bats. Although fully protected, this species (and the Common Pipistrelle) are common and adaptable species and the loss of hedgerow habitat used by low numbers of bats would not be significant in the local context and will be effectively ameliorated through mitigation measures provided.

12.4.3.3.2.2 *Change in insect fauna available to foraging bats*

The loss of existing habitats during the *Proposed Road Development* has the potential to affect the invertebrate fauna and lessen the availability of insect prey for bats along the corridor. However, the proposed route generally crosses improved agricultural and wet grassland habitats and these areas are not of particular importance for insect production. There are no significant impacts identified in this regard.

12.4.3.3.2.3 *Disturbance of bats during construction work*

The disturbance effects arising from the construction works i.e. noise and dust generated during the construction of the road are not evaluated as being significant, taking account of the absence of important bat roosting habitats within the zone of influence. It is unlikely that construction works would be undertaken during hours of darkness that would have the potential to significantly affect bats.

12.4.3.3.2.4 *Loss of bat tree roosts*

The removal of trees (especially mature deciduous) gives rise to the potential for the loss of roost sites. Removal of mature deciduous trees along the line of the *Proposed Road Development* occurs throughout the alignment, notably north of Toberscanavan Lough. These trees are of local importance to Soprano Pipistrelle bats. Such trees will be examined for the presence of bats in advance of removal. No maternity roosts in trees were found during the current survey.

12.4.3.3.2.5 *Loss of bat roosts in buildings*

There are a number of bridges over the rivers and streams in the study area. Some of these bridges, particularly the older ones, provide summer roosting locations for bats. Bats have occasionally been recorded hibernating in bridges in Ireland. Daubenton's Bat and Natterer's Bat were recorded roosting in Behy Bridge. No bats were found in hibernation in bridges during this study. No bridges are directly affected by the proposed development. Old and new buildings are present in the immediate vicinity of the proposed road corridor. No potential hibernacula were observed in any of the buildings along the road corridor. Droppings indicated that bats use, in small numbers, some of the older building and sheds in the study area. Dwellings within the CPO line which will require removal and which are of relevance in terms of bat activity include:

- An uninhabited house at Toberbride, to the west of the existing N4 corridor, this has been identified as a possible Pipistrelle roost;
- An uninhabited house to the south of Toberbride (in Mullaghnabreena Td.), identified as a confirmed roost; and
- An inhabited dwelling at Cloonamahan, due south of the L-3606-9 local road.

12.4.3.3.3 *Aquatic ecology and fisheries*

All rivers and streams affected by the *Proposed Road Development* are currently crossed by and receive untreated runoff from the existing N4 road. The *Proposed Road Development* includes design stage mitigation measures to avoid impacts affecting water quality in the long term, through the provision of appropriate

runoff/pollution controls in these areas. The *Proposed Road Development* requires the crossing of a number of small rivers and watercourses, which flow into the Unshin River.

The current assessment is undertaken with regard to the impacts of the *Proposed Road Development* on aquatic ecology and fisheries. Although related, impacts on water quality are addressed in the Hydrological and Hydrogeological Assessment, Chapter 14 of the EIS. The potential impacts of road development projects, including the *Proposed Road Development*, with regard to aquatic ecological receptors include the following:

- Pollution of watercourses with suspended solids due to runoff of soil from construction areas, or due to disturbance of fine subsurface substrates during instream construction and excavation.
- Pollution of watercourses with other substances such as fuels, lubricants, waste concrete, waste water from site toilet and wash facilities, etc.
- Permanent loss of habitat where the road is constructed over or in close proximity to streams/rivers or where streams/rivers are permanently diverted to new channels.
- Obstruction to upstream movement of fish, particularly salmon and trout, due to construction of culverts.
- Pollution of streams/rivers with contaminated water draining from the new road during its operation.
- Changes in hydrology, peak and minimum flow rates, including the proposed clearing of channel vegetation and riparian margins to facilitate flood conveyance.

Suspended sediment due to runoff of soil from construction areas, or due to disturbance of fine sub-surface sediments in the course of instream construction and excavation, can have severe negative impacts on invertebrate and plant life and on all life stages of salmonid fish, trout and other fish species. Suspended solids in small quantities may have a serious effect on the spawning sites of salmonids (O'Connor & Andrew, 1998; Turnpenny & Williams R., 1980; Shackle et al, 1999). The effects of suspended solids are a function of concentration and exposure duration. The main mechanism used by adult fish to deal with elevated concentrations of suspended solids is to move away from the area. However, this action is not possible for ova and larval salmonids and seasonal restrictions on instream/riparian working times will be necessary in some areas as part of mitigation prescriptions.

The potential exists for a range of serious pollutants to enter watercourses during new road construction. For example uncured concrete and grouts; wash down water from site vehicles, fuels, lubricants and hydraulic fluids and from waste from on site toilet and wash facilities would have deleterious effects on fish, plants and invertebrates if allowed to enter watercourses. Pollution and water quality impacts are identified as having the potential for significant impacts, arising at all points where the new road is constructed close to or over watercourses, particularly where this involves instream works, construction of culverts or river diversion. Potential impacts are dealt with on a site by site basis in Table 12.21.

12.4.3.3.4 *Birds*

The most significant potential impact to bird species will be the loss of habitat. Hedgerow loss is limited to the alignment of the *Proposed Road Development* and associated works within the CPO line, with impacts potentially affecting breeding and wintering birds evaluated as not significant in the local context. The loss of additional habitats including wet grassland and woodland are not considered significant in the local context, taking account of the species communities recorded and the relatively small area of these habitats affected in the local context. No loss of wetland or waterbodies are identified with regard to potential effects on breeding and wintering waterbirds and no significant impacts are identified with regard to these species. Mitigation measures for the restoration of habitats, including hedgerow planting and recreation of wet woodland / scrub habitat will be positive for breeding birds.

12.4.3.3.5 *Reptiles and Amphibians*

Both common frog and smooth newt have been recorded from within the study area, although only the common frog has been recorded from within the footprint of the *Proposed Road Development*. The potential impact of the *Proposed Road Development* is evaluated as not being significant with regard to these species, where their conservation status in the local context would not be affected. Though no reptiles were encountered during any of the surveys, the common lizard may occur and any disruption of habitat for this species is evaluated as not being significant in the local context.

12.4.3.3.6 *Terrestrial Invertebrates*

The Annex II listed Marsh fritillary butterfly was recorded from the study area of the *Proposed Road Development*. Its food plant, Devil's bit scabious was found to be common within the wet grassland and fen

habitats present throughout the proposed road corridor. Although the land take of the *Proposed Road Development* does cross habitat supporting this plant species, the proposed corridor avoids the majority of fen and high diversity habitats at Lackagh Fen and Aghalenane Lough, where this species was recorded during 2010. Although a small area of breeding habitat lies within the footprint of the *Proposed Road Development* at the southern end of Lackagh Fen, it is evaluated that the loss of this habitat (identified as becoming increasingly rank and less suitable for *Succisa*) would not be significant in the local context. This evaluation is reached in consultation with the NPWS Divisional Ecologist. It is considered likely that the adult/larval populations of this species are mobile and transient within the study area of the *Proposed Road Development* during successive breeding seasons, utilising the wet grassland habitats which support the food plant. Overall, the land take of the *Proposed Road Development* will mean a reduction in habitat for butterflies and other insects, but in terms of the general area would be a small proportion in the local context and would not be significant.

The *Proposed Road Development* follows the south-western border of the Aghalenane and Ardloy Loughs wetland complex in close proximity to the transition mire and associated calcareous spring habitats within this wetland area. The potential exists for construction phase impacts to adversely affect the groundwater regime at this site due to excavation and fill operations during construction. The alteration of the hydrogeology of this site would have the potential to significantly affect the *Vertigo geyeri* populations within this wetland complex. Additional water quality impacts arising during the construction phase including run-off or spillages would have further potential to adversely affect this species. Specific design-stage mitigation and construction phase mitigation are provided to avoid significant effects on this species and its supporting habitats.

12.4.4 Operational Phase Impacts

12.4.4.1 Designated areas

As the *Proposed Road Development* is not located within any area designated for nature conservation, there will be no direct impacts on any such site as a result of the construction and operation of the *Proposed Road Development*. However, the *Proposed Road Development* is located in proximity to a number of designated conservation sites, with pathways for impacts via surface water connections. There is therefore the potential for indirect impacts on water quality in Lough Arrow and in the Unshin River cSAC during the operation of the road; in the absence of the proposed drainage design and design stage mitigation to allow for water treatment measures during the operation of the *Proposed Road Development*.

12.4.4.2 Habitats and flora

Fragmentation of the landscape is a cumulative impact of increases in linear infrastructure such as roads. The separation of semi-natural habitats from the wider countryside can reduce their viability as wildlife habitats, as their connectivity to the surrounding landscape is reduced. In this way, Lackagh Fen, Aghalenane and Ardloy Loughs and Cuileencroobagh Lough will become isolated between the existing N4 and the proposed route. The *Proposed Road Development* includes design stage mitigation to effectively avoid impacts affecting hydrology or hydrogeology, therefore, these fen systems will continue to function as semi-natural habitats during the operational phase of the road. The drainage design of the *Proposed Road Development* includes the provision of an effective drainage design system corresponding to SuDS principles (described in Chapter 4 of the EIS), which will serve to protect water quality and maintain existing baseline drainage to these wetland systems during the operation of the *Proposed Road Development*.

12.4.4.3 Fauna

12.4.4.3.1 *Non-volant mammals*

The existing N4 road between Collooney and Castlebaldwin was built during a time when little priority was given to nature conservation or protection of wildlife. The existing N4 has no underpasses or mammal-friendly culverts and there is evidence that this has contributed to habitat fragmentation in some areas along the route. In addition to significantly improving safety for people using the road, the new *Proposed Road Development* will also ensure that animal deaths on the roads are much reduced by providing mammal resistant fencing and targeted mammal underpasses along the route. Although most of the existing N4 will be left in place following the construction of the new road, traffic along this route will be much reduced following the construction of the new road and the reduced traffic and disturbance is expected to significantly reduce the impact that this road currently has on local habitat connectivity with regard to mammals. The potential for

operational impacts are limited to habitat loss and habitat fragmentation; both of which are reduced to below significant levels with the provision of design stage mitigation in the form of mammal underpasses.

12.4.4.3.1.1 *Badger*

During the operation of the *Proposed Road Development*, it is evaluated that the potential impact affecting badger communities would be below significant levels in the local context of each individual community identified along the realignment corridor. Impacts are identified arising from the loss of foraging habitats and impacts to commuting routes within established territories over the long term. However, the potential impact of the *Proposed Road Development* affecting badgers within the overall study area is evaluated as being below significant levels where the conservation status of this species will not be affected and taking account of ongoing trends in the wider study area. Mitigation measures are proposed to further reduce the scale and significance of potential impacts.

12.4.4.3.1.2 *Otter*

Operational impacts affecting otter would be limited to localised long term impacts affecting otter habitats within the direct footprint of the new N4 culverts and bridges required at the main watercourse crossings. However, with the provision of suitably designed structures, following NRA (2008) '*Guidelines for the treatment of Otters prior to the construction of National Road Schemes*', any impacts on otters in the area can be reduced to below any significant effects in the local context.

12.4.4.3.1.3 *Pine marten, Irish Stoat and Irish Hare*

Operational impacts affecting pine marten, Irish stoat and Irish hare may potentially include both fragmentation of habitat, dissected by the road route, and also the ongoing, long term disturbance arising from the road traffic in the local context. Strategic mitigation measures to be implemented for the protection of non-volant mammal species such as badger and otter will reduce the scale and significance of effects on pine marten, Irish stoat and Irish hare within the study area to below significant levels in the local context.

12.4.4.3.1.4 *Other mammals*

Impacts affecting additional mammals recorded in the study area, including red squirrel, fox, rabbit etc. are assessed as being below significant in the local context. These species would benefit from the provision of mitigation measures such as underpasses, mammal-friendly culverts and underpasses included as part of the development proposal.

12.4.4.3.2 *Bats*

12.4.4.3.2.1 *Increased Lighting*

The *Proposed Road Development* will result in the introduction of artificial lighting to sections of the study area currently unlit as a result of traffic activity. Effects upon bat species recorded in the study area are likely to be minimal as these species are tolerant of light. This is evaluated as a long term impact in the local context but would be below significant levels.

12.4.4.3.2.2 *Increased disturbance*

Although the existing N4 will be left in place, it is expected that traffic levels on this road will be much reduced thus reducing disturbance in this area. This will offset to some degree disturbance in new currently undisturbed areas. Effects upon Pipistrelle bats are likely to be minimal as these species are tolerant of disturbance and regularly feed along roads. The main areas where *Myotis* sp. bats were recorded will be further away from the new road than the existing road. Overall, increase disturbance from the new road on bats would not be significant in the local context.

12.4.4.3.2.3 *Habitat creation*

New linear hedgerow and treeline habitats will be planted as part of the *Proposed Road Development* (set out in Chapter 10 of the EIS, Landscape and Visual Impact Assessment). This new habitat creation will be of some benefit to bats and is likely to result in a positive effect for bats at a local scale in the medium to long-term. Habitat creation arising from the *Proposed Road Development* will not have significant effects on bats in the local context.

12.4.4.3.2.4 *Increased risk of road death*

The *Proposed Road Development* traverses the established feeding areas and territories of the local bat community. In isolated incidents this may lead to death when bats encounter moving vehicles while attempting to access feeding sites or alternative roosts on the opposite side of the road. However, the *Proposed Road Development* does not affect any significant roosts or feeding areas with only low numbers of common and adaptable bat species (i.e. Pipistrelles) identified feeding along the existing N4 road and within the study area of the new alignment. Increased risk of road death is therefore evaluated as not being significant in the local context.

12.4.4.3.3 *Aquatic ecology and fisheries*

The principal potential impact affecting water quality and fisheries associated with the operational phase of any road development, in the absence of an effective drainage design system, is the pollution of rivers/streams from storm water run-off from the road. Contaminated surface run-off comprising rainwater and pollutants are mobilised from the surface and boundaries of the road corridor. The principal sources of which have been identified as:

- Degradation of road surface and vehicles producing small discrete particles;
- The products of combustion from vehicle exhausts;
- Salts used for de-icing;
- Accidental spillages of transported goods;
- Soil erosion;
- Aerial deposition.

Operational impacts arising from the *Proposed Road Development* are evaluated as being below significant levels and limited to the local context of the development; taking account of the Drainage Design set out in Chapter 4 of the EIS and with cognisance of the strategic mitigation measures provided for the current development. The significance and scale of impact affecting the watercourses and fish communities within the zone of influence of the proposal will depend on the implementation of effective mitigation measures and the management of surface water along the *Proposed Road Development*, primarily through the implementation of the Drainage Design set out in Chapter 4 of the EIS, with the incorporation of additional mitigation measures for the protection of water quality as described in Chapter 14 Hydrology and Hydrogeology.

12.4.4.3.3.1 *Permanent loss of habitat / hydrological changes*

Permanent loss of aquatic and/or riparian habitat would take place where the new road would be constructed over or in close proximity to streams/rivers/lakes/ponds or if streams/rivers were permanently diverted to new channels to facilitate the new road and/or its associated interchanges and access roads. Major changes in hydrology reflected in significant changes in peak and minimum flows would have the potential for significant effects on instream flora and fauna, both directly and through the effects of increased erosion.

12.4.4.3.3.2 *Barriers to migration*

Culverts and other artificial channels, if not appropriately designed and constructed with fish passage in mind, can totally prevent any upstream fish movement, thereby preventing adult fish from reaching favourable spawning areas. Negative effects of culverts on the upstream movements of salmonids have been well documented (Dane, 1978; Fitch, 1995; Armin, 1996; Scottish Executive, 2000). Impacts on downstream movement of salmonids have also been reported in the literature (Aarestrup, 1999). Impacts of culverts on the upstream migration of eels have been discussed by Knights & White (1995) and White & Knights (1997). Culverts have also been shown to prevent upstream migrations of crayfish in rivers (Light, 2003). Otters and other mammals are known to use culverts to pass under roads (Clevenger *et al.*, 2001); it recommended that culverts greater than 1m in diameter incorporate a mammal ledge to facilitate use by otters (Philcox, 1999).

12.4.4.3.3.3 *Pollution of streams/rivers*

There are significant differences between the sources that contribute to routine discharges and accidental discharges. More than 30 potential polluting substances have been identified in highway runoff. The effects of these may range from aesthetic nuisance, to causing biochemical and ecological deterioration of the receiving body of water. The pollutants that are of most concern in highway drainage are discussed in detail in the Hydrological and Hydrogeological Assessment, Chapter 14 of the EIS. Salmonid fish would be particularly vulnerable to run-off pollutants at the egg and early juvenile stages. These stages are present in the mid-

winter to late-spring period. The run-off from major roads contains contaminants from various sources. The principal sources that have been identified are:

- Degradation of road surface and vehicles producing small discrete particles;
- The products of combustion from vehicle exhausts;
- Salts used for de-icing;
- Accidental spillages of transported goods;
- Soil erosion;
- Aerial deposition;

12.4.4.3.4 *Birds*

Impacts affecting birds within the study area are assessed as being limited to a local context, with no direct impacts affecting bird species anticipated during the operational phase of the *Proposed Road Development*. Long-term effects on breeding and wintering water bird populations on wetland habitats, including Boathole Lough & Lough Corran, are evaluated as not being significant in the local context given the distance of these sites from the route. Mitigation, including planting along the proposed road corridor will further reduce operational impact significance, with cognisance of habituation of wetland bird species to road developments.

12.4.4.3.5 *Reptiles and Amphibians*

Both the common frog and smooth newt were recorded from the study area and impacts potentially affecting these species in the long term are limited to the local context and would not be significant. Although no reptiles were encountered during any of the surveys; where they do occur, any impacts including disruption of habitat would not be significant in the local context over the long term.

12.4.4.3.6 *Terrestrial Invertebrates*

The land take of the *Proposed Road Development* will result in a reduction in habitat for butterflies and other terrestrial invertebrates, but in terms of the wider study area would be a small proportion and is evaluated as not being significant in the local context. The protected Marsh Fritillary butterfly was recorded from within the study area of the *Proposed Road Development*. Larval nests of this species were recorded from within the footprint of the road at Lackagh Fen during surveys undertaken in 2010 and 2012. The operational phase of the road may result in the severance or isolation of populations of this species. The loss of food-plant habitat at the southern end of Lackagh Fen is not evaluated to result in adverse effects on the conservation status of this species at this site. Taking account of the fact that the *Proposed Road Development* avoids any direct or indirect impacts on the most important habitats for this species in the immediate zone of influence and in the wider study area, the scale of operational impacts affecting this species are not evaluated as being significant in the local context.

Whorl snail species were recorded from wetland habitats within the study area with *Vertigo antivertigo* and *V. substriata* occurring at Lackagh Fen, Aghalenane & Ardloy Loughs Complex and Drumderry Bog. These species are listed on the Irish Red Data List and are identified as being dependant on the wetland hydrological conditions present at the above fen/reed swamp habitats. Additionally *V. geyeri*, an Annex II species was recorded at the Aghalenane and Ardloy Lough Complex. Operational phase impacts of the *Proposed Road Development* would potentially include hydrological or hydrogeological change to the fen/transition mire mosaic which is supporting these species, where alteration of the calcareous groundwater springs upon which *V. geyeri* depends would have the potential for significant negative impacts on this species in the long term. The construction and design of the *Proposed Road Development* includes specific measures to avoid long term alteration to the hydrology and hydrogeology of this wetland system supporting this Annex II species, as set out in Chapter 4 and the Hydrological and Hydro-Geological Chapter 14 of the current EIS. The provision of constructed wetland attenuation ponds to protect water quality (which would result in the creation of new suitable habitat) and also the incorporation of sensitive design mitigation measures to avoid the drainage or alteration of ground water levels within these sites are included as a design stage mitigation measure (see Chapter 4).

12.4.5 Summary of potential impacts on aquatic areas

12.4.5.1 Lough Arrow

The Drumderry Stream flows into this lake from the north. The *Proposed Road Development* requires a crossing of this watercourse (and its tributary) directly south of Castlebaldwin village. Taking account of the

distance between the proposed crossing point and the lake environment, in combination with the small size of this minor stream it is concluded that any potential impacts affecting Lough Arrow will be effectively avoided with the implementation of the operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter 14 of the EIS. The implementation of the road runoff attenuation and SuDS treatment of surface water run-off during the operational phase, will ensure that there will be no significant impacts on Lough Arrow.

12.4.5.2 Markree Demesne Stream (Toberscanavan Lough outflow)

Toberscanavan Lough is located directly adjacent to the online section of the *Proposed Road Development* at the northern end, within the townlands of Mullaghnabreena, Ardcurley, Cloonamahan, Knockmullin and Carrigeensallagh. Although the provision of a retaining wall will significantly reduce direct impacts there will be some direct impacts to the wet woodland habitats along the eastern margin of this waterbody, with a crossing of the outflow stream from this lake also required. Any potential for significant impacts affecting this waterbody will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological (Chapter 14) of the EIS. The implementation of the road runoff attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that no significant impacts occur with regard to water quality and aquatic ecology at the Markree Demesne Stream or the adjacent Toberscanavan Lough. Incorporated into the proposal for the Proposed Road Development is the installation of a weir upstream of the culverted section of the Markree Demesne Stream, below Lough Toberscanavan. This weir is designed to replicate the existing invert level (29.26m aOD) of the current upstream invert of the 1200mm diameter pipe culvert and is described in detail in Section 4.8.5.1.4 of Chapter 4 of the EIS. This weir level shall be adjustable to a minimum elevation of 28.96m aOD, which is in cognisance of local opinion that the historical low water lake levels were lower preceding roadwork's carried out to the existing N4 in the 1980's. Any lowering of this weir plate level (29.26m aOD) shall only be done in stages which shall be agreed in advance with the local authority in consultation with the NPWS. The effect of these drops shall be assessed based on:

- An examination of continuous lake level water monitoring results (carried out over a minimum of two years);
- An examination of the effects on the riparian habitats based on the baseline habitat results;
- Any associated resulting flood risk occurring downstream;

Only when it is assessed that effects are not considered to result in an increase in the impact significance assessed in Chapter 12 of this EIS (not significant at a local scale) should an additional drop be considered in consultation with the NPWS; by the same respect if the resulting impact is considered to be higher, then the weir level shall be returned to its previous position and fixed at that point. The same approach will apply to any subsequent drops of the weir plate.

12.4.5.3 Unshin River

The *Proposed Road Development* crosses a number of minor watercourses which drain into the Unshin River. The mainline road corridor also lies within 300m of this river channel at its closest point; however, at this location it is separated from this river by the existing N4. During the operational phase, there is the potential for this watercourse to receive untreated road runoff or be at risk from any accidental spills on the new road, via tributaries of this watercourse crossed by the Proposed Road Development. Specific design stage mitigation (Drainage Design, Chapter 4) in addition to construction and operational phase mitigation prescriptions (Hydrological and Hydro-Geological Chapter 14) will ensure the aquatic environment of the river, including water quality, will be protected. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will provide effective treatment of potential indirect pollution both to the influent tributaries of the Unshin River and to this watercourse itself. The *Proposed Road Development* will not give rise to significant effects on this watercourse, or the water-dependant ecological communities it supports. This is recognised both with regard to the local ecology of the catchment within the study area and also with regard to the European importance of the Natura 2000 designation of the Unshin River.

12.4.5.4 Turnalaydan Stream (Lough Corran outflow)

The Turnalaydan Stream would be vulnerable to pollution runoff during the operation phase of the *Proposed Road Development*; however, with the provision of modern pollution control systems any impacts of storm

water runoff would be minimised. This river is also crossed by the existing N4 and receives untreated runoff from this road. Long-term habitat loss for fish at the bridge crossing would not be a significant impact due to the absence of important or significant fisheries habitat at the proposed crossing point and the existence of extensive areas of similar river habitat in the immediate area. Following consultation with Inland Fisheries Ireland and with consideration of design options for the crossing of this watercourse, it is proposed to incorporate a river diversion at the crossing point of the Turnalaydan Stream. This will allow for works to be undertaken in the dry and will also provide an opportunity for further instream measures for aquatic habitat enhancement in the newly constructed channel. The bridge will be constructed to allow otters to pass and will not interfere with fish passage in the river. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter 14 of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant. Such measures are required taking cognisance of the designation of this watercourse within the Unshin River cSAC approximately 40m to the east of the footprint of the *Proposed Road Development*.

12.4.5.5 Boathole and Lough Corran

These Loughs are important receptors and are connected to the Unshin River by the Turnalaydan Stream outflow. The Loughs would not be directly affected by the *Proposed Road Development*. However, the proposed road passes within 50m of the Loughs. Any potential for significant impacts affecting these waterbodies will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter 14 of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.5.6 Drumfin River

This river would be vulnerable to pollution runoff during the operation of the road; however, with the provision of modern pollution control systems, in the form of the proposed drainage design, any impacts of storm water runoff would be minimised. Although the existing N4 alignment will be left in place following the opening of the new road; traffic and associated contaminated runoff from the existing road would be significantly reduced following completion of the *Proposed Road Development*. Long-term habitat loss for fish at the proposed bridge crossing is evaluated as not being significant due to the low habitat potential at the crossing site and the existence of extensive areas of similar river habitat in the immediate area. The bridge crossing will be a clear span one. The required bridge crossing will allow otters to pass and will not interfere with fish passage in the river. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.5.7 Drumfin River tributary

This stream is a minor tributary of the Drumfin River and is not important for fish species or aquatic ecological communities. Pollution entering this stream could potentially result in contamination of the Drumfin River so methods to control releases of suspended solids and other pollutants during construction will be necessary. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.5.8 Aghalenane and Ardloy Loughs

These Loughs have a high botanical diversity and are connected to the Unshin River by a small outflow stream. These Loughs will not be directly affected by the *Proposed Road Development*. However, the proposed road

passes within 100m of the Loughs. This would make this sub-catchment susceptible to pollution during both the construction and operation phases in the absence of mitigation measures. It is proposed to divert runoff away from these lakes and constructed wetlands have been provided for in the proposed drainage design (see Chapter 4 of the EIS). Any potential for significant impacts affecting these waterbodies will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.5.9 Lissycoyne Stream (Cleavry Lough outflow)

This is a minor stream/drain which flows out of Cleavry Lough and is a tributary of the Unshin. It is not of any fisheries value due to its small size and drain-like nature. However, the Unshin River is considered to be an important receptor and is vulnerable to pollution in the absence of mitigation. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.5.10 Springfield Stream

This is a small stream which flows from Loughymeenaghan Lough to the 'Swallow Holes' at Tawnagh. It is crossed by the existing N4 at Ardloy Bridge and would be crossed by the *Proposed Road Development* 300m downstream of the existing crossing. It is considered of low fisheries value due to its small size. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant with regard to water quality and aquatic ecology.

12.4.5.11 Drumderry Stream

The Drumderry Stream (and its minor tributary, known as a tributary of the Drumderry Stream) is a minor watercourse which flows from the south of Castlebaldwin Village into Lough Arrow. Within the study area the Drumderry Stream it is not of any fisheries value due to its small size and extensively drained nature. It is currently crossed by the existing N4 and a number of smaller roads. The minor tributary of the Drumderry Stream is identified as being of local importance with regard to spawning habitat for Brown trout. Because of its connection to the *Proposed Road Development* and its hydrological connection to Lough Arrow the Drumderry Stream is considered vulnerable to pollution by suspended solids and other sources of contamination during the construction phase of the *Proposed Road Development*. During the operation of the road, the stream, and its tributary, would be vulnerable to pollution runoff in the absence of an effective drainage design. Any potential for significant impacts affecting this watercourse will be effectively avoided with the implementation of the construction and operational mitigation measures. These include water quality protection measures set out in the Drainage Design (Chapter 4) and in the Hydrological and Hydro-Geological Chapter (14) of the EIS. The implementation of the attenuation and SuDS treatment of surface water run-off during the operational phase will ensure that impacts arising with regard to water quality and aquatic ecology are limited to the local context and will not be significant.

12.4.6 Impact assessment for the key ecological receptors

The impact assessment and significance of impacts during both construction and operational phase of the proposed N4 *Proposed Road Development* has been summarised with respect to the key ecological receptors identified within the zone of influence; these results are summarised in Table 12.21.

Table 12-21: Impact characterisation for key ecological receptors; based on the 'Guidelines for the Assessment of Ecological Impacts of National Road Schemes' *(Rev.2, NRA 2009)*

Key Ecological Receptor	Ecological Rating	Construction phase impacts	Operational Impacts	Ecological significance if unmitigated
Toberscanavan Lough	National Importance	Limited habitat loss along the western boundary of the existing N4 corridor.	Operational impacts are in line with those of the existing N4 corridor and are not identified as being significant in the local context.	Potential exists for direct and indirect effects on the wetland and aquatic habitats of this wetland complex. Impacts are likely and may potentially be significant in the local context in the absence of mitigation.
Lackagh Fen Complex	National Importance	Limited habitat loss along the boundary of the wetland complex, due to road construction. Potential for hydrological and hydrogeological change during construction due to cut and fill adjacent to the wetland. Potential water quality impacts in the absence of effective mitigation would be locally significant.	There is the potential for long term hydrological and hydrogeological change affecting the wetland habitat directly adjacent to the road route in the absence of effective mitigation, with the potential for significant impacts in the local and county context.	Potential effects are limited to indirect impacts resulting in the loss of Annex I habitat viability within the Lackagh Fen Complex, taking account of the sensitivity of the Annex I habitats present with regard to hydrological and hydrogeological change. Impacts incurred during the construction phase may have longer term impacts with respect to drying out of these wetland habitats. These fen habitats are also important for the terrestrial invertebrates they support. Direct impacts to marginal fen habitat within the study area, particularly at the western boundary of the complex are considered certain; however, the extent of direct impacts are limited in size, taking account of the small area of wetland habitats affected and the avoidance of the more important and intact Annex I habitats in this area. The *Proposed Road Development*, taking account of design stage modifications and amendments, does not have the potential for significant direct effects on this habitat complex. The potential for significant indirect impacts affecting the groundwater-dependant habitats remains in the absence of design and habitat-specific mitigation; the extent of these impacts is uncertain ranging from the local to the county scale.
Boathole Lough & Lough Corran	County Importance	Habitat loss limited to the south-eastern corner of this site within cutover raised bog and transition mire habitat. Potential runoff of pollutants from construction area affecting this wetland downstream.	Surface water run-off and potential pollution events through road spill affecting this wetland habitat downstream	The proposed development requires the removal of a small portion of cutover raised bog, transition mire habitat within cutover depressions and scrub habitat at the south-eastern corner of this habitat complex. Habitats for which this site is identified as being of County Importance i.e. Lake and raised bog will not be affected. However, the extent of direct impacts are limited in size, taking account of the small area of wetland habitats affected and the avoidance of the more important and intact Annex I habitats in this area. The *Proposed Road Development*, taking account of design stage modifications and amendments, does not have the potential for significant direct effects on this habitat complex. There is the potential for indirect impacts affecting the wetland habitats and aquatic communities within the Boathole Lough and Lough Corran complex arising from hydrological change. The proposal contains design stage geotechnical mitigations to avoid the potential for significant effects.
Aghalenane & Ardloy Loughs	International Importance	The *Proposed Road Development* will avoid direct habitat loss within this	There is the potential for long term hydrological and hydrogeological change	The drainage design incorporated into the proposal has included substantive strategic mitigation to avoid significant direct and indirect impacts affecting

Key Ecological Receptor	Ecological Rating	Construction phase impacts	Operational Impacts	Ecological significance if unmitigated
		wetland complex, being located on higher ground to the west and south. The construction phase works would have the potential for hydrological and hydrogeological change affecting the wetland taking account of excavation and fill construction techniques and the requirement for embankment construction across soft ground.	affecting the wetland habitat directly adjacent to the road route in the absence of effective mitigation. Potential runoff of pollutants from construction area	the habitats within the Aghalenane/Ardloy Loughs Complex. Taking account of the sensitivity of the Annex I habitats present with regard to hydrological change and the water-dependant species occurring within this wetland i.e. Annex II listed *Vertigo geyeri* there would be the potential for significant impacts in the absence of this design stage mitigation.
Cuileencroobagh Lough	County Importance	The construction phase of the *Proposed Road Development* does not give rise to any significant landtake within this wetland complex. Indirect impacts are related to water quality and potential hydrological alterations.	There is the potential for long term hydrological and hydrogeological change affecting the wetland habitat directly adjacent to the road route in the absence of effective mitigation. Potential runoff of pollutants from construction area	The *Proposed Road Development* has the potential for direct and indirect impacts affecting surface water quality, habitat integrity and hydrogeological alteration during the construction and operational phases. In the absence of mitigation, impacts affecting this wetland habitat area are evaluated as probable and potentially significant, limited to the local context.
Swallow Holes Complex	National Importance	The *Proposed Road Development* has the potential to give rise to downstream water quality impacts potentially affecting the aquatic habitats of the Swallow Holes complex. Any impacts affecting flows from Loughymeenaghan to the complex would have the potential for hydrological impacts.	Surface water run-off and potential pollution events through road spill.	Impacts potentially arising from the *Proposed Road Development* are limited to water quality impacts and potential alteration of the outflow stream from Loughymeenaghan. The potential for impacts affecting this wetland complex is evaluated as being likely and in the absence of mitigation, impacts may be significant in the local context with regard to water quality.
Marsh (GM1)	Local Importance (higher value)	Direct loss of marsh habitat within the footprint of the road. Hydrological change to low-lying marsh areas as a result of excavate and fill construction.	Operational phase impacts are limited to long-term drying out of marsh areas i.e. hydrological/hydrogeological change.	Impacts affecting marsh habitat within the study area are evaluated as certain and in the absence of mitigation would have the potential to be significant in the local context.
Wet willow/alder/ash woodland (WN6)	Local Importance (higher value)	Habitat loss due to road construction	No further operational impacts affecting this habitat are expected.	Land take causing habitat loss is considered a certain impact, although limited to the local scale. In the absence of mitigation, it is considered that impacts affecting this habitat would have the potential to be significant but limited to the local context.
Oak/ash/hazel woodland (WN2)	Local Importance (higher value)	Habitat loss due to road construction	No further operational impacts affecting this habitat are expected.	Impacts affecting woodland habitat within the study area are evaluated as certain and potentially significant negative in the absence of mitigation, limited to the local context.

Key Ecological Receptor	Ecological Rating	Construction phase impacts	Operational Impacts	Ecological significance if unmitigated
Scrub (WS1)	Local Importance (higher value)	Habitat loss due to road construction	No further operational impacts affecting this habitat are expected.	Impacts affecting scrub within the study area are assessed as certain, given the proposed route requires removal of sections of this habitat within the land take. The potential for significant effects, in the absence of mitigation, are evaluated as being unlikely and limited to the local context.
Hedgerows (Wl1) / treelines (WL2)	Local Importance (higher value)	Habitat loss due to road construction	No further operational impacts affecting this habitat are expected.	Impacts affecting hedgerows and treelines are assessed as being certain, given the proposed route requires removal of sections of this habitat within the land take. The potential for significant effects, in the absence of mitigation, are evaluated as being unlikely and limited to the local context.
Exposed calcareous rock (ER2) at Carrownagark.	Local Importance (higher value)	No direct impacts are identified potentially affecting this habitat. Indirect impacts may potentially occur arising from disturbance or trampling in the absence of suitable fencing mitigation.	No further operational impacts affecting this habitat are expected.	Impacts potentially affecting this habitat are limited to the potential for direct effects at the Carrownagark site. The potential for effects, in the absence of mitigation are evaluated as being probable. However, taking account of the poor representation of this habitat and ongoing trends of habitat degradation arising from agricultural management; it is evaluated that these effects would not be significant in the local context.
Badger	Local importance (higher value)	Road construction including direct land take of territory and dwellings	Fragmentation of territories, loss of foraging habitat, loss of wildlife corridors between main setts and outlier setts.	The *Proposed Road Development* is evaluated as giving rise to direct and indirect impacts affecting badger communities in the local context; arising from the loss of breeding setts, and long term impacts to foraging/ commuting routes within established territories. Impacts affecting badgers are evaluated as certain in the absence of mitigation and have the potential to be significant in the local context.
Otter	Local importance (higher value)	Road construction including bridges and culverts.	Resulting in the loss of riparian habitats with further potential impacts affecting foraging connectivity and also the fish populations within the river.	Impacts affecting otter would be limited to indirect effects in the local context; with the potential for long term localised disturbance effects within the direct footprint of the new bridges on the main watercourses. These impacts are evaluated as being certain in the absence of mitigation; however, are unlikely to be significant in the local context.
Pine marten, Irish stoat and Irish hare	Local importance (higher value)	Road construction including direct loss of suitable habitats	Loss of habitat and foraging habitat with additional fragmentation impacts due to presence of road.	Impacts affecting pine marten, Irish stoat and Irish hare are considered to include both fragmentation of habitat, dissected by the road route, and also the ongoing, long term disturbance arising from the road traffic. Impacts affecting these mammal species are evaluated as being likely in the absence of mitigation; however, they are not considered likely to be significant in the local context.
Bats	Local importance (higher value)	Road construction requiring the felling of forestry habitats and the demolition of derelict buildings	The main impacts on bats during the operational phase of the proposed new road would be increased lighting and disturbance and increased risk of road	In the absence of mitigation, construction phase and operational phase impacts would give rise to habitat loss and increased disturbance from the new road, both of which are evaluated as being certain; however, the potential for significant impacts affecting bats is evaluated as being unlikely and limited to

Key Ecological Receptor	Ecological Rating	Construction phase impacts	Operational Impacts	Ecological significance if unmitigated
			death.	the local context.
Atlantic salmon	Local importance (higher value)	Impacts to water quality: release of pollutants, increased suspended solids, loss of instream habitat and disturbance due to dewatering.	Operational impacts are limited to potential for pollution events arising from surface water run-off.	Water quality impacts arising during the construction or operational phase may potentially result in significant negative effects on salmon supporting watercourses, including the Drumfin River, the Markree Demesne Stream and Turnalaydan Stream. Habitat loss and instream disturbance may also result in significant adverse effects. In the absence of mitigation, the potential for significant impacts are evaluated as probable and may have implications for this species within the Unshin River cSAC, an internationally important conservation site.
White-clawed crayfish	Local importance (higher value)	Impacts to water quality: release of pollutants, increased suspended solids, loss of instream habitat/ disturbance due to dewatering.	Operational impacts are limited to potential for pollution events arising from surface water run-off.	Impacts to crayfish within the aquatic environment would be strongly linked to habitat loss and disturbance of aquatic habitats suitable for this species, with further potential impacts arising from impacts to water quality and increased suspended solids. In the absence of mitigation, impacts are identified as being probable and potentially significant in the local context with the potential for impacts affecting this species within the internationally important Unshin River cSAC.
Brook lamprey	Local importance (higher value)	Impacts to water quality: release of pollutants, increased suspended solids, loss of instream habitat and disturbance due to dewatering	Operational impacts are limited to potential for pollution events arising from surface water run	Brook lamprey are not as sensitive to water quality impacts as salmonids during their juvenile life stage. However habitat loss along the riparian zone and water's edge may significantly affect this species. In the absence of mitigation, the loss of spawning habitat and impacts to water quality during the spawning season would also give rise to significant negative impacts affecting this species in the local context. In the absence of mitigation, impacts affecting lamprey are evaluated as certain and may potentially affect populations of this species within the internationally important Unshin River cSAC.
Marsh Fritillary butterfly	County importance	Removal of the food plant of this species or direct loss of larvae during the clearance of the site footprint. Drainage or alteration of the hydraulic regime within the water-dependant habitats which support the food plant of this species.	Potential for long term alteration to supporting habitats resulting in loss of food plant	Impacts affecting high diversity wet grassland and fen habitat have the potential to result in direct and indirect impacts affecting this species. In the absence of mitigation impacts are evaluated as probable and potentially significant in the local context, where breeding sites occur e.g. at Lackagh Fen.
Vertigo geyeri	International importance	Construction phase impacts have the potential to result in hydrological or hydrogeological impacts affecting the discrete calcareous springs which support this species at Aghalenane Lough.	The *Proposed Road Development*, in close proximity to the groundwater dependant habitats of this species, has the potential for long term change to supporting habitats at Aghalenane and Ardloy Loughs.	Any impacts affecting the hydrology and hydrogeology of the habitats supporting this species at Aghalenane and Ardloy Loughs would have the potential for significant negative impacts affecting this species in the long term at this location, with implications for this species at a national level. In the absence of mitigation, impacts affecting this species are evaluated as likely. However, cognisance is taken of the strategic design-stage mitigation included

Key Ecological Receptor	Ecological Rating	Construction phase impacts	Operational Impacts	Ecological significance if unmitigated
				in the proposal to minimise groundwater and hydrological impacts on the habitats supporting this species.

12.5 Mitigation Measures & Environmental Commitments

12.5.1 Construction phase

12.5.1.1 Designated areas

No designated conservation sites are located within the footprint of the proposed works and no direct impacts are identified potentially affecting any European Site or nationally important designated conservation site (NHA, pNHA). The mitigation measures highlighted for the flora and fauna sections below will be sufficient to protect those Annex I habitats and Annex II species for which the designated sites within the zone of influence have been designated. With regard to the Unshin River cSAC and the Lough Arrow cSAC and SPA complex, specific mitigation measures for the protection of water quality have been set out for works undertaken within or adjacent to watercourses connected to these designated areas. The drainage design, set out in Chapter 4 of the EIS, provides the best available mitigation by avoidance to minimise impacts on watercourses and waterbodies within the study area, thus reducing the potential for downstream impacts potentially affecting water-dependant qualifying interests within designated sites during construction stage. Individual mitigation measures for the protection of surface water quality, provided in the Hydrological and Hydrogeological Assessment, Chapter 14, will effectively reduce the potential for impacts affecting the watercourses within the River Unshin catchment, with regard to the ecological sensitivities of the water-dependant qualifying interests of the River Unshin cSAC and also to the Lough Arrow cSAC and SPA complex. The specific measures set out in the Outline Erosion and Sediment Control Plan contained within Volume 4 of this EIS provides deliverable avoidance and control for water quality protection during the construction phase of the works. From the impact assessment and mitigation measures specified for the protection of sensitive aquatic receptors (both groundwater and surface water) set out in the Hydrological and Hydrogeological Assessment, Chapter 14 of the EIS, it is evaluated that the proposed design stage mitigations, by way of increased attenuation and containment, will result in a reduction in surface water pollution risk to the River Unshin cSAC catchment within the study area during the operational stage.

Any plant or equipment that may have worked in environments where invasive species are present (including but not restricted to zebra mussel *Dreissena polymorpha*, curly waterweed *Lagarosiphon major,* Japanese knotweed *Fallopia japonica*, Indian balsam *Impatiens glandulifera,* giant hogweed *Heracleum mantegazzianum*, rhododendron *Rhododendron ponticum*, New Zealand flatworm *Arthurdendyus triangulata*), shall be suitably cleaned by high pressure hose before being employed on site to prevent the spread of invasive species. Water used for this washing process shall always be intercepted and prevented from draining back into watercourses. It is recommended that all fill and material sourced or relocated within the site be screened at source for the presence of invasive species by a qualified ecologist to prevent the spread of these species within the road corridor, with particular reference to the River Unshin cSAC corridor and the Lough Arrow cSAC and SPA complex downstream of the site. This is in line with the guidance for the control of non-native invasive species set out in the NRA publication '*Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads*' (NRA, 2010) to be employed by the contractor.

12.5.1.2 Habitats and flora

The description of mitigation measures is provided in terms of mitigation by avoidance, reduction and remediation.

The operation of machinery adjacent to or in the vicinity of water courses is identified as having the potential for impacts on riparian and aquatic habitats; with further implications for sensitive aquatic receptors downstream. Works within the aquatic environment will be limited to the footprint of the works area and will be subject to further mitigation measures specified for aquatic fauna (see Section 12.5.1.3.2). All construction machinery operating nearby these water courses will be systematically checked in order to avoid leaks of oils, hydraulic fluids and fuels. Disturbed areas along semi-natural river corridors and within wetland habitat areas that are crossed by the *Proposed Road Development* will be subject to landscape and replanting measures, with specified native seed mix and native tree species as detailed in the Landscape and Visual Assessment, Chapter 10 of the EIS.

Appropriate measures, following the NRA (2010) '*Guidelines on the Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads*'will be taken to ensure that machinery does not facilitate the establishment and spread of non native species into the *Proposed Road Development* area. No non-native, invasive species were identified within the greenfield section of the *Proposed Road Development;* neither were

the online sections of the road route identified as containing infestations of these species. It is noted that Japanese knotweed does occur along the existing N4 corridor within the study area between Castlebaldwin and Collooney; illustrating the potential for the spread of infestations of this species along such linear corridors, as opposed to the noted absence of this species within the agricultural landscape of the study area. Existing stands of Japanese knotweed recorded along the existing N4 corridor will not be affected by the *Proposed Road Development*, where no works are located within affected areas. Management of stands of this species along the existing road corridor are therefore within the remit of Sligo County Council.

Refuelling of machinery will be undertaken away from the watercourses. Temporary toilet facilities will be provided and there will be no discharges to site from this unit. Site management procedures will include provisions for removing rubbish generated by on-site staff. Direct crossing of the roadway over watercourses will be required at some locations and will require specific mitigation measures for the protection of aquatic and riparian habitats, as set out in the Fauna mitigations with regard to fisheries and aquatic ecology (Section 12.5.1.3.2).

In order to compensate for the loss of the hedgerows and sections of semi-natural woodland; native tree and shrub species are to be planted; namely ash *Fraxinus excelsior*, hawthorn *Crataegus monogyna*, blackthorn *Prunus spinosa*, holly *Ilex aquifolium* and oak *Quercus robur*. Smaller trees also suitable for planting alongside road margins include rowan *Sorbus aucuparia* and birch *Betula pubescens.* Wet willow/alder/ash woodland corresponding to the priority Annex I habitat type at the eastern side of Toberscanavan Lough and willow carr habitat at the proposed Drumfin River crossing will require compensatory planting, which has been agreed within the proposed Landscaping mitigation (Chapter 10). However, the ash tree component of these habitat types will be avoided, with no ash proposed for planting within the limits of the *Proposed Road Development*. The proposed riparian and semi-natural woodland replanting utilises native willow species and alder at these locations. The species mixes in these woodland areas are to reflect species found and in accordance with the Native Woodland Scheme Guidelines (Department of Agriculture, Fisheries and Food - Native Woodland Scheme – Establishment August 2011). Where possible semi-natural scrub and unmanaged habitats should be left undisturbed during the bird breeding season (February-August inclusive, as per the Wildlife Acts); however, cognisance is taken of the derogation within this legislation for the construction of road schemes. Care will be taken to ensure that disturbance will be restricted to the foot-print of the roadway route to ensure that the surrounding habitats are not disturbed. Felled mature trees with ivy should be left to lie on the ground for 24 hours to allow bats that may have been roosting in them to escape.

The loss of small areas of Annex I fen and wet grassland habitat will be limited to the section at the southern boundary of the Lackagh Fen complex. Ecologically sensitive habitats have been avoided to the greatest extent possible; this has included adjusting and re-routing the proposed corridor to avoid Annex I habitats at Aghalenane and Ardloy Loughs complex and also at Lackagh Fen. Specific design-stage mitigations have been developed to include drainage layers and perforated drainage pipes below the road embankment, in addition to hydraulic barriers to prevent hydrological or hydrogeological change to these sensitive wetland habitats. These measures are detailed in Section 4.6.4 of Chapter 4 of the current EIS and are further evaluated in the Hydrological and Hydrogeological Chapter 14 of the EIS, in relation to these wetland sites. Mitigation for the avoidance of impacts to the hydrological and hydrogeological regime at these sensitive sites (Aghalenane / Ardloy and Lackagh) is of particular importance for the protection of groundwater-dependant priority Annex I Tufa spring habitats which occur within the zone of influence of the *Proposed Road Development* at these wetland sites. The wetland habitats within the Aghalenane and Ardloy complex have been included in the CPO of the *Proposed Road Development* as part of a management agreement with the NPWS in order to secure the future of the Annex I habitats and Annex II species within this site into the future.

Where the *Proposed Road Development* crosses high value habitat or habitats of greater value, all habitat areas outside of the direct road footprint will be fenced off as an exclusion zone. This will minimise unnecessary trampling, compaction or habitat loss/alteration. Works within and adjacent to wetland and cutover peatland habitats at Toberscanavan Lough and Lough Corran and Boathole Lough, respectively, have been considered at design stage with regard to minimising impacts on sensitive habitats. This includes the provision of a retaining wall and the minimisation of the works footprint at Toberscanavan Lough and the provision of linear and transverse drainage systems to the east of the road embankment to maintain hydrological and hydrogeological connectivity at Lough Corran.

The creation of new wetland habitats as part of the proposed drainage design, incorporating constructed wetlands would be considered appropriate to mitigate for the removal of marsh and wet grassland habitat within the study area. The turf and top soil removed from any wetland, marsh or high diversity grassland habitat will be retained and replaced where possible. As set out in Chapter 10 (Landscape and Visual Impact

Assessment) the Type 2 Spoil Repository/Borrow Pit areas will comprise a species diversity to mimic bog wetland conditions and to encourage re-colonization. The *Proposed Road Development* will include the creation of Constructed Wetlands and incorporating wetland ecological integration planting using native species and the creation of associated riparian woodland areas, as detailed in the Landscape and Visual Assessment, Chapter 10 of the EIS. Planting of native grassland species will provide for the regeneration of high diversity grassland within the route corridor.

During the construction of the *Proposed Road Development* excavation works will result in the generation of surplus spoil material. This material shall be treated in the spoil repositories identified in Chapter 4 of the EIS and in any event will not be used for infilling any wetland areas identified as being of local importance (higher value) or greater importance, in the *Proposed Road Development* area. Treatment of these soil repository sites with reference to the creation of new peatland habitats has been set out in Chapter 10 (Landscape and Visual Impact Assessment) and will in some instances provide for the creation of new, peatland habitat within the study area.

12.5.1.3 Fauna

12.5.1.3.1 *Mammals*

12.5.1.3.1.1 *Badgers*

The general mitigation measures for badgers closely follows the National Road Authority's '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*' (NRA, 2006). Mitigation measures for badgers and other non-volant mammals are set out in the '*Flora and Fauna: Non-Volant Mammal Report*' (Appendix 12.3, Volume 4 of the EIS) and are summarised below. These measures include a pre-construction survey, badger evacuation measures, protection of setts, provision of underpasses, badger resistant fencing, supervised sett destruction and creation of artificial setts, following the NRA (2006) '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'. Prior to any work commencing in the vicinity of a badger sett that will be directly affected by the realignment (including inactive setts) it must be ensured that badgers are excluded and evacuated. Badger evacuation procedures are outlined in the NRA (2006) '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'. It is an offence under the Wildlife Act (1976) and the Wildlife (Amendment) Act (2000) to injure or kill badgers and any works requiring the closure of a sett will require a licence from the NPWS. A derogation license to exclude the setts within the development area will be sought from the National Parks and Wildlife Service. Standard measures to exclude badgers and to excavate the sett will be employed under the '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*' (NRA, 2006) and supervision of a suitably qualified and experienced ecologist to ensure that badgers are unharmed. Exclusions must not be carried out in the period January to July to ensure that breeding badgers are not affected.

As a result of keeping badgers off the road, which are a potential driving hazard, other animals such as otters, rabbits, and foxes will also be excluded by the proposed mammal fencing and will be directed to the underpasses, culverts and under-bridges along the route. The *Proposed Road Development* will therefore comprise a long-term positive contribution to local mammal populations through the provision of exclusion fences and mammal passes.

Mammal resistant fencing will be installed along the entire length of the alignment, where the provision of mammal fencing will address the requirement for agricultural fencing along the corridor length ('*Flora and Fauna: Non-Volant Mammal Report*', Appendix 12.3, Volume 4 of the EIS). In this regard the following will be adhered to in the provision of such fencing:

- It is of particular importance to avoid gaps or weak points in fencing at awkward features such as undulating ground or streams, as badgers may exploit such weaknesses, thus negating the effectiveness of fencing;
- Badger-resistant fencing will be incorporated at early stages of road construction, during erection of the permanent land-take fencing. The fencing shall be turned into the headwalls of all culverts which are greater than 1m in height and into all road underbridges and river bridges;
- Where provision of access to Constructed Wetland attenuation ponds is achievable without compromising the overall security of the fence then this shall be provided;
- The standard specification for fencing is plastic-coated, heavy gauge chain-link on timber post and rail. The chain-link will be buried for a depth of 200 mm vertically and extend a further 300 mm

horizontally to prevent badgers from digging under it (as set out in the '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*' (NRA, 2006);
- In order to ensure that the mitigation measures are operating effectively, badger-resistant fencing will be properly maintained and underpasses checked for viability;

It is considered that the provision for fencing the entire corridor would have the advantage over fencing targeted sections, taking account of the proposed central median on the road corridor. The primary aim is to reduce the number of animals entering the road corridor. In the event of a breach in the proposed mammal fencing, there are limited options for an animal to exit to the road corridor; however, it is considered that this is preferable to allowing higher numbers of animals onto the new alignment, where mortality rates have found to be particularly high in the initial operational period of a new road development, particularly where a central barrier could potentially be in place.

All culverts and bridges greater than 1m in diameter will be designed to be passable by badgers (also otters, bats and other mammals) by providing a ledge on both banks, as per the NRA (2006) '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'. The ledge will be elevated above normal flood levels. An alternative approach to the provision of a ledge is a separate pipe culvert (minimum 600mm diameter), set above flood level adjacent to the stream culvert. Specific badger/mammal underpasses will be required where badger groups' setts are to be divided by the *Proposed Road Development*; for example, at the townlands of Cloonlurg, Tawnagh and Doorly.

All contractors working on the site will be made aware of the presence of badger setts and their protection status, via a 'tool-box talk' to be provided by the Environmental Manager, or appointed ecologist, under the prescribed Environmental Operating Plan (following the requirements of the NRA guidance, 2006) responsible for monitoring and auditing the ecological elements of the construction works. In advance of any construction works taking place, temporary fencing will be installed to protect all known badger setts. Exclusion zones for badgers will be marked clearly on ecology drawings made available to the contractor responsible for the land clearance works at an early stage of the development. During the construction phase, the use of heavy plant and machinery within 30m of a badger sett will be restricted and only light digging by hand is permitted within 10m of an active sett. All site offices and depots will be sited at least 50m away from badger setts. No work will be undertaken at night in the vicinity of setts (unless as expressely consented to by the EAO upon consultation with the NPWS), to avoid contact with badgers and to reduce the need for artificial lighting.

As with all fauna and wildlife in general, badgers are mobile and can dig new setts and start using unused setts within a short space of time. It is therefore proposed that further surveying of badgers will be undertaken, immediately prior to the land clearance and construction phases and that the mitigation measures are altered according to the results of these surveys. Prior to any work commencing in the vicinity of a badger sett that will be directly affected by the realignment, it must be ensured that badgers are excluded and evacuated following NRA (2006) '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'. All works affecting badger setts will require consultation with the National Parks and Wildlife Service and can only be carried out under licence and with the supervision of a qualified ecologist. Exclusions must not be carried out in the period January to July to ensure that breeding badgers are not affected. A suitably qualified ecologist will be on-site during this course of action. A derogation license to exclude the setts within the development area will be sought from the National Parks and Wildlife Service.

The destruction of a successfully evacuated badger sett may only be conducted under the supervision of qualified and experienced personnel, under license from the NPWS. Prior to demolition works badgers using a sett are usually excluded from the sett over a period of about two weeks using 'one way gates', which block badgers from re-entering the sett. The possibility of badgers remaining within a sett must always be considered; suitable equipment will be available on hand to deal with badgers within the sett or any badgers injured during sett destruction. To compensate for the loss of active badger setts, alternative or artificial setts may have to be constructed. The requirement, location and design of any artificial setts will be agreed at the pre-construction/detailed design stage with an ecologist, site engineers and NPWS. The provision of artificial setts may be reviewed based on activity surveys directly prior to construction.

12.5.1.3.1.2 *Otters*

No work will be undertaken at night in the vicinity of watercourses to avoid contact with otters and to reduce the need for light. The provision of badger / mammal fencing will serve to reduce the potential for otter entering the road corridor.

All culverts/bridges greater than 1m in internal diameter (or height in the case of a box) will be designed to be passable by badgers/otters by providing a ledge on both banks, as per the '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'(NRA, 2006). The ledge will be elevated above normal flood levels. An alternative approach to the provision of a ledge is a separate pipe culvert (600 mm) set above flood level adjacent to the stream culvert. Badger proof fencing will be installed at both sides of the road to ensure that otters do not enter onto the road above watercourse crossings.

12.5.1.3.1.3 *Pine marten, Irish stoat and Irish hare*

The inclusion of the pine marten under Annex V of the EU Habitats Directive (1992) provides for the protection of this species habitat and dwellings. Should a breeding den for pine marten be recorded from within the proposed road route or within the impact zone (ca. 50m), a licence to close the den will be required from the NPWS. If a den is found, no works will be carried out within a 50m radius during the breeding season (this can range from February to August). This species will benefit from the mitigation measures which will be provided for badgers. Pine marten and Irish stoat were not recorded during the current survey. It is proposed to remove hedgerows, ditches and scrub habitat slowly to ensure that any stoats, pine marten or hares present can escape. This will be the common procedure, due to practical constraints. The provision of badger/mammal fencing would keep hares off the road. Hares would also use the underpasses to be provided at bridges/culverts and in specific areas, as part of the badger mitigation measures.

12.5.1.3.1.4 *Bats*

The general mitigation measures for bats will closely follow the NRA (2005a) '*Guidelines for the Treatment of Bats during the Construction of National Road Schemes'* and also the Irish Wildlife Manual No. 25, published by the NPWS '*Bat Mitigation Guidelines for Ireland*' (Kelleher and Marnell, 2006). These documents outline the requirements to be met in the pre-construction (site clearance) and construction phases of road realignment projects in order to minimise negative impacts on resident bats, or prevent avoidable impacts resulting from significant alterations to the immediate landscape. Prior to the commencement of any site works, the contractor(s) should be familiar with all the bat mitigation measures specified in Table 12.22.

It is recommended that a pre-construction bat survey be undertaken in the summer prior to the construction of the road. This survey will be designed to provide an update of the current assessment and to ensure that no significant changes with regard to bat activity have occurred within the study area.

Table 12-22: Summary of mitigation measures for bats along the corridor of the proposed N4 from Collooney to Castlebaldwin.

Mitigation measure	Reason	Location	Method
Habitat creation and provision of vegetation corridors along the alignment	Proposed N4 road may form a linear barrier for bats undertaking local migrations.	Linear planting of high and low canopy woodland and also hedgerow planting mix along almost the entire length of the proposed alignment.	Planting native trees and shrubs such as oak, birch, rowan, willow, blackthorn, hawthorn, etc. Reconnection of hedgerows where feasible to do so, as set out in the proposed Landscape mitigations (Chapter 10)
Provision of alternative roosts	Compensate for loss of roosts/ potential roosts in trees and buildings.	Installation of bat boxes on upstream and downstream sides of proposed new Drumfin and Turnalaydan watercourse crossings. Bat boxes installed on mature trees at Toberscanavan, Tawnagh and directly south of Castlebaldwin.	Schwegler 'woodcrete' boxes have the highest rates of occupation of all box types and are recommended. All bat boxes will be positioned in an elevated position and preferably on the eastern side of the tree (away from prevailing winds).
Provision of underpasses	Allow bats to safely cross the road and connect with vegetation corridors (old and new)	Bridges over the Drumfin River and the Turnalaydan Stream and any underpasses for local/agricultural access will be passable by bats.	Bridge and underpass structures proposed will be passable for bats, allowing for crossing below the alignment.

Mitigation measure	Reason	Location	Method
Careful timing of the works	Bats need to feed at night time, imperative for mothers suckling young during the summer.	Throughout the alignment.	No heavy plant should be in operation in times of darkness. Tree-felling will be undertaken in the period late August to late October/early November when bats (young and old) are capable of flight but not yet in hibernation. Buildings which have been identified as bat roosts should not be demolished during the breeding period of late-May to mid-October.
Restriction on lighting	Artificially boosts insect numbers at night and adversely affects bat species intolerant to light.	Throughout the entire length of the proposed new road, with the exception of specified locations e.g. roundabouts and junctions.	Recommended that artificial lighting along the route is kept to the minimum required for road junctions and their approach roads (as proposed in Chapter 4 of this EIS).
Checking of mature trees prior to felling by an ecologist	Mature trees can be used intermittently by bats during the seasons when they are most active.	All mature trees affected.	The felling of trees will be undertaken piece by piece; after felling, trees are left on the ground and not cut up immediately.
Checking of buildings/ structures prior to demolition by an ecologist	Occupancy by bats.	Old buildings along the proposed corridor.	Demolish immediately following a negative examination by the ecologist. Buildings which have been identified as bat roosts will not be demolished during the breeding period of late-May to mid-October.

The mitigation measures will aim to provide proportional type mitigation responses. Mitigation measures for bats are detailed in the '*Flora and Fauna: Bat Survey Report*' (included as Appendix 12.4, Volume 4 of the EIS) and are summarised here. Progress on the implementation of the measures for bats will be reported to NPWS. In line with NRA (2005b) *'Guidelines for the Treatment of Bats during the Construction of National Road Schemes*' post-construction monitoring of bats will be required in order to establish the effectiveness of the measures that have been put in place.

12.5.1.3.2 *Aquatic ecology and Fisheries*

Any civil engineering works taking place in the immediate vicinity of any watercourse have the potential to generate and release suspended solids and other pollutants. The potential for release to watercourses is greatest during wet weather. An Outline Erosion and Sediment Control Plan has been developed for the construction stage of the proposal for development and implementation by the appointed Contractor. Compliance will be required with this Plan and with the specific measures set out in the Hydrological and Hydrogeological Assessment, Chapter 14 of the EIS.

Control of suspended solids and other pollutants arising from construction activities will employ mitigation measures set out in the Outline Erosion and Sediment Control Plan during the construction phase. The SuDS strategy, as set out in Chapter 4 of the EIS will be implemented during the operation phase to protect the surface water features in the study area. Additional mitigation measures required for pollution prevention and protection of water quality are detailed in the Hydrological and Hydro-Geological Chapter 14 of the EIS; these measures will also provide suitable mitigation for aquatic ecological receptors including fish and macroinvertebrates.

In general, road runoff will be conveyed through Surface Water Channels (on the mainline) before passing through a petrol/oil interceptor and Constructed Wetland attenuation facility at the outfall point. This will result in a treatment standard equivalent to ambient water quality in the affected watercourses.

Constructed Wetlands are provided at all outfall locations for road runoff emanating from the mainline. Spill containment will be placed at all outlets to receiving waters so, in the event of an accidental spillage (e.g. petrol, milk or toxic substances) the spill can be retained. The constructed wetlands will incorporate a permanent vegetated wetland (including native wetland flora as specified in the Landscape and Visual Impact Assessment Chapter 10) to enhance treatment measures. The ponds will improve water quality through the settlement of coarse silts.

Inland Fisheries Ireland is charged under the Inland Fisheries Act (2010) with the responsibility to protect and conserve all freshwater fisheries within its area of jurisdiction. Where the proposed road route requires the

crossing of streams and rivers that support fish, culvert and bridge installations are proposed. As culverts can present major barriers to fish passage, culvert design will incorporate 'fish-friendly' design principles as summarised below: -

- Replication of existing fish favourable conditions (for example riffle flow with loose gravel at the bottom of culverts).
- Culverts will be as short as possible and unscreened.
- Where possible, arch type, "bottomless" units should be used to avoid disturbing the natural bed and gradient. In any event this type of culvert shall be provided for the crossing of the A minor stream (tributary of the Drumderry Stream) at circa Ch. 14,220m. In other cases box culverts shall be used with round culverts limited to short runs, temporary crossings and drains / channels that do not support fish.
- Culverts at all watercourse crossings within the *Proposed Road Development* that support fish will be oversized and laid below the riverbed grade level by approximately 500mm, in line with the requirements set out in the '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes'* (NRA, 2008) and the '*Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites*' (Murphy, 2004). This includes the crossings on the Markree Demesne Stream, the Springfield Stream, the Lissycoyne Stream, the Drumderry Stream and the Drumderry tributary due south of Castlebaldwin.
- Where topography allows, culverts should be laid so as to remain backwatered in drought flow to a depth of not less than 500mm at the upstream invert, thereby providing a fishway over their full length.
- In all cases, provision must be made to ensure that the velocity of flow will be less than the swimming speed.

In the case of the clear span river bridges on the Turnalaydan Stream and the Drumfin River the following mitigation is required:

- No permanent structural features are permitted within the channel, therefore instream works will be to the minimum required and will be restricted to the opening of the proposed Turnalaydan Stream Diversion;
- Adequate clearance will be allowed under river bridges for angler access and mammal passage, if required;

During the course of the works, fish passage conditions must be maintained at all times. Necessary precautions will be taken to ensure the entry of concrete, silt or any other polluting matter to the river is avoided.

Work in the aquatic environment will be carried out outside of the salmonid spawning season and the times that early life stages of salmonid fish will be present. Overall, no instream work will be undertaken during the period October to May. The publication '*Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites'* by Murphy (2004) and the NRA's '*Guidelines for the crossing of watercourses during the construction of national realignments'* (NRA, 2005) will be followed during the construction of the *Proposed Road Development*.

Vegetation clearance works along the riparian corridor of the Markree Demesne Stream to improve flood conveyance will be limited to the removal of vegetation above the water level on one bank of the watercourse, with the opposite bank left intact. No removal of instream vegetation or dredging of the channel will be undertaken. Removal of riparian vegetation will be targeted to include individual trees that are causing an impediment to flood conveyance and overgrown sections of the river bank.

Fisheries enhancement measures including the provision of instream habitat features are proposed for the re-profiled section of channel at the Turnalaydan Stream crossing. These features include the installation of rock armouring along the river bank, random boulder features within the wetted width and the creation of a meandering channel. The provision of these measures within the watercourse is to be agreed with IFI during construction works.

Taking account of the presence of Annex II listed Brook lamprey within the watercourses crossed by the *Proposed Road Development*, instream works in rivers supporting these species will not be carried out during their spawning season. The window for instream works is therefore recommended as July to September inclusive within these watercourses.

12.5.1.3.3 *Birds*

Areas that have been identified as of importance for breeding birds are limited to the wetland habitats, including reed beds, within the wider study area. No habitats of significant importance for breeding birds will

be affected by the Proposed Road Development. The protection of bird breeding habitats during the breeding season (March to August inclusive), are set out in the Wildlife Acts (1976 and Amendment 2000); however, derogations in this legislation for road construction are acknowledged. In addition, no removal of semi-natural habitat, (hedgerows and scrub) will be removed during the breeding season. This will prevent unnecessary impacts on nesting birds. It is recommended that an advance clearance contractor be procured to carry out necessary vegetation removal over the winter season, and supervision of these works undertaken by a qualified and appropriately experienced ecologist appointed by the Project Environmental Manager.

12.5.1.3.4 *Reptiles and amphibians*

Crossing of standing water and drainage channels that could potentially be used by amphibians for spawning, between the months of February to June, will require an inspection by an ecologist to ensure that no spawn or tadpoles are present. A derogation license from the NPWS will be required if frogs are to be interfered with and frogs will be relocated to a suitable habitat in the locality.

12.5.1.3.5 *Terrestrial macroinvertebrates*

Areas to be removed or directly impacted will be examined by a suitably qualified ecologist for the presence of Marsh Fritillary butterfly larvae prior to the commencement of works and a translocation programme undertaken should Marsh Fritillary be recorded. This includes in particular the areas of marsh, fen and wet grassland within the direct route of the proposed road. The construction works adjacent to the sensitive wetland habitats identified within the *Proposed Road Development* will require adequate fencing to avoid trampling and further impacts outside of the required land take. Monitoring for the presence of Marsh Fritillary and control of the contractor's works on site within these sites will be managed by an appointed site ecologist in direct consultation with the NPWS.

Measures for the protection of the hydrological and hydrogeological regime at Aghalenane and Ardloy Loughs have been included in the design for the *Proposed Road Development* and are set out in the section 4.8.5 of Chapter 4. There have been significant design-stage measures adopted for the protection of the wetland habitats at Aghalenane and Ardloy, to the point that the road alignment avoids these sensitive habitats completely. These requirements are specified to avoid impacts affecting the calcareous spring habitats at this location which support *Vertigo geyeri*. The protection of these spring habitats, as detailed in the Hydrological and Hydrogeological assessment, Chapter 14, will effectively protect the population of this protected species with regard to the *Proposed Road Development*.

12.5.2 Operational phase

12.5.2.1 Designated areas

Mitigations for the protection of designated conservation sites are provided with respect to effective water quality protection measures to avoid downstream impacts arising from the *Proposed Road Development* which would have the potential to affect these sites. Surface water treatment systems set out in the design (Chapter 4), as well specific water quality protection measures set out in Chapter 14 Hydrology and Hydrogeology will effectively avoid any significant impacts affecting the aquatic environment of the water-dependant qualifying interests of these designated areas which occur downstream of the *Proposed Road Development.*

12.5.2.2 Habitats and flora

The incorporation of prescribed mitigation measures (in section 10.5) will allow for the landscaped corridor of the *Proposed Road Development* to act as a wildlife corridor or 'stepping-stone' linking agricultural grassland and wetland habitats, with the incorporation of linear hedgerow and woodland habitats with further beneficial impacts for wildlife supported by these habitats. Replanting of wetland and roadside flora during the construction phase will require monitoring and management during the operational phase to ensure the success and establishment of newly created habitats; particularly with regard to the constructed wetland sites.

The success of the geotechnical, hydrological and hydrogeological mitigation for road construction at Lackagh Fen and at Aghalenane / Ardloy Loughs Complex shall be measured by comparing post construction monitoring results against those obtained during pre construction survey, with regard to Fen habitat and Tufa forming springs. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These results will be used to inform future design measures on road construction projects.

12.5.2.3 Fauna

During the operational phase of the realignment the mammal proof fencing will be required to be maintained in effective order. The ongoing management of constructed wetland habitats are expected to contribute to the long term viability of Marsh fritillary within the study area, providing suitable habitat for the development of Devil's bit scabious on wetter ground/wetland fringes. The long term viability of the Aghalenane and Ardloy Loughs wetland complex for *Vertigo* spp. is determined by the efficacy of mitigation measures prescribed in the Hydrological and Hydro-Geological Chapter 14 of the EIS for the protection of the hydrological regime within the Aghalenane and Ardloy Loughs Complex; taking account of the potential for indirect effects on Annex I habitats arising from the *Proposed Road Development*.

12.5.3 Monitoring

During the construction phase of the project the works will be monitored by an independent ecologist, appointed as required by the Environmental Project Manager (as per the NRA guidance in the development of an Environmental Operating Plan) to ensure that the measures to protect water quality and terrestrial ecology are fully implemented by the appointed Contractor. Direct consultation and discussion with the NPWS will be carried out by the Environmental Assurance Officer, or specialist ecologist appointed as necessary, to ensure compliance with all nature conservation legislation, to the satisfaction of all statutory bodies and the correct management of the site to best ecological standards.

As most mammal fauna is highly mobile; it is possible that badger, otter and pine marten dwellings may become active during the current breeding season or interim period following the most recent surveys. It is therefore recommended that further surveying of the route should be undertaken, immediately prior to the construction phase, as per the NRA (2006) '*Guidelines for the treatment of badgers prior to the construction of National Road Schemes*'. The installation of artificial setts for badgers will require a detailed monitoring programme to establish the success of the setts. Construction and operational phase monitoring will be implemented by the Environmental Project Manager, or qualified ecologist appointed as necessary, as per the guidance set out in the NRA Environmental Operating Plan.

Construction phase monitoring will be carried out by the contractor under the Environmental Operating Plan. Regular auditing will be carried out by the Environmental Assurance Officer who will be employed on site by the Client as described in Chapter 4 of this EIS.

The success of the geotechnical, hydrological and hydrogeological mitigation for road construction at Lackagh Fen and at Aghalenane and Ardloy Loughs shall be measured by comparing post-construction monitoring results against those pre construction ones. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These results will be used to inform future design measures on road construction projects. Wetland habitats at Aghalenane and Ardloy Loughs will be subject to ongoing management by the NPWS who are undertaking the management of this wetland habitat and its ecological interests within the CPO of the *Proposed Road Development*.

12.5.4 Reinstatement

The proposed replanting and habitat creation measures set out in the Landscape and Visual Assessment Chapter 10 of the EIS makes provision for recreating and connecting foraging and commuting routes for mammals. The landscaping plan for the road corridor includes provision for the reinstatement of native habitats following the botanical communities recorded to ensure that the benefit of such measures to wildlife are maximised. The native species planting and native grassland seed mixes proposed for Constructed Wetland sites (set out in Chapter 10 Landscape and Visual Impact Assessment) will provide high diversity scrub, hedgerow and wet grassland habitat of value to biodiversity within the study area. Reinstatement of river banks and riparian vegetation is also proposed, where water courses will be crossed by the *Proposed Road Development*.

12.6 Residual Impacts

12.6.1 Designated areas

There will be no direct impact on any designated conservation area. With the mitigation measures proposed any potential indirect impacts on designated areas arising due to downstream water quality effects will also be avoided. Significant mitigation at construction and operational phase have been included in the design (Chapter 4) and also within the Hydrological and Hydrogeological assessment (Chapter 14) to ensure that any

water quality impacts are avoided or are limited to the immediate vicinity of the *Proposed Road Development*, negating downstream effects within any Natura 2000 designation.

12.6.2 Habitats and flora

The *Proposed Road Development* will not result in any significant short-term or long-term impacts affecting habitats evaluated as being of local importance (higher value) to national and international importance i.e. key ecological receptors. Potential significant impacts affecting ecologically sensitive sites which occur within wetland complexes at Toberscanavan Lough, Lackagh Fen, Boathole Lough and Lough Corran and Aghalenane & Ardloy Loughs will be effectively avoided through sensitive design. Design phase mitigations are in place to minimise and avoid hydrological and hydrogeological impacts affecting the groundwater regime at these sites. These habitats areas are not located within, nor are they scheduled for designation as conservation sites. The undulating landscape and calcareous geology leads to ideal conditions for these habitats within the wider study area of the *Proposed Road Development*. It is noted that both fen and transition mire Annex I habitats occur commonly within Co. Sligo outside of any nature designations. There are no significant residual impacts identified with regard to Annex I habitats arising from the *Proposed Road Development*.

The removal of habitats of local ecological value such as wet grassland, treelines and scrub is also anticipated, with effects limited to the local context and not evaluated as significant. Removal of habitats of low or insignificant ecological value such as conifer plantation, artificial surfaces, improved grasslands, drainage ditches, earth banks and stone walls will not be significant in the local context. Temporary and localised effects are envisaged during the construction of the proposed road at proposed watercourse crossings. These will include increased suspended solids and habitat disturbance at each crossing point of the road. With the implementation of the Outline Erosion and Sediment Control Plan, provided for effective mitigation, these impacts are deemed to be temporary at most with a full recovery of the aquatic ecology expected in the local context; therefore these impacts will not be significant. The scale of these impacts will be limited to the local context and will not extend downstream, negating any potential for adverse effects on the water-dependant qualifying interests of the designated Natura 2000 sites within the study area.

12.6.3 Fauna

12.6.3.1 Non-volant mammals

12.6.3.1.1 *Badgers*

The predicted impact of the *Proposed Road Development* on badgers is limited to the local context with implications for individual communities. Impacts will arise during both the short term construction and long term operational phase of the *Proposed Road Development*. The badger populations within the study area are evaluated as being of local importance (higher value). The road will result in the disruption of up to nine badger social groups along the route corridor and will result in the direct loss of one active main sett and two active annex/outlier setts. Other setts may also be lost due to disturbance impacts, as a result of their proximity to the *Proposed Road Development*. It is considered that the additional 3 inactive annexe/outlier setts within the *Proposed Road Development* may become active prior to construction. In addition to impacts on setts the road will result in disturbance to foraging areas, habitat fragmentation and restriction of access to water in some cases. Mitigation measures have been provided to reduce the potential impacts and these will allow badgers to continue to use the local area following the completion of the *Proposed Road Development*.

Overall the study area presents sub-optimal habitat for badgers, with evidence of a depletion in badger territories and loss of previously recorded dwellings between the period 2006 to 2013. In the context of ongoing trends and taking account of the mobility of badger communities within the study area and the mitigation measures provided, the predicted impacts are evaluated as not being significant in the context of the overall project, i.e. within the local scale. Impacts affecting the single active sett are evaluated as significant in the local context, but with mitigation will be reduced to not significant, i.e. the integrity of this badger community (its conservation status) will not be affected.

12.6.3.1.2 *Otter*

With the provision of suitably designed structures and badger/mammal proof fencing, the impacts on otters in the local area can be reduced to below significant levels in the local context, with no significant impacts expected outside of the current study area.

12.6.3.1.3 *Pine marten, Irish stoat and Irish hare*

Although Pine marten and Irish stoat were not recorded during the current survey, it is likely that both species are common in the study area. Both species are expected to use the mammal underpasses, mammal-friendly culverts and road/river underpasses described above. Stoats will live in close proximity to human disturbance and the operation of the *Proposed Road Development* is not considered to pose a significant impact to this species. With the mitigation measures proposed, impacts on this species would be expected to be below significant levels, in the local context. Pine marten populations associated with affected woodland habitats may potentially be impacted; however, residual impacts are evaluated as being below significant levels for both species, limited to the local context.

Hares were recorded in a number of areas along the proposed road corridor. The *Proposed Road Development* has the potential for habitat loss, habitat fragmentation, disturbance and potential road mortality affecting this species. Mitigation measures in place will minimise disturbance during the construction phase and the provision of badger/mammal fencing would keep hares off the road. Hares would also use the underpasses to be provided at bridges/culverts and in specific areas as part of the badger mitigation measures. Overall, residual impacts on hares will be below significant levels in the local context.

12.6.3.1.4 *Other mammals*

The provision of suitably designed culverts and mammal passes, in addition to mammal proof fencing will reduce the impacts on locally important mammal populations in the study area. The predicted impact on these species is assessed as being below significant negative in the local context.

12.6.3.2 Bats

With the mitigation measures proposed, disruption to some established bat commuting routes along the corridor of the proposed road will be reduced to below significant levels. The scale of the predicted impacts will be within a local context only and will not be significant.

12.6.3.3 Birds

Interference with nesting birds would not take place with the mitigation measures proposed. No significant populations of protected species were recorded within the survey area. Although, potential nesting habitat would be lost (scrub, treelines, hedgerows and woodland), these are common throughout the study area. Therefore, predicted impacts on birds would be below significant levels, in the local context.

12.6.3.4 Fish

With the mitigation measures proposed, predicted impacts during construction affecting watercourses and aquatic ecological interests will not be significant. The provisions for water quality protection set out in the Outline Erosion and Sediment Control Plan will effectively reduce the potential for negative effects on fish species within the zone of influence to below significant levels. The drainage design for the *Proposed Road Development*, as specified in Chapter 4, includes for surface water treatment and attenuation systems which will adequately protect the watercourses within the study area during the operational phase of the *Proposed Road Development*. This would lead to improvements in water quality and subsequently fisheries value resulting in positive effects, with reference to the existing N4 road corridor.

12.6.3.5 Aquatic macroinvertebrates

The mitigation measures proposed for fish during the construction phase will ensure that impacts on aquatic macroinvertebrates would not be significant. Drainage design measures set out in Chapter 4, to include surface water treatment and constructed wetland attenuation systems will provide protection for the surface water features within the study area and would lead to improvements in water quality with respect to the unregulated run-off currently derived from the existing road. This is considered to be of benefit to aquatic macroinvertebrates and predicted impacts would be positive in the long term.

12.6.3.6 Terrestrial macroinvertebrates

With the proposed road, there would be a slight reduction in habitat for terrestrial macroinvertebrates. The most ecologically significant habitats affected with regard to terrestrial macroinvertebrates are fen/peatlands, wet grassland and woodland; however, the loss of these habitats would be proportionally small considering the availability of these habitats in the vicinity of the *Proposed Road Development* and the wider study area.

The predicted impact on terrestrial macroinvertebrates will not be significant in the local context, with the implementation of the mitigation measures proposed. Two Annex II listed terrestrial invertebrates were recorded within the study area; the Marsh fritillary butterfly and the whorl snail *Vertigo geyeri*. The dispersed nature of the Marsh fritillary population within the study area, in addition to the limited footprint of the *Proposed Road Development* affecting habitats supporting this species and mitigation measures proposed results in the evaluation that residual impacts affecting this species arising from the *Proposed Road Development* will not be significant in the local context.

Predicted impacts with regard to *Vertigo geyeri*, take account of the proposed drainage design (set out in Chapter 4 of the EIS) and the impact evaluation set out in the groundwater and surface water mitigations (Chapter 14 of the EIS). With the implementation of these measures for the avoidance of groundwater impacts affecting *Vertigo geyeri* habitat, there will not be any significant impacts affecting this species in the local context. It is proposed that theAghalenane / Ardloy complex will be managed into the future by the NPWS with the potential for positive impacts on this species.

12.6.4 Residual impacts affecting key ecological receptors

The key ecological receptors including habitats, flora and fauna have been assessed with respect to the residual impacts remaining following the implementation of the recommended mitigation measures. These residual impacts are summarised and presented in Tables 12.23 and 12.24.

*Table 12-23: Assessment of the Construction Phase Residual Impacts scale and significance; based on the '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes*' (Rev.2, NRA 2009);*

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
Toberscanavan Lough	Road construction leading to direct and indirect habitat loss/disturbance. Installation of an adjustable weir on the outflow stream (Markree Demesne Stream)	Loss of habitat (wet woodland and marginal wetland habitat) and potential water quality impacts with indirect impacts on the aquatic community of this waterbody.	Impacts have the potential to be significant in the local context.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	Based on the provisions with regard to construction phase water quality mitigations set out in the Outline Erosion and Sediment Control Plan; significant impacts in the local context affecting this habitat will be avoided.
Lackagh Fen Complex and other fen habitats	Road construction leading to direct and indirect habitat loss/disturbance	Loss of habitat and potential for hydrological and hydrogeological change resulting in water quality impacts, increased surface water flows and alteration of the recharge rate may affect these wetland habitats. This may result in an indirect impact at a larger scale than the footprint of the works with adverse implications for the ecological structure and function of these habitats within the study area.	Impacts resulting in direct or indirect loss of fen habitat within and adjacent to the route are assessed as potentially being significant negative (as discussed in Chapter 14 Hydrological and Hydrogeological Assessment) and in the absence of mitigation would be certain. Impacts incurred during the construction phase may have longer term impacts with respect to drying out of these wetland habitats which would persist through the operational phase.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat.	Impacts affecting this habitat complex and its ecological functioning are not evaluated as being significant in the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
Boathole Lough & Lough Corran	Road construction leading to direct and indirect habitat loss/disturbance within the south-eastern portion of this site, at a distance from Lough Corran. Construction works in the vicinity of waterbodies and their associated watercourses.	Loss of habitat and potential for hydrological and hydrogeological change resulting in water quality impacts, increased surface water flows and alteration of the recharge rate may affect habitats within the cutover peatland complex. This may result in an indirect impact at a larger scale than the footprint of the works with adverse implications for the ecological structure and function of these habitats within the study area. Water quality impacts would have direct effects on the aquatic communities within the lakes.	Impacts resulting in direct or indirect loss of fen habitat within and adjacent to the route are assessed as potentially being significant negative in the local context and in the absence of mitigation would be certain. Impacts affecting water quality and the ecological communities within the lakes can be avoided with mitigation.	The road construction works area will be fenced off to avoid any further loss of peatland habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access and will not require works within raised bog or lake/lakeshore habitats identified as ecological interests of the Boathole Lough & Lough Corran Co. Sligo Biodiversity Site. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	Impacts affecting this habitat complex and its ecological functioning are not evaluated as being significant in the local context. Based on the provisions with regard to construction water quality mitigations set out in the Outline Erosion and Sediment Control Plan; significant impacts affecting this habitat will be avoided.
Ardloy & Aghalenane Loughs	The *Proposed Road Development* is in close proximity to these lakes and associated wetland habitats and will cross watercourses associated with these lakes	Construction works may potentially affect water quality indirectly, with operational phase impacts arising with regard to increased surface water run-off. Water quality impacts would have direct effects on the aquatic communities within the lakes. The *Proposed Road Development* including excavation and embankment	Impacts are assessed as potentially significant at a national scale in the absence of mitigation. Impacts affecting water quality and the ecological communities within the lakes can be avoided with mitigation.	The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	Based on the provisions with regard to construction phase water quality mitigations set out in the Outline Erosion and Sediment Control Plan; significant impacts in the local context affecting this habitat will be avoided.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
		works would have the potential to affect the groundwater and surface water regime.			
Cuileencroobagh Lough	The *Proposed Road Development* is in close proximity to this small lake/fen complex.	Construction works may potentially affect water quality indirectly. Water quality impacts would have direct effects on the aquatic communities within the lakes.	Impacts are assessed as potentially at a local to county scale, in the absence of mitigation. Impacts affecting water quality and the ecological communities within the lakes can be avoided with mitigation.	The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	Based on the provisions with regard to construction phase water quality mitigations set out in the Outline Erosion and Sediment Control Plan; significant impacts affecting this habitat in the local context will be avoided.
Swallow Holes Complex	Road will cross watercourse draining into this complex	Construction works may potentially affect water quality, surface water run-off and groundwater recharge, with indirect implications for this habitat complex. Water quality impacts would have direct effects on the aquatic communities within the swallow holes and potentially affect groundwater and perhaps the River Unshin	Impacts are assessed as potentially significant at a local to national scale and in the absence of mitigation are considered likely.	The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	Based on the provisions with regard to construction phase water quality mitigations set out in the Outline Erosion and Sediment Control Plan; significant impacts affecting this habitat in the local context will be avoided.
Marsh (GM1)	Habitat loss due to road construction	Loss of marsh habitat due to the footprint of the road is expected. Impacts are assessed as being imperceptible in the local context and would not constitute a significant impact	Impacts affecting marsh habitat are considered to be certain within the land take of the *Proposed Road Development*; however these will be limited to a local scale and will not be significant in this context.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Compensatory planting of native wet	Residual impacts affecting this habitat will not be significant in the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
		to the conservation status of this habitat at the local or County scale		grassland species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	
Wet willow/alder/ash woodland (WN6)	Habitat loss due to road construction	Habitat loss and the removal of woodland within the land take is assessed as being slight to moderate in the local context and would not constitute a significant impact to the conservation status of this habitat at the local or County scale	Land take causing habitat loss is considered a certain impact, although limited in scale. This will result in potentially significant impacts with respect to the local context of the woodland at Toberscanavan and at the Drumfin River crossing, in the absence of mitigation.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Replanting of riparian and wet woodland is prescribed in the Landscape and Visual Impact Assessment (Chapter 10), to compensate for habitat loss. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat.	Residual impacts affecting this habitat will not be significant In the local context.
Oak/ash/hazel woodland (WN2)	Habitat loss due to road construction	Habitat loss and the removal of woodland within the land take are assessed as being slight to significant in the local context.	Land take causing habitat loss is considered a certain impact, although limited in scale. This will result in potentially significant impacts with respect to the local context of the study area, in the absence of mitigation.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	Residual impacts affecting this habitat will not be significant In the local context.
Scrub (WS1)	Habitat loss due to road construction	Loss of scrub habitat, with loss of integrity affecting the botanical communities reliant on this habitat.	Impacts affecting scrub within the study area are assessed as being potentially significant in the local context, in the absence of mitigation. Impacts	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and	Residual impacts affecting this habitat will not be significant. In the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
			are considered to be certain, given the proposed route requires the removal of sections of this habitat within the land take.	machinery access. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	
Hedgerows (WL1) / Treelines (WL2)	Habitat loss due to road construction	Hedgerow habitats will be affected by the *Proposed Road Development*, where the route requires the removal of these linear habitats.	Impacts affecting hedgerows and treelines are assessed as potentially significant in the local context, in the absence of mitigation. Cognisance is also taken of the ongoing trends of hedgerow removal identified in the local context.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	Residual impacts affecting this habitat will not be significant In the local context.
Exposed calcareous rock (ER2) at Carrownagark	Habitat loss due to road construction	Loss of calcareous rock habitat due to the footprint of the road is expected and is identified as being in line with local trends, taking account of ongoing land management works at this location.	Impacts affecting this habitat are considered to be certain within the land take of the *Proposed Road Development*; however these will be limited to a local scale. The proposed alignment will not constitute a significant impact to the conservation status of this habitat at the local or County scale.	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access.	Residual impacts affecting this habitat will not be significant.
Badger	Construction phase removal of dwellings. Habitat loss and fragmentation due to road construction	Road construction direct land take of territory and dwellings Direct loss of setts, territory fragmentation, loss of foraging habitat, loss of	Impacts are assessed as being potentially significant within the local context of the individual badger territory / community. Impacts at the scale of the overall *Proposed*	Mitigation measures for badgers are set out in the 'Non-volant Mammal Report' (Appendix 12.3 of Volume 4) and include: a pre-construction survey, badger evacuation measures, protection of setts, provision of four underpasses in the	In the context of ongoing trends and taking account of the mobility of badger communities within the study area and the mitigation measures

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
		wildlife corridors between main sett and outlier setts.	*Road Development*, with regard to the conservation status of this species in the local context are assessed as being potentially significant within established territories, in the absence of mitigation	townlands of Cloonymeenaghan (2 no.), Carrownagark and Drumderry, badger resistant fencing along the entire corridor, supervised sett destruction and creation of artificial setts. All culverts/bridges greater than 1m in diameter will be designed to be passable by mammals by incorporating a ledge. An alternative approach to the provision of a ledge is a separate pipe culvert (minimum 600mm diameter), set above flood level adjacent to the stream culvert. Badger-proof mammal fencing will be installed along the entirety of the road corridor to provide protection for foraging and commuting animals, as detailed in the Non-volant Mammal Report (Appendix 12.3 of Volume 4). Further surveying of badgers will be undertaken immediately prior to the land clearance and construction works and mitigation measures altered according to the results of these surveys. Prior to any work commencing in the vicinity of a badger sett directly affected by the road (within 30m), it must be ensured that badgers are excluded and evacuated All works affecting badger setts will require consultation with the NPWS and can only be carried out under licence and with the supervision of an approved ecologist.	provided the predicted impacts are evaluated as not being significant in the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
Otter	Habitat loss and fragmentation due to road construction	Road construction and bridge building on the main watercourses resulting in the loss of riparian habitats with further potential impacts affecting foraging connectivity and also the fish populations within the river.	Impacts are assessed as potentially significant in the local context of each watercourse crossing in the absence of mitigation.	Mitigation measures for otter include the provision of mammal ledges within culverts and mammal fencing along the road corridor, as detailed in the Non-volant Mammal Report (Appendix 12.3 of Volume 4).	With the provision of suitably designed structures and mammal proof fencing, as detailed in the Non-volant Mammal Report (Appendix 12.3 of Volume 4) the impacts on otters in the local area will be reduced to below significant levels in the local context.
Pine marten, Irish stoat and Irish hare	Road construction leading to habitat loss and fragmentation	Loss of habitat and foraging habitat with additional fragmentation impacts due to presence of road.	The impacts affecting these species are evaluated as potentially significant within the zone of influence of the *Proposed Road Development* (i.e. local scale), in the absence of mitigation	Exclusion fencing and mammal passes for badger and otter will minimise disturbance to these species.	With the mitigation measures proposed, impacts on this species will not be significant in the local context.
Bats	Road construction leading to habitat loss and fragmentation	Road construction requiring the felling of linear and localised woodland habitats and the demolition of derelict buildings.	Impacts affecting bats are evaluated as being potentially significant in the short term and local in extent – in the absence of mitigation.	Habitat creation and provision of linear woodland corridors as set out in the Landscape and Visual Impact Assessment mitigations (Chapter 10); provision of alternative roosts after consultation with NPWS; careful timing of the works; restriction on lighting; checking of mature trees prior to felling by an ecologist; checking of buildings/ structures prior to demolition by an ecologist	With the mitigation measures proposed, impacts on this species will not be significant in the local context.
Atlantic salmon	Road construction adjacent to aquatic environment, construction of culverts and bridges across the main watercourses	Construction works may potentially affect water quality and habitat integrity with direct impacts affecting salmon. Water quality impacts would	In the absence of mitigation impacts affecting water quality and the Atlantic salmon populations within these watercourses are assessed as certain, based on the proximity	No works will be carried out during the salmonid close season (unless agreed with IFI). Water quality protection measures will be adhered to following the prescriptions of the Hydrological and Hydrogeological	With the mitigation measures proposed, impacts on this species will not be significant in the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
		have direct effects on the salmon and fisheries communities within the rivers. The seasonality of works may impact on the breeding season of salmon, when they are most susceptible.	of construction works to the river corridors. Potential impacts are evaluated as potentially significant in the local context, in the absence of mitigation.	Assessment (Chapter 14) and the Outline Erosion and Sediment Control Plan for the construction stage of the development.	
White-clawed crayfish	Road construction adjacent to aquatic environment, construction of bridge across the main watercourses	Construction works may potentially affect water quality and habitat integrity with direct impacts affecting white-clawed crayfish. Water quality impacts would have direct effects on the aquatic communities within the rivers.	Impacts affecting water quality and the crayfish communities within these watercourses are assessed as certain, based on the proximity of construction works to the river corridors. Potential impacts are evaluated as significant in the local context, in the absence of mitigation.	Minimisation of footprint within the aquatic environment, with further requirements for removal of this species in advance of works in the aquatic environment. Water quality protection measures will be adhered to following the Hydrological and Hydrogeological Assessment (Chapter 14) and the Outline Erosion and Sediment Control Plan for the construction stage of the development.	With the mitigation measures proposed, impacts on this species will not be significant in the local context.
Brook lamprey	Road construction adjacent to aquatic environment, construction of bridge across the main watercourses	Construction works may potentially affect water quality and habitat integrity with direct impacts affecting salmon. Water quality impacts would have direct effects on the aquatic communities within the river. The seasonality of works may impact on the breeding season of lamprey, when they are most susceptible.	Impacts affecting water quality and the brook lamprey populations within these watercourses are assessed as certain, based on the proximity of construction works to the river corridors. Potential impacts are evaluated as potentially significant in the local context, in the absence of mitigation.	Mitigations for water quality and the protection of salmon within the aquatic environment will serve to protect lamprey. Water quality protection measures will be adhered to following the Hydrological and Hydrogeological Assessment (Chapter 14) and the Outline Erosion and Sediment Control Plan for the construction stage of the development. Brook lamprey will be removed prior to any works carried out within the instream habitats, particularly along the shallow water's edge. This will require an electrical fishing survey and a licence to undertake	With the mitigation measures proposed, impacts on this species will not be significant in the local context.

	Construction Impacts				
Key Ecological receptor	Proposed Activity	Characterisation of unmitigated impact on the feature	Significance without mitigation and confidence level	Mitigation and Enhancement	Residual significance and confidence level
				this work from the Department of Communications, Energy and Natural Resources.	
Marsh Fritillary butterfly	Direct loss of habitat within the footprint of the *Proposed Road Development*, isolation / fragmentation of metapopulation	Potential for long term alteration to hydrological and hydrogeological regime with potential water quality and direct drainage impacts identified resulting in loss of food plant	Without mitigation impacts are assessed as potentially significant in the local context.	Mitigation includes design and creation of new wetland habitats in the form of Constructed Wetlands as set out in the Landscape and Visual Impact Assessment (Chapter 10). These habitats will be suitable for colonisation by the food plant (Devil's bit scabious) and will form 'stepping stones' for the connectivity of suitable habitat within the *Proposed Road Development*. Additional surveys in advance of construction are required for larvae / larval webs, with potential requirement for translocation during the construction stage.	With the mitigation measures proposed, impacts on this species will not be significant in the local context.
Vertigo geyeri	Road construction works including excavation and embankment construction	The proposed alignment is in close proximity to the Annex I wetland habitats supporting this species and has the potential to affect the groundwater and surface water flows regime.	Potential impacts affecting the supporting habitats at construction stage are considered likely and would have the potential for significant impacts on the *Vertigo geyeri* population.	Mitigation measures set out in the Hydrological and Hydrogeological Assessment (Chapter 14) for the effective protection of surface water and groundwater flows will effectively protect the supporting habitats of this species. The protection of groundwater-dependant spring habitats at Aghalenane and Ardloy Loughs Complex will effectively protect this species.	With the mitigation measures proposed, impacts on this species will not be significant in the local context.

*Table 12-24: Assessment of the Operational Phase Residual Impacts scale and significance; based on the '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes*' (Rev.2, NRA 2009);*

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
Toberscanavan Lough	No further operational impacts affecting this habitat are expected.	Impacts are characterised as being at a local scale with no further operational impacts anticipated.	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant in the local context with regard to groundwater quality, groundwater contributions and surface run-off.	The Drainage Design (Chapter 4) and mitigation measures specified in the Hydrological and Hydrogeological Assessment (Chapter 14) provide operational stage mitigation for the effective protection of surface water and groundwater. There will be no road run-off or surface water discharge to this waterbody. The proposal to allow for a potential incremental change to water levels via an adjustable weir includes the requirement that no significant change be affected on the receiving environment in the local context, and requires consultation with the NPWS (Section 4.8.5.1.4 of the EIS).	Residual impacts affecting ecological interests during the operational phase are assessed as not being significant in the local context.
Lackagh Fen and other fen habitats	No further operational impacts affecting this habitat are expected.	Impacts are characterised as being at a local scale with no further operational impacts anticipated.	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant in the local context with regard to groundwater quality, groundwater contributions and surface run-off.	Mitigation measures for the protection of Lackagh Fen are limited to effective management of surface water and groundwater flows. Measures for the protection of groundwater flows are set out in Chapter 4 and include the provision of a drainage layer at the base of the road embankment; rock fill to allow the through-flow of groundwater; and vertical hydraulic barriers to stop groundwater from flowing along the embankment. The Constructed Wetlands / attenuation ponds on the alignment adjacent to Lackagh Fen are evaluated as being sufficient to balance the surface/ground water flows within the fen complex. The creation of wetland habitats, as part of a surface water and drainage management system i.e. Constructed Wetlands as per the Drainage Design (see	Residual impacts during the operational phase are assessed as not being significant in the local context, with regard to the conclusions of the Hydrological and Hydrogeological Assessment (Chapter 14).

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
				Chapter 4) with the incorporation of wetland habitats, as set out in the Landscape and Visual Impact Assessment Chapter (Chapter 10) in addition to new peatland habitats within spoil repository sites would be considered appropriate to mitigate for the removal of wet grassland and fen habitat.	
Boathole Lough & Lough Corran	Surface water run-off and potential pollution events through road spill.	Negative impacts affecting the ecological status of the river in the local context, with potential for further impacts downstream; particularly in relation to water quality	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant negative in the local context with regard to groundwater quality, groundwater contributions and surface run-off.	Measures for the protection of groundwater flows are set out in Chapter 4) and include the provision of a drainage layer at the base of the road embankment and vertical hydraulic barriers to stop groundwater from flowing along the embankment. Water quality mitigation measures have been set out in Chapter 14 Hydrological and Hydrogeological Assessment for the effective protection of surface water and groundwater.	Residual impacts during the operational phase are assessed as not being significant in the local context, with regard to the conclusions of the Hydrological and Hydrogeological Assessment (Chapter 14).
Ardloy & Aghalenane Loughs	Surface water run-off and potential pollution events through road spill.	Negative impacts affecting the ecological status of this wetland habitat in the local context, with potential for further impacts downstream; particularly in relation to water quality and also with regard to alteration to groundwater and surface water regime	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant in the local context with regard to groundwater quality and groundwater contributions and surface run-off.	Measures for the protection of groundwater flows are set out in Chapter 4) and include the provision of a drainage layer at the base of the road embankment and vertical hydraulic barriers to stop groundwater from flowing along the embankment. During the operational phase the surface water runoff and attenuation ponds must be managed to ensure that they are working effectively and impacts to surface and ground water quality are not arising.	Residual impacts during the operational phase are assessed as not being significant in the local context, with regard to the conclusions of the Hydrological and Hydrogeological Assessment (Chapter 14).
Cuileencroobagh Lough	Surface water run-off and potential pollution events through road spill.	Negative impacts affecting the ecological status of the river in the local context, with potential for further impacts downstream; particularly in relation to water quality	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant in the local context with regard to	Measures for the protection of surface water and groundwater flows are set out in the Hydrological and Hydrogeological Assessment (Chapter 14).	Residual impacts during the operational phase are assessed as not being significant in the local context, with regard to the conclusions of the

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
			groundwater quality and with regard to groundwater contributions and surface run-off.		Hydrological and Hydrogeological Assessment (Chapter 14).
Swallow Holes Complex	Surface water run-off and potential pollution events through road spill.	Potential water quality impacts affecting the ecological status of this wetland habitat in the local context, with potential for further impacts downstream.	Operational impacts are informed by the Hydrological and Hydrogeological Assessment (Chapter 14) and are evaluated as certain and potentially significant in the local context with regard to groundwater quality with regard to groundwater contributions and surface run-off, in the absence of mitigation.	Measures for the protection of surface water and groundwater flows are set out in the Hydrological and Hydrogeological Assessment (Chapter 14).	Residual impacts during the operational phase are assessed as not being significant in the local context, with regard to the conclusions of the Hydrological and Hydrogeological Assessment (Chapter 14).
Marsh (GM1)	No further operational impacts affecting this habitat are expected.	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts are not likely to give rise to significant effects.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.
Wet willow/alder/ash woodland (WN6)	No further operational impacts affecting this habitat are expected.	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts are not likely to give rise to significant effects.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.
Oak/ash/hazel woodland (WN2)	No further operational impacts affecting this habitat are	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts are not likely to give rise to significant effects.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
	expected.				
Scrub (WS1)	No further operational impacts affecting this habitat are expected.	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts are not likely to give rise to significant effects.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.
Hedgerows (WL1) / Treelines (WL2)	No further operational impacts affecting this habitat are expected.	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts are not likely to give rise to significant effects.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.
Exposed calcareous rock (ER2) at Carrownagark	No further operational impacts affecting this habitat are expected.	Impacts are characterised as not significant at a local scale with no further operational impacts anticipated.	Operational impacts evaluated are not likely to be significant.	There are no operational mitigations proposed for this receptor.	Residual impacts during the operational phase are assessed as not significant in the local context.
Badger	Potential for increase of disturbance and habitat fragmentation	Impacts would include the fragmentation of territories and foraging habitat, with further impacts affecting the dispersal of badger communities within the local area	Impacts are evaluated to be likely, and potentially significant in the local context	Operational mitigations for badger are limited to ensuring that the mitigations employed during construction phase including artificial setts and wildlife fencing are operating effectively.	Residual impacts during the operational phase are assessed as not significant in the local context.
Otter	Potential for increase of disturbance and habitat fragmentation	Impacts affecting otter would be limited to disturbance and access along the Drumfin River and Turnalaydan Stream.	Operational impacts are evaluated as being limited to the local context, where probable impacts affecting water quality and increased disturbance are likely, and may potentially be significant.	No operational mitigations, other than the maintenance of mammal fencing as for badger, are required for otter.	Residual impacts during the operational phase are assessed as not significant in the local context.

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
Pine marten, Irish stoat and Irish hare	Potential for increase of disturbance and habitat fragmentation	Permanent loss of woodland habitat and fragmentation of woodland corridors would impact on this species within the zone of influence.	Without mitigation impacts are assessed as being unlikely to give rise to significant effects in the local context.	No operational mitigations, other than the maintenance of mammal fencing as for badger, are required for pine marten, Irish stoat and Irish hare.	Residual impacts during the operational phase are assessed as not significant in the local context.
Bats	Operational phase include disturbance and increased risk of road death	Impacts on bats during the operational phase of the proposed new road would be increased lighting and disturbance and increased risk of road death	Impacts affecting bats during the operational phase are not evaluated as having the potential for significant effects.	No operational mitigations are prescribed for bats	Residual impacts during the operational phase are assessed as not significant in the local context.
Atlantic salmon	Operation of the N4 realignment	Potential for uncontrolled surface runoff and pollution events resulting in deterioration in water quality within the aquatic environment.	Without mitigation impacts are assessed as potentially significant in the local context.	Operational mitigations to protect water quality within the aquatic environment will also protect salmon.	Residual impacts during the operational phase are assessed as not significant in the local context.
White-clawed crayfish	Operation of the N4 realignment	Potential for uncontrolled surface runoff and pollution events resulting in deterioration in water quality within the aquatic environment.	Without mitigation impacts are assessed as potentially significant in the local context.	Operational mitigations to protect water quality within the aquatic environment will also protect white-clawed crayfish.	Residual impacts during the operational phase are assessed as not significant in the local context.
Brook lamprey	Operation of the N4 realignment	Potential for uncontrolled surface runoff and pollution events resulting in deterioration in water quality within the aquatic environment.	Without mitigation impacts are assessed as potentially significant in the local context.	Operational mitigations to protect water quality within the aquatic environment will also protect brook lamprey.	Residual impacts during the operational phase are assessed as not significant in the local context.
Marsh Fritillary butterfly	Operation of the N4 realignment	Potential for long term alteration to hydrological and hydrogeological regime with potential water quality and	Without mitigation impacts are assessed as being potentially significant in the local context.	Mitigation includes replanting and management of high diversity grassland and wetland habitat within the proposed Constructed Wetlands within the CPO as	Residual impacts during the operational phase are assessed as not significant in

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
		direct drainage impacts identified resulting in loss of food plant		detailed in the Landscape and Visual Impact Assessment (Chapter 10). This will provide suitable habitat to support the colonisation of the food plant (Devil's bit scabious). It is proposed to undertake a pre-construction baseline survey of Marsh fritillary populations at Lackagh Fen, Aghalenane/Ardloy Loughs and at any other locations this species has been recorded within the development footprint. The success of the geotechnical, hydrological and hydrogeological mitigation for road construction in each of these areas shall be measured by comparing post construction monitoring results against those pre construction ones. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These results will be used to inform future design measures on road construction projects.	the local context.
Vertigo geyeri	Operation of the N4 realignment	Potential for long term alteration to hydrological and hydrogeological regime with potential water quality and direct drainage impacts identified resulting in loss of supporting habitats.	Without mitigation impacts are assessed as likely, and potentially significant in the local and national context.	The measures for the protection and sustainable management of the hydrological and hydrogeological regime at the supporting Annex I habitats (Aghalenane and Ardloy Loughs) are set out in Chapter 4 and in the Hydrological and Hydrogeological Assessment (Chapter 14). It is proposed to undertake a pre-construction baseline survey of Vertigo geyeri at Aghalenane/Ardloy Loughs. The success of the geotechnical, hydrological and hydrogeological mitigation for road construction at this location shall be measured by comparing post-construction monitoring results against those pre construction ones. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These results will be used to	Residual impacts, taking account of the groundwater and surface water measures in place during the operational phase are assessed as not significant in the local context.

	Operational Impacts				
Key Ecological receptor	**Proposed Activity**	**Characterisation of unmitigated impact on the feature**	**Significance without mitigation and confidence level**	**Mitigation and Enhancement**	**Residual significance and confidence level**
				inform future design measures on road construction projects.	

12.7 Mitigation to offset Residual Impacts

12.7.1 Enhancement measures

Measures to offset impacts have been incorporated into the mitigation proposals, as described in Section 12.5 of the current assessment. Further enhancement measures may be a requirement following impacts imposed within the zone of influence that were not predicted or foreseen during the preparation of the current assessment, or alternatively, resulting from impacts arising from non-compliance with mitigation measures during the construction operations.

12.7.2 Compensation measures

No further requirements for compensation measures are envisaged that have not been addressed in the mitigation measures section of the current assessment

12.8 Cumulative Impacts

Cumulative impacts affecting the flora and fauna within the zone of influence of the *Proposed Road Development* include pressures arising from agriculture, land drainage, one off housing, forestry operations, drainage maintenance works on the aquatic habitats within the Unshin River catchment (particularly within the cSAC) and also further agricultural land reclamation works affecting the fen and wetland habitats within the study area. Further cumulative impacts would be expected to affect mobile fauna within the study area, particularly arising from the continued use of the existing N4 corridor, with further traffic disturbance and habitat fragmentation along the proposed new road corridor. The study area is relatively free of non-native invasive species; however, Japanese knotweed was recorded at a number of discrete locations along the existing N4 during the survey work undertaken during 2012.

12.8.1 Potential Waste Activity outside the limits of the Proposed Road Development

Chapter 4 of this EIS provides an outline of the spoil management approach for the *Proposed Road Development* which considers that the majority of the surplus spoil material produced will be contained within controlled areas within the limits of the *Proposed Road Development*. However, in considering that there may be some surplus still accruing after exhaustion of these sites, this assessment considers the sites recommended for consideration in the Spoil Management Report contained within volume 4 of this EIS. These sites which include LDCP 01, 04, 05 & 06 and LDAG01 & 02 have been assessed from an ecological perspective and are not considered to give rise to any significant cumulative impacts with respect to the *Proposed Road Development*.

12.9 Summary

The *Proposed Road Development* will extend from the townlands of Collooney/Toberbride to the north to the townland of Cloghoge Lower to the south. It will involve construction of both a new greenfield route and also the retrofitting of a section of the existing N4 south of Collooney which will incorporate some online improvement works. This report assesses the implications of this *Proposed Road Development* on Flora and Fauna (Ecology) and builds upon the constraints study and route selection assessment carried out by Dr. Don Cotton during 2000. The current assessment was prepared following the updated '*Guidelines for the assessment of ecological impacts of National Realignments – Revision 2*' (NRA, 2009); and took cognisance of additional relevant NRA Guidance as follows:

- *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes* (NRA, 2008);
- *Environmental Impact Assessment of National Road Schemes – A practical guide* (NRA Re. 1 2008);
- *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* (NRA 2006b)
- *Guidelines for the Treatment of Badgers Prior to the Construction of a National Road Schemes* (NRA 2006);
- *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (NRA 2005b);
- *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (NRA 2008);
- *Guidelines for the Treatment of Otters during the Construction of National Road Schemes* (NRA, 2008);

- *Institute of Ecology and Environmental Management Guidelines for Ecological Impact Assessment* (IEEM 2006);

Following a desktop review of available literature and data pertaining to the ecological interests within the study area, a suite of field surveys were undertaken during 2005 and 2006, which included a survey of the habitats and flora within the study area, as well as a mammal survey and freshwater aquatic study. Additional field surveys were carried out during 2009, 2010, 2012 and 2013 to establish the status of mammal activity (particularly badger) and also to carry out a screening survey for the presence of Marsh Fritillary butterfly and whorl snails within the study area. The field study covered a survey corridor width of 350m on both sides of the route, and was extended to 500m where necessary to include particular ecological features of importance (i.e. main badger setts). The corridor was examined for mammal signs and direct observations were also recorded. A detailed bat study was carried out along the route of the proposed road, with bat surveys carried out during the spring, summer, autumn and winter of 2006, during 2010 and also during the summer of 2013.

Further field surveys along the proposed route corridor were carried out during September to December 2012 and again during the botanical growing season over the summer of 2013 to assess wetland habitats within the study area and to provide informed evaluations of same, with specific regard to the priority Annex I habitat 'Petrifying Springs with Tufa formations' and the Annex II whorl snail species *Vertigo geyeri*. The 2013 surveys were also commissioned to determine whether there had been any significant changes in the receiving environment during the intervening period. Updated surveys to assess any changes in mammal activity or land-use are recommended, should a period of ten to twelve months pass between survey data and works commencing on site (NRA, 2006), or if a successive breeding season has elapsed.

There are no designated nature conservation sites within the footprint of the *Proposed Road Development*. The River Unshin cSAC and the Lough Arrow cSAC and SPA complex are identified as being hydrologically connected to the *Proposed Road Development* via surface water hydrology and watercourses crossed by the *Proposed Road Development* which lie within the River Unshin catchment. There are no designated Natural Heritage Areas (NHA) or proposed Natural Heritage Areas (pNHAs) affected by the Proposed Road Development, other than those sites that are already identified as being designated within the Natura 2000 network. The field study recorded thirty habitats within the study area of the *Proposed Road Development*, classified according to '*A Guide to Habitats in Ireland*' (Fossitt, 2000). Of the habitats recorded within the study area, six areas / habitat complexes were identified as being of greater than local importance (higher value): The Toberscanavan Lough complex (National Importance), Lackagh Fen Complex (National Importance); Boathole Lough & Lough Corran (County Importance); Ardloy and Aghalenane Loughs Complex (Nationally Important habitats, entire wetland complex evaluated as being Internationally Important taking account of the Annex II invertebrate species present); Cuileencroobagh Lough (County Importance); and the Swallow Holes Complex (National Importance). An additional six habitats were identified as being of local importance (higher value); as evaluated following the '*Guidelines for the assessment of ecological impacts of National Realignments – Revision 2*' (NRA, 2009). No protected flora were recorded during the field survey element of the study.

New realignments have the potential to have a wide range of impacts on mammals. Construction results in habitat loss due to land take and once built, roads can act as physical barriers to wildlife migrations, therefore reducing dispersal and colonisation movements. With regard to fauna within the zone of influence of the *Proposed Road Development*, a wide range of mammalian fauna were recorded, with badger densities evaluated as being of local importance (higher value), taking account of a general trend of reduction in badger activity within the study area over the survey period of 2006 to 2013. Mammal species including otter, Irish hare, fox, rabbit and hedgehog were recorded from the study area; additional species including Pine marten, Irish stoat and rodent species common in the Irish countryside are also expected to occur.

Overall, seven out of the ten Irish bat species were recorded during the summer bat surveys. These were Soprano Pipistrelle *Pipistrellus pygmaeus*, Daubenton's bat *Myotis daubentonii*, Common pipistrelle *Pipistrellus pipistrellus*, Leisler's bat *Nyctalus leisleri*, Natterer's bat *Myotis nattereri*, Whiskered/Brandt's bats *Myotis sp*, and brown long-eared *Plecotus auritus*. Soprano Pipistrelle bats were the most common species recorded during the current survey and are the dominant bat species in this area of County Sligo. The *Proposed Road Development*, in the main, does not significantly impact on commuting, foraging or roosting sites for bats. Most of the *Proposed Road Development* is located in areas currently occupied by agricultural and wet grassland. These areas are of low value to the bat populations present, both in terms of habitat and insect prey production. Moreover, the proposed road generally runs parallel to the existing N4, with the northern and southern section of the proposed road online with the existing road.

Bird species of ecological importance included a significant number of amber listed species which are associated with the lakes and river corridors in the study area (identified as key ecological receptors). The Drumfin River and the Turnalaydan Stream (the Lough Corran outflow) were identified as being key ecosystem receptors; with Annex II listed Atlantic salmon, Brook lamprey, White-clawed crayfish and Otter all supported by these watercourses.

There are no direct impacts arising from the *Proposed Road Development* affecting designated conservation sites; taking account of distance between the development and these sites and in the absence of any direct ecological pathways for impacts potentially affecting cSAC, SPA and NHA (including pNHA) sites. However, all the watercourses in the study area drain into water-dependant Natura 2000 sites; the Unshin River cSAC and the Lough Arrow cSAC and SPA complex. This gives rise to the potential for indirect effects on these designated areas. A separate Natura Impact Statement (NIS) has been prepared to inform the Appropriate Assessment for the *Proposed Road Development*. The NIS report concludes that the *Proposed Road Development* will not, beyond reasonable scientific doubt, have adverse effects, whether directly, indirectly or cumulatively, on the integrity of any Natura 2000 site.

Direct loss of habitats within the footprint of the road with further impacts arising from site clearance and potential water quality impacts affecting aquatic habitats were identified. The scale of impacts affecting habitats identified as key ecological receptors are identified as being potentially significant in the local context evaluated as certain for a portion of fen habitat in the southern area of Lackagh and also with regard to cutover peatland and transition mire at the southeastern corner of Boathole Lough and Lough Corran. Impacts affecting the main watercourses were also evaluated as being potentially significant in the absence of mitigation. Unmitigated impacts affecting fauna identified as key ecological receptors were not considered to be significant for the majority of mammalian species, with the exception of badger communities in the local context; where breeding setts, foraging ground and commuting routes will be lost through the construction of the proposed road. Overall, the construction and operation of the *Proposed Road Development* is not evaluated as having the potential for significant effects on local bat populations in the short or long term.

Specific mitigation measures have been identified to reduce, ameliorate or negate potential impacts affecting key ecological receptors identified during the current assessment. These mitigation measures will require implementation in full in order to achieve an acceptable residual impact as assessed. It is considered that following the implementation of the prescribed mitigations for both the habitats and faunal receptors within the study area the residual impact have been significantly reduced. Further compensatory measures including reinstatement and enhancement measures will be required where works affecting fen, wetland and aquatic habitats (including their dependant faunal communities) will be affected in the long term. Following the implementation of the proposed mitigation measures residual impacts for habitats identified as being key ecological receptors within the zone of influence are evaluated as being reduced to not significant in the local context.

Badger communities were assessed as being affected in the short term in the local context, but not at a significant level with the implementation of mitigation. No long term impacts affecting the conservation interests of this species are identified. Residual impacts affecting the remaining fauna within the zone of influence were assessed as being below significant levels in the local context.

A Schedule of Environmental Commitments is also provided in Chapter 16 of this EIS which highlights the individual mitigation measures necessary for implementation during the construction and operational phases as determined during the preparation of the current assessment; this is provided in addition to those mitigation measures set out in the Hydrological and Hydrogeological Assessment (Chapter 14) and the associated Outline Erosion and Sediment Control Plan for the protection of water quality.

The mitigation measures identified in this assessment will be implemented and adhered to. Construction phase monitoring by a suitably qualified ecologist with knowledge of terrestrial habitats and fauna, as well as protected aquatic conservation interests is required whom will be appointed by the Environmental Manager as is required during the construction phase, as per the NRA Environmental Operating Plan guidance (2006). Post-construction monitoring to establish the efficacy and success of the mitigation measures is also required with regard to protected habitats and species.

12.10 Relevant Figures and Appendices

12.10.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 12.1: Designated Sites and Stream Names;

Fig. 12.2.1-12.2.8: Habitat Mapping and Sensitive Ecological Sites;

Fig. 12.3.1-12.3.8: Volant and Non Volant Mammals;

Fig. 12.4.1-12.4.8: Aquatic Ecology and Fish.;

12.10.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 12.1.: Natura Impact Statement;

Appendix 12.2.: Flora Species List;

Appendix 12.3.: Non Volant Mammals;

Appendix 12.4.: Bats Survey;

Appendix 12.5 Bird Survey Report;

Appendix 12.6.: Aquatic Ecology and Fish Assessment;

Appendix 12.7.: Targeted Molluscan Survey;

Appendix 12.8.: Dedicated Spring Survey;

Appendix 12.9: Photographic Plates

13 Soils and Geology

13.1 Introduction

13.1.1 Overview

The *Proposed Road Development* is part of an upgrade to the existing N4 which passes through Collooney and Castlebaldwin in eastern County Sligo. The proposed road upgrade realigns the existing N4 to pass through the townlands of Collooney, Toberbride, Toberscanavan, Cloonamahan, Ardcurley, Doorly, Knocknagroagh, Drumfin, Cloonlurg, Carrowkeel, Carrownagark, Kingsbrook Aghalenane, Ardloy, Springfield, Tawnagh, Cloonymeenaghan, Sheerevagh, Cloongad, Drumderry, Castlebaldwin, Cloghoge Upper and Cloghoge Lower as outlined in Figure 4.1.1 to 4.1.8 (Volume 3 of this EIS). The proposed road total length is approximately 14.71km. This detailed study on the Soils and Geology of the study area forms part of the general Environmental Impact Statement on the proposed route, for a design issued by the National Road Design Department of Sligo County Council in July 2013.

13.1.2 Aim of Study

The aim of this detailed study is to identify the impacts of the construction and operation of the *Proposed Road Development* and associated works on the hydrology and hydrogeology of the study area and to identify possible mitigation measures to minimise these impacts.

The study includes:

- A survey, description, classification and assessment of the existing hydrological and hydro-geological aspects of the environment through which the road is proposed to be built;
- A description and assessment of the likely impacts of the road, both positive and negative, on these aspects of the environment;
- A description and assessment of the possible mitigation measures to minimise these impacts;
- A description and assessment of the residual impacts after mitigation;
- A description and assessment of the impact interactions and cumulative impacts.

13.2 Methodology

13.2.1 Relevant Guidance & Legislation

This detailed study has been prepared using the following guidelines outlined in Table 13-1.

Table 13-1: Guidelines Considered

Guidelines
Environmental Protection Agency (2002) Guidelines on Information to be Contained in an Environmental Impact Statement – March 2002
Environmental Protection Agency (2003) Advice Notes on Current Practice (in preparation of Environmental Impact Statements – September 2003
DG Environment (2002) Guidelines on the Assessment of Indirect & Cumulative Impacts as well as Impact Interactions
National Roads Authority (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1, November 2008
National Roads Authority (2008) Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
British Standard (1990) Methods of test for soils for civil engineering purposes, Parts 1 to 9 - BS 1377:1990
British Standard (1999) The code of practice for site investigation - BS 5930: 1999

13.2.2 Desk Study

The proposed road design, road cut and fill depths, details of site investigation and water level data from monitoring boreholes installed along the proposed road route were supplied by Sligo County Council. The proposed road design used herein was provided by the design team and is based on a design prepared for the purposes of Phases 3 and 4 of the NRA Project Management Guidelines (2010).

The desk based work items involved the following:

1. Definition of the study area, in accordance with NRA guidelines[58] as 250m beyond the landtake boundary of the proposed route and taking account of potentially significant impacts which could arise at a greater distance away;
2. Compilation of all relevant plan maps relating to the study area and *Proposed Road Development* ;
3. Acquisition and compilation of all available regional information on the geology of the study area, including interrogation of the Geological Survey of Ireland's (GSI) geological and hydrogeological mapping and national karst feature databases and the Exploration and Mining Division of the Department of Communications, Energy and Natural Resources;
4. Acquisition and examination of the Ordnance Survey of Ireland's (OSI) mapping and aerial photography;
5. Identification of possible karst features on OSi 1:50,000 and 1:10,560 scale maps and aerial photography;
6. Acquisition and compilation of the available borehole logs, trial pitting logs and geotechnical results of site investigations conducted for the study area;
7. Acquisition and examination of the results of geophysical surveys undertaken along the *Proposed Road Development*;
8. Consultation with statutory consultees and interested organisations, namely the GSI and the Speleological Union of Ireland;
9. Assessment of proposed road cuts, soft ground areas and potential borrow pits which are required to be excavated as part of the *Proposed Road Development* and which are relative to the geology in the study area.

13.2.3 Field Investigations

Site investigations were conducted for the study area by Priority Geotechnical Limited between May 2006 and November 2012, which involved drilling, monitoring, borehole installation, trial pitting and geotechnical testing. The results of these investigations were made available to this study. These field investigations consisted of the following:

- 96 trial pits (TP);
- 57 exploratory cable percussion boreholes;
- 40 rotary cored boreholes;
- 6 Geobore points;
- 73 dynamic probes;
- In situ testing consisting of Standard Penetration Tests and California Bearing Ratio (CBR) tests;
- Laboratory testing consisting of moisture content, particle size distribution, atterberg limits, pH and sulphate content, dry density, MCV, re-compacted CBR, BOD, COD and point load testing.

The field investigations conducted for this study involved the following:

1. Route walkover survey within the study area;
2. Karst feature survey to locate and examine any karst features and to identify where karstified bedrock is located within the study area;
3. Geophysical surveying was conducted over specific study areas along the *Proposed Road Development* by Minerex Geophysics Limited in February 2006and Apex Geophysics in 2006 and 2013. This survey involved seismic refraction to map overburden thickness, depth to bedrock and to indicate overburden stiffness and bedrock quality. The results of this survey were made available to this study.

[58] *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

13.2.4 Limitations & data gaps

The identification of collapse karst features or sinkholes buried beneath the subsoil geology often requires historic knowledge of an area, as these features are often not identified on OSI maps. Therefore, the presence of karst features near the proposed road alignment cannot be limited to those identified on a map or found during a site walkover and the findings should rather be taken as an indication of the susceptibility of the study area to karstification. However all practical efforts were made during the route walkover to identify karst features along and near the *Proposed Road Development* and within the study area.

13.2.5 Analytical Quantities estimated

The earthworks volumes quoted in this Chapter of the EIS are as supplied by the design team and are based on the preliminary alignment design, preliminary ground investigations and the subsequent geotechnical interpretation of these investigations. The volumes are calculated primarily on a cut/fill basis outputted from the road design package '*MX Road',* the volumes are then categorised into their acceptability limits with the surplus volume being that which is required to be imported. Additionally, portions of the road alignment are located on soft ground, principally peat material that is not usually 'suitable' for road construction purposes. The exact method of construction will not be known until a contractor has been appointed for the project; however, the design aided by results of the preliminary GI has adopted the assumption that all soft material unsuitable for supporting the weight of the proposed route would be dug out and replaced with suitable fill material. These volumes have been calculated and are generally based on the assumption that the soft ground will be excavated from within a 1V:1H influence line from the crest of the embankment, or to the embankment toe at the final ground surface, whichever is greater. Class 6A granular fill is required to fill below standing water. Class 1 or Class 2 general fill material can be used to construct the embankment above water level with a suitable geotextile separator or Class 6H blinding layer at the interface with the Class 6A fill.

In terms of additional site-won material, the Spoil Management Report included in appendix 4.3 has been referred to and the assumptions made therein are relevant in terms of this assessment.

13.2.6 Impact Assessment Methodology

The impact assessment compiled for this report is based on the design of the proposed road and revisions to date (July 2013). The design incorporates measures to mitigate impacts by avoidance, such as the raising of the alignment out of sensitive areas and specific geotechnical measures to avoid indirect Hydro-Geological Impacts (as described in Chapter 3 of this EIS); for assessment purposes, these measures are considered as design mitigation measures. The design incorporates measures to mitigate impacts by reduction, such as the provision of a drainage design system which seeks to adopt SUDS principles through Pre Treatment, Source Control and Site Control as outlined in section 4.8.2. of Chapter 4, however, for the assessment purposes of this Chapter and for transparency the benefits which these features will provide are not considered during the impact assessment process but rather as mitigation in the proceeding section. For residual assessment purposes, the design proposal is then considered taking these measures into account.

From the desk and field data acquired, the following assessments were undertaken to evaluate the potential impacts of the *Proposed Road Development* on the geological environment:

1. Characterise the existing geological environment based on the topographical and geological data acquired;
2. Identify the potential impacts on the geological environment, having regard to soil and subsoil geology, soil and materials handling, soil removal and disposal, bedrock geology, karst geology, economic/ mineral geology and geological heritage, in line with NRA guidelines58;
3. If impacts are identified, consider measures that would mitigate, re-mediate or reduce the identified impact;
4. Identify any residual impacts that would remain or arise from the mitigation measures identified;
5. Present and report these findings in a clear and logical format that complies with EIS reporting requirements.

The above approach was undertaken following the EPA guidelines[59]. The likely significant impacts were described using the five-tier system presented in the EPA advice notes[60], by reference to quality of impact,

[59] Environmental Protection Agency *Guidelines on Information to be Contained in an Environmental Impact Statement* – March 2002.

[60] Environmental Protection Agency (2003) *Advice Notes on Current Practice (in preparation of Environmental Impact Statements* –

significance of impact, duration of impact and types of impact and using the criteria for rating site attributes and for rating impact significance as presented in the NRA guidelines58.

13.3 Existing Environment

13.3.1 Geology

13.3.1.1 Soil geology

The regional soil geology for the *Proposed Road Development* and study area is mapped by Teagasc as predominantly soil association no. 28, with interspersed pockets of soil associations numbers 7, 43 and 44[61]. The following Table summarises the principal and associated soil types for each association, the parent material, the broad physiographic division, the topography and the land use potential61.

Table 13-2: Regional Soil Types

No.	Principal Soil Type	Associated Soil Types	Parent Material	Physiographic Division	Topography	Usage
28	Grey brown podzolics (60%)	Gleys (20%, Inter-drumlin peats & peaty gleys (20%)	Mostly limestone glacial till	Drumlin with drier mineral & organic soils	Gently rolling with subdued drumlins	Limited use range, tillage or grassland
7	Rendzinas (15%) & outcropping bedrock (75%)	Lithosols (5%) & shallow brown earths (5%)	Limestone	Hill	Rolling to steep	Limited use range, sheep & dry stock grazing
43	Gleys (60%)	Brown earths (20%) & peaty gleys (20%)	Alluvium	Flat to undulating lowland	Flat	Production of wide range of tillage crops & pasture production
44	Basin peat	-	-	Flat to undulating lowland	Flat	Very limited usage

According to the soil geology mapping compiled by Teagasc, the *Proposed Road Development* and study area are underlain predominantly by acid brown earths and brown podzolics (AminDW interspersed with pockets of surface and groundwater gleys (AminPD), peaty gleys (AminPDPT), basin peats and blanket peats (Cut), renzinas and lithosols (BminSW) and alluvium type soils[62] (A) (Figure 13.1 contained within volume 3 of this EIS). The following Table summarises the soil types, drainage characteristics and parent material.

Table 13-3: Soil Types

Code	Soil type	Drainage characteristics	Parent material
AminDW	Acid brown earths & brown podzolics	Deep well-drained mineral soil	Non calcareous sandstone/ shale till
AminPD	Surface & groundwater gleys	Deep poorly-drained mineral soil	Non calcareous sandstone/ shale till
AminPDPT	Peaty gleys	Peaty gleys	Non calcareous sandstone/ shale till
Cut	Basin peats & blanket peats	Cutaway/ cutover peat	Cutaway/ cutover peat

September 2003.

[61] An Foras Taluntais (1980) *Soil associations of Ireland and their land use potential.*

[62] Teagasc (2006) *Forest Inventory and Planning System – Irish Forest Soils, Subsoil Mapping Element, Methodology for Subsoil Mapping.*

Code	Soil type	Drainage characteristics	Parent material
BminSW	Renzinas & lithosols	Shallow well-drained mineral soil	Calcareous - limestone till
AlluvMin	Alluvium	Variable	Variable

The results of site investigations conducted by Priority Geotechnical generally recorded the soil type as brown clay, slightly sandy to sandy to slightly gravelly to gravelly in places, with numerous roots and rootlets or dark brown slightly sandy to sandy peat or peaty/ organic clay with numerous roots and rootlets[63]. The 'topsoil' depths range from 0.1m to 0.5m63.

The significance of the soil geology is that the study area contains pockets of basin peats, blanket peats, surface and groundwater gleys and peaty gleys, which are likely to be more difficult to re-use or dispose of appropriately than the well-drained mineral type soils. The sensitivity of the soil geology is that removal and appropriate re-use or disposal will be required for the excavation of the proposed road cuts, soft ground areas and potential borrow pit locations.

13.3.1.2 Subsoil geology

According to the subsoil geology mapping compiled by Teagasc, the *Proposed Road Development* and study area are underlain predominantly by shale and sandstone till, derived chiefly from till derived chiefly from Namurian rocks, interspersed with pockets of alluvium, karstified bedrock at the surface and cutover peat (Figure 13.2 contained within volume 3 of this EIS)[58].

Till is a non-lithified, non-sorted or poorly sorted sediment, which contains a wide range of particle sizes deposited by or from glacier ice and are also referred to as 'boulder clays'61. Alluvium is a post-glacial deposit, usually bedded, may consist of gravel, sand, silt or clay in a variety of mixes and usually consists of a fairly high percentage of organic carbon (10%-30%)[61]. Alluvium is mapped only on modern day river floodplains. Peat is also a post-glacial deposit, consisting mostly of vegetation which has only partially decomposed61. This vegetation fills and compacts in marshes, ponds and other lakes carved out and left by Quaternary ice sheets. Thus, in Ireland, peat usually overlies badly drained glacio-lacustrine silts and clays. Cutover peat is mapped where peat thickness is of 1 metre or more61.

According to the results of site investigations, the *Proposed Road Development* is generally underlain by sandy gravelly clay/ silt and/ or very clayey sandy gravel63,[64] (see Figure 13.4.1 – 13.4.8 in volume 3 and Appendix 13.4 contained within volume 4 of this EIS). In addition, the site investigations identified isolated areas of very soft peat at the surface along the proposed alignment to a maximum depth of circa 6.3m. These areas of soft ground are further described in section 13.3.1.3. These results generally concur with the subsoil geology as mapped by Teagasc58, with the exception of areas of peat around BH36-38 which are mapped as being underlain by alluvium.

The subsoil thickness ranges from 0.8m and 14.7m (see Figure 13.4.1 – 13.4.8 in volume 3 of this EIS). The highly variable nature of subsoil thickness is indicative of a karstified bedrock surface and a landscape punctuated with drumlin glacial features. The following Table summarises the locations where thin subsoil was encountered during site investigations (1-2m deep).

Table 13-4: Areas of thin subsoil

Road Chainage	Location	Site Investigation Points
Ch. 4100	Knocknagroagh	RC04
Ch. 8300-8600	Carrownagark	RC17, RC20
Ch. 9400-10400	Aghalenane	RC22, RC25, RC30, RC31

[63] Priority Geotechnical Limited (2006) *Report on Preliminary Ground Investigation – Factual Report for N4 Realignment Collooney to Castlebaldwin, Co. Sligo* & Priority Geotechnical Limited (2012). *Preliminary Ground Investigation Phase II– Factual Report for N4 Realignment Collooney to Castlebaldwin, Co. Sligo.*

[64] AGL Consulting Engineers (2008) *Preliminary soils and geology report for the N4 Realignment – Collooney to Castlebaldwin Road Scheme, Final Report. Preliminary Ground Investigation Phase II– Factual Report for N4 Realignment Collooney to Castlebaldwin, Co. Sligo.*

Road Chainage	Location	Site Investigation Points
Ch. 10600	Ardloy	RC34
Ch. 13400	Drumderry	RC49
Ch. 13800	Castlebaldwin	RC52

The significance of the subsoil geology is that the study area contains pockets of cutover peat, which is likely to be more difficult to re-use or dispose of appropriately than the other well-drained mineral type soils. The sensitivity of the subsoil geology is that removal and appropriate re-use or disposal will be required for the excavation of the proposed road cuts.

13.3.1.3 Ground conditions

According to the results of the site investigations, approximately 35% of the *Proposed Road Development* is underlain by soft to very soft soil material. This classification is based on the results of Standard Penetration Tests (SPT) and shear strength (Cu) conducted by Priority Geotechnical Limited and on the geological descriptions of soft peat and soft to very soft slightly sandy organic clay63. These materials are generally considered unsuitable for road construction purposes. The following Table summarises these locations, the thickness of soft material and the associated SPT and Cu results, from drilled boreholes where available. Trial pit and dynamic probe results where peat and/or marl were encountered are also included.

Table 13-5: Areas of soft subsoil

Approx. Chainage (m)	ID	Description (BH & TP description relates to the soil type while PH description relates to probe progress)	Thickness (m)	SPT
Ch 1,400	BH103	Silt, fill and soft peat	6	SPTN=2-3
Ch1,500	BH104	firm silt	4.5	SPTN=12
Ch2,240	BH105	Very soft, dark brown, plastic amorphous peat with decaying wood.	2.0	SPTN=1-2
Ch3,400	TP206	FIRM, peaty silt, soft slightly sandy and gravelly clay	1.8	-
Ch3,420	DP102	-	3.9	N100=0
Ch 3,440	TP07	Pseudo fibrous peat, organic silt	2.85	-
Ch3,500	DP103	-	4.1	N100=0
Ch3,500	TP207	Soft peat, soft slightly sandy and gravelly clay	2.8	-
Ch3,570	PH02	Easy	4.0	-
Ch3,600	TP208	peat, soft, slightly sandy and gravelly clay	2.6	-
Ch3,620	PH03	Easy	3.1	-
Ch3,700	TP209	Sandy, peaty SIL, soft slightly sandy and gravelly clay, very silty very sandy gravel	2.8	-
Ch3,710	PH04	Easy	1.1	
Ch4,000	BH5	Very soft sandy, slightly gravelly clay	0.4	-
Ch4,050	BH6	Very soft slightly sandy, slightly gravelly clay	0.38	SPTN=1
Ch4,400	BH107	Very soft, dark brown, plastic amorphous peat with lenses of cream, slightly sandy Silt with shells. Sand is fine. Light brown, slightly gravelly sandy silt with lenses of cream slightly sandy Silt with shells. Sand is fine to	1.9	SPTN=2

Approx. Chainage (m)	ID	Description (BH & TP description relates to the soil type while PH description relates to probe progress)	Thickness (m)	SPT
		medium. Gravel is fine, subangular.		
Ch4,420	PH06	Easy/medium	3.1	-
Ch4,510	PH07	Easy/medium	4.0	-
Ch4,540	TP122	Fibrous Peat, very soft slightly sandy marl	4.5	-
Ch4,610	PH08	Easy/medium	3.8	-
Ch4,610	TP123	Fibrous Peat, very soft slightly sandy marl	4.5	-
Ch,4,710	PH09	Easy/medium	4.5	-
Ch4,810	TP09	Very soft gravelly clay	1.9	-
Ch4,910	PH10	Easy	1.8	-
Ch5,010	PH11	Easy/medium	2.7	-
Ch5,100	TP124	Amorphous Peat, very soft slightly sandy marl, soft clay	4.5	-
Ch5,110	PH12	Easy	4.5	-
Ch5,210	PH13	Easy/medium	4.5	-
Ch5290	TP125	Fibrous Peat, very soft slightly sandy marl	4.5	
Ch5,310	PH14	Easy	4.3	-
Ch5,410	PH15	Easy/medium	4.1	-
Ch5,500	BH9	Very soft peat	3.5	SPTN=0
Ch5,500	BH10	Very soft peat	1.5	SPTN=0
Ch5,630	TP10	Plastic amorphous peat	0.7	-
Ch5,700	BH11	Very soft slightly sandy, slightly gravelly peat	1.5	SPTN=0
Ch6,600	BH13	Very soft slightly sandy, gravelly silt	3.25	SPTN=1-2
Ch6,660	PH209	-	3.2	N100=0-9
Ch6,740	TP17	Soft, sandy, gravelly clay	2.5	-
Ch6,770	PH210	-	2.1	N100=0-10
Ch6,800	PH20	Easy/medium	5.2	-
Ch6,860	PH212	-	4.4	N100=0-4
Ch6,870	PH211	-	3.7	N100=0-19
Ch6,910	PH21	Easy/medium	6.1	-
Ch6,960	PH213	-	2.1	N100=0-11
Ch7,000	PH22	Easy	6.1	-

Approx. Chainage (m)	ID	Description (BH & TP description relates to the soil type while PH description relates to probe progress)	Thickness (m)	SPT
Ch7,060	PH214	-	3.0	N100=1-8
Ch7,060	PH215	-	2.9	N100=0-5
Ch7,100	PH23	Easy	6.3	-
Ch7,150	PH216	-	2.7	N100=1-6
Ch7,210	PH217	-	4.5	N100=2-16
Ch7,220	PH218	-	2.5	N100=1-11
ch7,250	BH108	Very soft, black, spongy fibrous peat. Very soft, dark brown, plastic, amorphous peat.	3.0	SPTN=0-1
Ch7,360	PH219	-	1.5	N100-1-13
Ch7,390	DP105	-	7.5	N100=0-3
Ch7,390	DP106	-	6.9	N100=0-3
ch7,400	BH109	Very soft, dark brown, plastic, amorphous peat. Very soft, yellow/ light brown, sandy silt with decaying organic material and shells. Sand is fine to medium	4.0	SPTN=0-1
Ch7,410	PH26	Easy/medium	8.2	-
Ch7,480	PH220	-	2.6	N100=0-11
Ch7,480	PH221	-	3.4	N100=0-14
Ch7,510	PH27	Easy/medium	5.6	-
Ch7,600	PH28	Easy	2.9	-
Ch7,660	PH222	-	2.3	N100=0-6
Ch7,660	PH223	-	2.0	N100=1-14
Ch7,700	PH29	Medium	2.7	-
Ch8,300	BH19	Soft slightly sandy, slightly gravelly clay	1.5	SPTN=4
Ch9,510	TP129	Fibrous peat, very soft silt	3.4	-
Ch9,510	PH225	-	0.8	N100=1-12
Ch9,530	TP212	Soft, slightly sandy and gravelly clay	2.3	-
Ch9,540	TP212b	Soft, slightly sandy and gravelly clay, stiff clay, firm silt and firm silt	4.5	-
Ch9,600	BH28	Spongy to very soft peat Very soft silt	1.9 1.5	SPTN=0 SPTN=0
Ch9,610	PH226	-	1.5	N100=1-17
Ch9,670	TP213	Soft, slightly sandy and gravelly clay	2.5	-

Approx. Chainage (m)	ID	Description (BH & TP description relates to the soil type while PH description relates to probe progress)	Thickness (m)	SPT
Ch9,710	PH227	-	1.0	N100=1-14
Ch9,680	TP130	Amorphous peat, very soft silt, very soft clay	2.4	-
Ch10,200	BH31	Soft slightly sandy, slightly gravelly clay Very soft slightly gravelly peat	0.5 0.45	SPTN=0 SPTN=0
Ch10,400	BH34	Soft slightly sandy, slightly gravelly clay	0.95	SPTN=2
Ch10,700	BH36	Very soft peat Very soft organic clay	3.5 1.55	SP N=0 SPTN=2
Ch10,750	BH113	Very soft, dark brown, plastic, pseudofibrous peat. Very soft, dark brown, plastic, fibrous peat with shell fragments.	5.5	SPTN=0-4
Ch10,750	BH37	Soft peat Soft clay	4.2 3.3	SPTN=0-4 SPTN=5-7
Ch10,800	BH38	Very soft peat	2.0	SPTN=0-6
Ch11,920	TP32	Soft, slightly sandy silt	2.6	-
Ch12,120	TP131	Amorphous peat, very soft sandy clay, very soft silt	4.5	-
Ch12,300	BH45	Soft peat	4.6	SPTN=3-4
Ch12,740	DP109	-	1.3	N100=1-3
Ch13,300	BH50	Soft sandy, slightly gravelly clay	0.84	SPTN=14
Ch13,720	DP110	-	4.1	N100=0-4
Ch13,740	TP43	Soft-firm, slightly sandy silt	1.5	-
Ch13,830	DP111	-	6.0	N100=0-12
Ch13,900	BH115	Very soft, dark brown, plastic, pseudofibrous peat. Very soft, grey/ brown, slightly sandy organic silt with decomposing organic material. Sand is fine to medium. Soft, dark grey, slightly sandy clay. Sand is fine to medium.	4.3	SPTN=1-7
Ch13,950	TP44	Very soft, pseudofibrous peat, very soft, slightly sandy organic clay, very soft, slightly sandy organic silt and clay	3.3	-

The significance of the ground conditions is that where the *Proposed Road Development* is underlain by soft ground unsuitable for road construction purposes, this material may require removal and appropriate re-use or disposal (refer to section 4.10.2 of chapter 4 for more information). The soft ground is likely to be sensitive to drying out and to compaction. Additional characterisation of existing ground conditions is presented in the Preliminary Geotechnical Interpretive Report for the development, extracts from which are presented in Appendix 13.4 contained within volume 4 of this EIS

13.3.1.4 Soil Chemistry

According to the soil mapping compiled by Teagasc, the soil geology underlying the *Proposed Road Development* is natural and assumed to be uncontaminated62. In addition, no observations of contamination are recorded in the site investigation data63. Therefore no soil sampling or analysis for chemical properties has been undertaken.

13.3.1.5 Bedrock Geology

According to the bedrock mapping compiled by the Geological Survey of Ireland (GSI), the *Proposed Road Development* and study area are underlain by wholly Carboniferous bedrock[65],[66],[67]. The majority of the *Proposed Road Development* is mapped as being underlain by the Bricklieve Limestone Formation (lower) (BKL) (Figure 13.3 contained within volume 3 of this EIS). The *Proposed Road Development* is also underlain by the Bricklieve Limestone Formation (upper) (BKU), and the Lisgorman Shale Formation (LG). The following Table summarises the bedrock geology underneath each section of road, formation description, depth and stratigraphy.

Table 13-6: Bedrock Geology

ID	Name	Description	Thickness	Stratigraphy
BKU	Bricklieve Limestone (upper)	Bioclastic cherty limestone	Unknown	Youngest to oldest ↓
BKL	Bricklieve Limestone (lower)	Bioclastic cherty limestone	Unknown	
LG	Lisgorman Shale	Thin-bedded calcareous shale, limestone	Approx. 275m	

The Bricklieve Limestone consists of medium to thick-bedded grey bioclastic limestones, generally wackestones and packstones devoid of internal bedding features[67]. Shale is almost absent except in the lowest exposed beds[67]. Chert is abundant throughout the formation, forming up to 70% of the rock towards the top of the sequence[67]. The Bricklieve Limestone forms part of the 'Upper Limestones' within this region, which were formed during a period of shelf sedimentation with local development of mudbank limestones of Holkerian and Asbian age[67]. The Bricklieve Limestone contains coral beds, and thin intervals of coarser-grained limestones which show cross-bedding, which are evidence of being laid down under shallow water conditions[67].

The Lisgorman Shale is described as dark grey calcareous shales, interbedded with very fine-grained limestones, limestone beds being less than 20cm and usually 5cm in thickness[67]. The formation is 275m thick near Knocknashee[67]. The Lisgorman Shale forms part of the 'Middle Limestones' within this region, which were formed during a regressive episode with a deltaic complex and associated pro-delta shales and muddy limestones of Arundian to Holkerian age[67].

The significance of the bedrock geology is that it permits the formation of distinct karst features and solutionally-enlarged subsurface drainage in areas underlain by the Bricklieve Limestone and potentially along the lithological boundary with the lesser permeable Lisgorman Shale. The sensitivity of the bedrock geology lies in the fact that karstified bedrock can be susceptible to subsidence and that the excavation of road cuts has the potential to impact on subsurface karst features.

13.3.1.6 Structural Geology

The Bricklieve Limestone and Lisgorman Shale formations form part of the Ballymote Syncline, which is bound to the northwest by the Ox Mountains Inlier and to the southeast by the Curlew Mountains Inlier[67]. Within this larger structure, there are two smaller synclines, separated by the north-east to south-west trending Belhavel Fault.

This fault separates the Bricklieve Limestone (upper) from the Lisgorman Shale and the Bricklieve Limestone (lower). The *Proposed Road Development* traverses this mapped fault at approximately ch10,350m, just south of Aghalenane Lough. The fault is generally normal (i.e. hanging wall is on the downthrown side) with some strike-slip movement, assumed to be steeply dipping with varying offset directions and throws along its length.

[65] Minerex Geophysics Limited (2004) *N4 Realignment Collooney to Castlebaldwin, Co. Sligo, Geophysical Survey.*

[66] Geological Survey of Ireland (GSI) online geological & hydrogeological mapping service – www.gsi.ie.

[67] Geological Survey of Ireland (1996) *Geology of Sligo-Leitrim.*

Research shows that faults of this orientation (north-east to south-west), of Caledonian age, are less likely to be associated with high yielding groundwater conditions than north-west to south-east trending ones[68].

The smaller synclines are orientated east-north-east and west-south-west and pass through Ballymote and between Gorteen and Arigna. The *Proposed Road Development* is approximately orthogonal to these synclinal axes. From Collooney to Ballymote, the bedrock dips and strikes towards the smaller Ballymote synclinal axis by approximately 2-5^{o}, with angles increasing to 25^{o} around Aghalenane Lough. The bedrock dips and strikes towards the Gorteen to Arigna synclinal axis by approximately 2-6^{o}[67] .

The significance of the structural geology is that the lithological boundaries between the Bricklieve Limestone and the lesser permeable Lisgorman Shale at approximately Ch. 2,900m and at approximately Ch. 10,350m where the proposed road traverses the mapped Belhavel Fault, may result in the localised formation of karst features.

13.3.2 Karstification

Karstification is the process whereby limestone is slowly dissolved away by percolation waters and results in landscapes characterised by largely underground drainage. The Bricklieve Limestone Formation is extensively karstified with numerous karst features evident at the surface[67]. The national karst feature database, compiled by the GSI, has records for 14 karst features within 2.5km of the *Proposed Road Development* (Figure 13.3 contained within volume 3 of this EIS)[66,67,69] and the karst feature survey identified 57 possible karst features on the ground. The following Table summarises the GSI records and the survey findings.

Table 13-7: Identified Karst Features

ID	Type/ Name/ GSI ID	Easting	Northing	Townland	Approx. distance from road (m)
1	Possible doline	568357	825258	Toberbride	50
2	Spring	568378	825271	Toberbride	50
3	Possible doline	568504	825075	Toberbride	190
4	Possible doline	569345	822898	Doorly	20
5	Spring	569416	823056	Doorly	100
6	Possible doline	569647	822866	Doorly	280
7	Possible doline	569662	822810	Doorly	280
8	Spring	569907	821908	Knocknagroagh	140
9	Spring	570457	821158	Lackagh	500
10	Spring	570954	820191	Drumfin	360
11	Spring (Tobernacreevagh)	573418	818357	Knockadoo	250
12	Spring (St. Patricks Well)	573736	817958	Tawnagh	250
13	Possible doline	571932	819203	Carrowkeel	530
14	Possible doline	571753	818829	Carrowkeel	150
15	Spring	572365	817889	Kingsbrook	0
16	Possible doline	570413	817426	Turlaghyraun	1,800
17	Spring (Tobernaglashy)	574277	818370	Tobernaglashy	1,500
18	Possible doline	572455	817831	Carrownagark	30
19	Possible doline	572057	817270	Kingsbrook	560
20	Possible doline	572257	817021	Kingsbrook	450

[68] Dunphy, R. (2004) *The role of fracture systems in controlling groundwater yields in the post-Silurian rocks of Ireland.*

[69] http://www.ubss.org.uk/irishcaves/irishcaves.php.

ID	Type/ Name/ GSI ID	Easting	Northing	Townland	Approx. distance from road (m)
21	Possible doline	572999	816968	Aghalenane	120
22	Possible doline	573045	817037	Aghalenane	70
23	Possible doline	573064	817105	Aghalenane	0
24	Possible doline	573107	817049	Aghalenane	0
25	Possible doline	573119	817084	Aghalenane	0
26	Possible doline	573231	817009	Aghalenane	0
27	Turlough	573704	817374	Tawnagh	160
28	Turlough	573673	817443	Cloonymeenaghan	160
29	Spring	573865	817514	Tawnagh	170
30	Possible doline	573890	817472	Tawnagh	170
31	Possible doline	573879	817488	Tawnagh	170
32	Spring	573854	817481	Tawnagh	170
33	Possible doline	573880	817490	Tawnagh	170
34	Swallow hole	573869	817442	Tawnagh	170
35	Turlough/ swallow hole	573816	817279	Tawnagh	160
36	Spring	574156	816859	Cloonymeenaghan	10
37	Possible doline	575318	815242	Drumderry	0
38	Possible doline	575368	815172	Drumderry	0
39	Possible doline	575443	815212	Drumderry	0
40	Spring	575483	815524	Drumderry	250
41	Possible doline	574055	816563	Cloonymeenaghan	150
42	Spring	574235	818362	Tobernglashy	1,500
43	Possible doline	574931	814564	Cleavry	650
44	Possible doline	573662	812710	Treanmacmamurtagh	2,500
45	Possible doline	573963	820448	Riverstown	2,700
46	Turlough	573933	820629	Riverstown	2,700
47	Turlough/ swallow hole	573816	817279	Tawnagh	160
48	Spring (Toberbride)	575568	814356	Castlebaldwin	0
49	Spring (Tobermahon)	576098	813386	Drumdoney	100
50	Spring (Tobermahon)	576089	813413	Drumdoney	100
51	Spring/ well (Tobernaveen)	573279	812981	Treanmacmamurtagh	2,600
52	Possible doline/ turlough	573662	812710	Treanscabbagh	2,400
53	Turlough 1731SWK031	573690	812662	Treanscabbagh	2,400
54	Spring	573502	812740	Treanmacmamurtagh	2,400
55	Spring	573493	812728	Treanmacmamurtagh	2,400
56	Spring (Tobermurly)	575526	814289	Castlebaldwin	0
57	Spring (Toberpatrick)	575546	814269	Castlebaldwin	0

The majority of these features lie between c. Ch. 7,000 and Ch. 14,400 and are mapped as being underlain by the Bricklieve Limestone (upper). The clean, thick-bedded nature of the formation, along with the presence of abundant chert renders them very susceptible to karstification. The presence of chert in the limestone acts to concentrate flow into pathways around the highly resistant chert material, thereby enhancing the process of karstification[68]. The remainder of these features are mapped as being underlain by the Lisgorman Shale and the Bricklieve Limestone (lower). These records are considered to represent only a portion of those actually on the ground.

13.3.2.1 Springs

A spring was identified at approximately 80m east of Ch. 0m, which is recorded in the GSI national karst feature database as Toberbride. Despite heavy rainfall, there was no flow observed from the spring during the site visit in November 2009.

A spring was identified at Ch. 1,100m which is recorded as Toberscanavan well. This is not the original spring well which was moved to its current location during previous road widening works. The flow from the spring during the August 2013 site visit was approximately 0.2 l/s.

A spring was identified at approximately 180m east of Ch. 2,750m. A flow of approximately 0.5 l/s was measured from the spring during the site visit in August 2013.

A spring was identified at approximately 200m east of Ch. 3,800m, which rises in an area of wetland to the west of the existing N4, passes under the road and joins a tributary of the Unshin River to the east of the existing N4. The water level was observed to be at approximately 1.5m below the existing N4 road surface during the site visit.

A spring was identified at approximately 400m east of Ch. 4,700m, which feeds an area of wetland to the east of the existing N4. The water level was observed to be at approximately 0.1m below the existing N4 road surface during the site visit in November 2009.

A spring was identified at approximately 400m east of Ch. 5,800m, which was observed to form a ponded area bound by rushes and wetland vegetation. The depth of ponded water was observed to be 0.3m during the site visit in November 2009.

A spring was identified under the footprint of the Proposed Road Development at c. Ch. 8,650m. This spring forms a small stream that drains towards Cuileencroobagh Lough and appears to flow intermittently.

A spring was identified at approximately 80m north of Ch. 10,900m, which was observed to form a ponded area within a woodland area, which flowed downhill at approximately 1-2l/s. The depth of ponded water was observed to be 0.1m during the site visit.

A spring was identified at approximately 250m east of Ch. 12,700m based on historical mapping but this feature was not identified on the ground.

A spring was identified at approximately 80m west of Ch. 13,800m, which is recorded in the GSI national karst feature database as Toberbride. No outcropping bedrock was observed.

13.3.2.2 Possible dolines

A doline is *'a natural depression or hole in the surface topography caused by the removal of soil or bedrock, often both, by water'*[70]. Archaeology such as collapsed souterrains can occasionally be mistaken for dolines and it was necessary to check possible doline locations against the National Monuments Database[71].

A possible doline was identified at approximately 50m east of Ch. 50m.however it is likely if not probable that this feature is part of a souterrain and therefore is archaeology as opposed to a geological feature.

A possible doline was identified at approximately 200m east of Ch. 400m, which contained outcrops of pale grey karstified limestone with Karren and chert and was observed to be dry during the site visit.

A possible doline was identified at approximately 20m east of Ch. 2750m but it is likely that this feature is in fact a disused, historic quarry.

A cluster of 2 possible dolines was identified at approximately 295m east of Ch. 2,900m and orientated approximately east-west. These features were observed to be dry and to contain no outcropping bedrock during the site visit in November 2009. This cluster is in the vicinity of the lithological boundary between the Bricklieve Limestone (lower) and the Lisgorman Shale (Figure 13.3 contained within volume 3 of this EIS).

A number of 5 possible dolines was identified at between c. 150m and 750m east of ch7,200m-8,400m and orientated approximately northeast-southwest. These features were observed to be dry and to contain outcropping pale grey karstified limestone bedrock during the site visit.

[70] USEPA (2002) *A Lexicon of Cave and Karst Terminology with Special Reference to Environmental Karst Hydrology*.

[71] National Monuments service www.archaeology.ie.

A cluster of 2 possible dolines and a spring were identified on and within c. 180m of Ch. 8,500m-8,800m and orientated northwest-southeast. The dolines were observed to be dry and to contain outcropping pale grey karstified limestone bedrock with Karren and chert during the site visit.

A cluster of 6 possible dolines was identified on and within c. 200m of Ch. 9,800m and orientated north-south. The dolines were observed to be dry and to contain no outcropping bedrock during the site visit. This cluster is located within 200m of the mapped lithological boundary between the Bricklieve Limestone (upper) and the Lisgorman Shale. The results of the geophysical survey suggest a thinning of the subsoil geology between Ch. 9,900m and Ch. 10,000m and that bedrock rises to within 2m of the surface, indicative of subsurface recharge features.

A possible doline was identified at approximately 200m southwest of Ch. 11,000m and orientated approximately northwest-southeast. This feature was observed to be dry and to contain no outcropping bedrock during the site visit.

A cluster of 3 possible dolines were identified on and within 60m of Ch. 12,800m-12,900m and orientated northwest-southeast. The possible dolines were observed to be dry, one contained ponded surface water, during the site visit and no outcropping bedrock.

A cluster of a possible doline and a spring were identified at approximately 900m northeast of Ch. 12,900m. The possible doline was observed to contain ponded surface water, while the spring contained ponded groundwater during the site visit. No outcropping bedrock was observed.

13.3.2.3 Turloughs

A turlough is described as *'a topographic depression in karst which is intermittently inundated on an annual basis, mainly from groundwater, and which has a substrate and/ or ecological community's characteristic of wetlands'*[70].

A complex of 1 turlough and 1 turlough-like lake, numerous springs and 2 swallow holes was identified at approximately 330m north of Ch. 10,600m[72] in the townland of Tawnagh. The complex is orientated north-south. The lakes were observed to be very full of water during the site visit in November 2009, with water spreading out onto the adjacent road, fence posts almost submerged and swallow holes totally submerged. No calcareous deposits or water markings on the grass were observed. The water levels were much reduced during site visits carried out during January, February, May and June 2011 with the turlough drying up completely. However, the lake at Tawnagh is fed by a surface channel and did not dry up completely. Due to its connection with the surface drainage system this lake should not be considered a 'classical' turlough in the hydrological sense, but rather as a karst lake highly interconnected with both the surface water and groundwater systems.

A turlough was identified at approximately 550m north of Ch. 10,500m. The turlough was observed to consist of a large area of ponded water during the site visit; however no calcareous deposits or water markings on the grass were observed.

13.3.2.4 Swallow holes

A swallow hole is described as *'a natural depression in the surface topography caused by the removal of soil or bedrock by water'* and which in some cases 'swallow' surface stream flows[70].

In addition to the swallow holes identified as part of the complex at Tawnagh, a swallow hole is mapped and was identified at approximately 2km southeast of Ch. 14,400m (Figure 13.3 contained within volume 3 of this EIS) A stream exits the northern margin of the lake at Tawnagh and discharges into a swallow hole at approximately 80m from the lake's northern boundary. A second swallow hole was identified at approximately 80m from the lake's western boundary.

13.3.2.5 Caves

No caves are recorded in the GSI national karst feature database or were identified during the survey.

[72] Quinlan, C. (2011) *Hydrological study of Tawnagh Lake, Tawnagh, Co. Sligo*.

13.3.2.6 Subsurface features

The results of the geophysical survey between c. Ch. 4,000m and Ch. 13,800m identified no large faults, fracture zones or cavities. The results of site investigation drilling identified a layer of weathered and possibly karstified bedrock underlying the subsoil in RC04-06, RC14-15, RC31, RC35, RC38, RC40, RC49, RC52, RC106, indicative of an epikarstic layer described in the groundwater body description63. This layer ranges from 2.6m to 6.8m in thickness63. The 2013 geophysical survey also identified a subsurface, clay-filled solutional feature to the east of c.Ch. 8,500. The site investigation drilling also encountered cavities, most likely solutional karst cavities in RC16-17 and RC49-50, generally within the top 6-8m of bedrock but at 23m in RC17. No other evidence of karst was noted during the site investigation drilling; however there is always the possibility of encountering further subsurface features during excavation.

The significance of the karst features identified is that the study area is susceptible to karstification and more unidentified subsurface features may exist. The sensitivity of the karstified bedrock lies in the fact that it can be susceptible to subsidence[73]and that the excavation of road cuts has the potential to impact on unidentified subsurface karst features.

13.3.3 Mineral geology

According to the bedrock mapping and the geological data compiled by the GSI and the Exploration and Mining Division (EMD) of the Department of Communications, Marine and Natural Resources, there are no mapped occurrences of industry minerals within the study area[74]. According to EMD records there are no active quarries within 5km (See Fig. 13.5 of Volume 3) of the *Proposed Road Development*[74].

The significance of the mineral geology is that there are no mapped occurrences within the study area; therefore no sensitivity to the *Proposed Road Development* is anticipated.

13.3.4 Geological heritage

To date, sites of geological interest and heritage have not been comprehensively covered by the existing nature conservation designations. The GSI are currently drawing up of a list of sites of national geological interest that will be proposed as Natural Heritage Areas (NHAs)[75],[76]. In the interim, Sligo County Council has listed in the County Development Plan (2011-2017)[77] the geological features of national and local importance with the objective of maintaining their conservation value. The Bricklieve Mountains and Keshcorran are located approximately 1.5km to the south and southwest of the *Proposed Road Development* (Figure 14.1 contained within volume 4 of this EIS). The site is a large isolated block of Carboniferous limestone that reaches a height of approximately 300m. Typical landscape features associated with karst topography are present, caves, dry valleys and limestone pavements.

The significance of the geological heritage is that there is a listed site within the study area, which is characterised by karst topography. The geological heritage in itself is not considered to be particularly sensitive to the *Proposed Road Development* due to its distance from the road footprint.

13.3.5 Land Use

According to the land use mapping compiled by Corine Landcover (2006), the *Proposed Road Development* is predominantly used for pasture, with pockets of peat bogs, discontinuous urban fabric, land occupied by agriculture and significant areas of natural vegetation, non-irrigated arable land and transitional woodland scrub.

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[73] Waltham, A.C. & Fookes, P.G. (2003) Engineering classification of karst ground conditions in *Speleogenesis and Evolution of Karst Aquifers.*

[74] http://www.dcenr.gov.ie/Spatial+Data/Exploration+and+Mining.

[75] Environmental Protection Agency (2007) *Development of a methodology for the characterisation of a karstic groundwater body with particular emphasis on the linkage with associated ecosystems such as turlough ecosystems (2002-W-DS-8-M1).*

[76] National Parks & Wildlife Service www.npws.ie.

[77] Sligo County Council www.sligococo.ie.

According to the Agroclimatic Atlas of Ireland, the area of land used for tillage as a percentage of crops and pasture within the study area is 0-5% and the area of land used for crops and pasture as a percentage of the total area is 70-85%[78].

The significance of the land use is that the study area is predominantly used for pasture and that this land would have a high value on a local scale for local farmers.

13.4 Description of Likely Impacts

13.4.1 "Do Nothing" Scenario

There are no known current environmental trends which would impact the geological environment, should the proposed road not be built.

13.4.2 Impacts on Topsoil Geology

The likely impacts of the *Proposed Road Development* on the soil geology are as follows and are further described in Appendix 13.2 and Appendix 13.3 contained within volume 4 of this EIS

13.4.2.1 Construction phase

(1) The removal and appropriate re-use or disposal of the 'topsoil' material along the proposed route is a certain direct impact to the soil geology during the construction phase. The total volume of topsoil material to be removed and requiring re-use or appropriate disposal is estimated to be in the region of 163,500m^3, based on analytical calculations carried out by the design team. The topsoil is considered to have a low quality on a local scale, consisting of poorly drained and low fertility soils and therefore the importance is estimated to be **low**. The magnitude of this impact is rated as **moderate adverse**, and therefore the significance of this impact is rated **slight**.

(2) The change to the soil structure of soft materials is a likely indirect impact to the soil geology during the construction phase. The construction works will most likely result in disturbance of the soil structure generally along the route corridor, but also in the areas for 'excavate and replace' in soft ground (Appendix 13.3 of volume 4) and on any lands within the CPO being proposed as spoil repositories or landscape infill sites to contain geological materials including sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-LI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, SR/BP Type 02-03, LS-Mit.-01 and LS-Mit.-02. Any changes to the soil structure along the route corridor in terms of compaction are an inevitable part of road construction, are considered to remain relatively localised where soft materials occur and are considered to remain within the CPO landtake as vehicular movements outside of the construction site will occur on constructed access roads or designated haulage routes. The importance of this attribute is rated **low**, the magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **slight.**

13.4.2.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the topsoil geology during the operational phase.

13.4.3 Impacts on Subsoil Geology

The likely impacts of the *Proposed Road Development* on the subsoil geology are as follows and are further described in Appendix 13.2 and Appendix 13.3 contained within volume 4 of this EIS.

13.4.3.1 Construction phase

(1) The removal and re-use or appropriate disposal of the subsoil material, in particular in the vicinity of the proposed road cuts is a certain direct impact on the subsoil geology during the construction phase. The total volume of subsoil material to be removed and requiring re-use or appropriate disposal in cuts is estimated to be in the region of 940,000m3, based on analytical calculations carried

[78] ASMET (1996) *Agroclimatic Atlas of Ireland.*

out by the design team. The total volume of suitable subsoil material to be removed at the proposed road cuts and considered appropriate for re-use (directly for road construction) is estimated to be in the region of 560,000m^3. The total volume of unsuitable subsoil material from cuts is estimated to be in the region of 380,000$m^{3.}$ Subsoil will also be removed from sites SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03. The subsoil geology is considered to have a medium quality on a local scale, with the volume of peat or soft subsoil underlying the route being moderate on a local scale, and therefore the importance is estimated to be **medium**. The magnitude of this impact is rated as **moderate adverse**, and the significance of this impact is rated **moderate**.

(2) The change to the soil structure of soft subsoil materials is a likely indirect impact to the soil geology during the construction phase. The construction works will most likely result in disturbance of the soil structure along the route corridor, but also in the areas for 'excavate and replace' in soft ground (Appendix 13.3 contained within volume 4 of this EIS) and on any lands within the CPO being used as spoil repositories for geological materials including sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03. Any changes to the soil structure in terms of compaction are an inevitable part of road construction but are considered to remain relatively localised where soft materials occur and within the CPO landtake as vehicular movements outside of the construction site will occur on constructed access roads or designated haulage routes. In addition the replacing of soft ground with Class 6A granular fill (classes as defined in accordance with series 600 of NRA Manual of Contract Documents for Roadworks) in the saturated zone and Class 1 or Class 2 general fill in the unsaturated zone will change the soil structure irreparably. The importance of this attribute is rated **medium**, the magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **moderate.**

(3) The reduction in the level of protection afforded to underlying groundwater resources is a likely indirect impact of the removal of geological materials during the construction phase. The excavation of road cuts and removal of geological materials has the potential to increase aquifer vulnerability to groundwater contamination. The proposed road cuts (1 to 12) will reduce the subsoil thickness to less than 3m in places, and therefore increase the aquifer vulnerability from high to extreme. However this impact is considered to remain localised at these proposed road cuts and temporary, exposing the subsoil during the construction phase only. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **small adverse**, and therefore the significance of this impact is rated **moderate.** The associated impacts on water quality are discussed in the Hydrological and Hydrogeological Impact Assessment Chapter.

(4) The potential acceleration of karstification processes in affected areas is a possible indirect impact of the removal of geological materials. However it is unlikely that significant dissolution and enhancement of the limestone would take place over the short duration of the construction phase. Therefore this impact is not considered further, in line with NRA *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*, section 5.4.258.

13.4.3.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the subsoil geology during the operational phase.

13.4.4 Impacts on Ground Conditions

The likely impacts of the *Proposed Road Development* are on ground conditions as follows and are further described in Appendix 13.2 contained within volume 4 of this EIS.

13.4.4.1 Construction phase

(1) The removal and appropriate re-use or disposal of the soft ground along the proposed route is a certain direct impact of the ground conditions. The total volume of soft ground or unsuitable soil and subsoil material, to be removed and requiring re-use or appropriate disposal is estimated to be in the region of 825,000m^3. The ground conditions are considered to have a medium significance on a local scale, with the volume of peat or soft subsoil underlying the route being moderate on a local scale,

and therefore the importance is estimated to be **medium**. The magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **moderate**.

(2) The change to the soil structure of soft materials is a likely indirect impact of the removal of soft materials along the proposed route. The importance of this attribute is rated **medium**, the magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **moderate.**

13.4.4.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the ground conditions during the operational phase.

13.4.5 Impacts on Soil Chemistry

The likely impacts of the *Proposed Road Development* are on soil chemistry as follows and are further described in Appendix 13.2 contained within volume 4 of this EIS.

13.4.5.1 Construction phase

(1) The potential contamination of soil by leakages or spillages is a possible indirect impact to the soil and subsoil geology during the construction phase. The potential contamination of exposed soil by leakages or spillages during construction is considered to remain localised due to the generally low permeability clayey or peaty 'topsoil' and subsoil. The importance of the soil geology and subsoil geology is rated **low** and **medium** respectively; the magnitude of this impact is rated as **small adverse**, and therefore the significance of this impact on the soil and subsoil geology is rated **imperceptible** and **slight** respectively**.** The associated impacts on water quality are discussed in the Hydrological and Hydrogeological Impact Assessment Chapter.

13.4.5.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the soil chemistry during the operational phase.

13.4.6 Impacts on Bedrock Geology

The likely impacts of the *Proposed Road Development* on the bedrock geology are as follows and are further described in Appendix 13.2 and Appendix 13.3 contained within volume 4 of this EIS.

13.4.6.1 Construction phase

(1) The removal and re-use or appropriate disposal of the rock material in the vicinity of the proposed road cuts, of which one extends into bedrock, is a certain direct impact on the bedrock geology. The total volume of rock material to be removed at the proposed road cuts and requiring re-use or appropriate disposal is estimated to be in the region of 27,000m^3. Bedrock will most likely also be removed from borrow pit sites SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03. The bedrock geology is considered to have a medium significance on a local scale, containing no county geological sites but of significance for its susceptibility to karstification, and therefore the importance is estimated to be **medium**. The magnitude of this impact is rated as **small adverse**, resulting in the loss of a small part of the bedrock geology, and therefore the significance of the impact is rated as **slight**.

(2) The potential acceleration of karstification processes in affected areas is a possible indirect impact of the removal of geological materials. However, it is unlikely that significant dissolution and enhancement of the limestone would take place over the short duration of the construction phase. Surface lowering and wall retreat within fissures are no more than a few millimeters per 100 years, unless under very high flow[79]. Therefore this impact is not considered further, in line with NRA *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*,[58].

[79] American Geological Institute (2001) *Living with Karst – A Fragile Foundation.*

13.4.6.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the bedrock geology during the operational phase.

13.4.7 Impacts on Structural Geology

The likely impacts of the *Proposed Road Development* on the structural geology are as follows and are further described in Appendix 13.2 contained within volume 4 of this EIS.

13.4.7.1 Construction phase

(1) The potential collapse of unidentified subsurface karst features associated with the lithological boundary between the Bricklieve Limestone and the lesser permeable Lisgorman Shale may result in the localised formation of karst features and is a possible indirect impact of the structural geology. Another impact of the *Proposed Road Development* on the structural geology is the potential collapse of unidentified subsurface karst features associated with the mapped northeast – southwest trending fault, which traverses the proposed road at c. ch10,300m. However the results of the site investigation show strong limestone bedrock here with some weathering along fracture surfaces. Therefore this impact is not considered further, in line with NRA *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*, section 5.4.258.

13.4.7.2 Operational phase

There are no anticipated impacts of the *Proposed Road Development* on the structural geology during the operational phase.

13.4.8 Impacts on Karst Features

The likely impact of the *Proposed Road Development* on the karst features are as follows and are further described in Appendix 13.2 contained within volume 4 of this EIS.

13.4.8.1 Construction phase

(1) The potential collapse of identified karst features is a possible direct impact on the karst features and on the *Proposed Road Development* during the construction phase. The only proposed road cut that extends into potential saturated limestone which is possibly karstified is 12. The borrow pit sites SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 could potentially intercept karst features although whether or not this is likely to occur will not be known until the borrow pits are excavated. There are no surface signs of karst features at these locations and no signs of subsurface karst were identified during the 2013 geophysical survey.

In general, rapid failure of the ground surface occurs when soil collapses into pre-existing cavities or voids in the bedrock[80]. This collapse or surface subsidence can be triggered by induced local increases of water input to the soil as a result of inadequate drainage along the *Proposed Road Development* or the lowering of the water table from above to below rock head, such as is likely to be required at cut 12. However once the road surface is sealed, the triggering mechanism of altering surface water drainage would tend to be confined to areas beyond the sealed road pavement i.e. along roadside drains[80].

Therefore the disturbance of ground conditions and soil drainage during construction, in particular around cut 12 may undermine the stability of these features and cause soil collapse, further inundation and surface subsidence. The karst features are considered to have a high significance on a local scale, containing no county geological sites but of importance for the prevalence of features and susceptibility for collapse, and therefore the attribute importance is rated as **high**. The magnitude of this impact on the karst features is rated **small adverse**, resulting in loss of a small part of the karst features, and therefore the significance of this impact is rated **moderate/ slight**.

[80] Creed, M.J. (2002) *Remedial measures applied to the engineering solution of Karst problems,* Karst Working Group Seminar, Tullamore, 4 October 2002.

(2) The potential collapse of unidentified subsurface karst features is a possible direct impact on the karst features and on the *Proposed Road Development* during the construction phase. A geophysical survey was conducted between three areas from c. Ch. 7,600m – 12,100m, 13,280m – 13,800m and at Ch. 8,500m which contains the karst features near the *Proposed Road Development*. The surveys identified no fracture zones or unfilled cavities apart from a clay filled solution cavity at Ch. 8,500m, but did identify a series of possible dipping faults and a variably karstified layer of bedrock indicative of an epikarstic layer mentioned in the groundwater body description[81]. The site investigation drill records here for RCs; 15, 16 ,17, 18, 19, 20, 21, 22, 25, 26, 30, 31, 32, 34, 35, 38, 40, 43, 47, 49, 50, 51, 52 and 106 show limestone bedrock that is frequently strong but commonly displaying core loss due to weathering and cavities, including one cavity 1.9m high at a depth of 14.1-16mbgl (RC16) and cavity infill described as 'sand & cave' material (RC31)[63].

The cumulative evidence from site investigation suggests that there is a variable degree of karstification along the route of the *Proposed Road Development* and, although only one large cavity was identified, it is possible that other isolated cavities may be encountered along the route, in particular in cut 12. All practical efforts were made to identify surface and subsurface karst features along and near the *Proposed Road Development*; however there always remains a possibility of encountering subsurface karst features during excavation work in karst environments. The importance of the karst features is rated as **high**. The magnitude of this impact on the karst features is rated **small adverse**, resulting in loss of a small part of the karst features, and therefore the significance of this impact is rated **moderate/ slight**.

13.4.8.2 Operational phase

(1) The change in soil chemistry and potential acceleration of karstification processes where the integration of peat in areas which do not naturally contain peat is a possible indirect impact on the karst features and on the *Proposed Road Development* during the operational phase. Any recharge infiltrating through the placed peat is likely to have a low pH and therefore have a higher potential to dissolve the underlying limestone bedrock. However the low pH is likely to be buffered by the underlying indigenous topsoil and subsoil and significant dissolution and enhancement of the limestone is unlikely to take place. Therefore this impact is not considered further, in line with NRA *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*, (section 5.4.2)58.

13.4.9 Impacts on Mineral Geology

There are **no predicted impacts** to the mineral geology as a result of the *Proposed Road Development* during the construction or operational phases. The mineral geology is considered to have a low value on a local scale, containing no mapped occurrences of industry minerals, and therefore the importance is rated as **low**.

13.4.10 Impacts on Geological Heritage

There are **no predicted impacts** to the geological heritage as a result of the *Proposed Road Development* during the construction or operational phases. The geological heritage is considered to have a low value on a local scale, containing no county geological sites, and therefore the importance is rated as **low**.

13.4.11 Impacts on Land Use

The likely impacts of the *Proposed Road Development* on the land use are as follows and are further described in Appendix 13.2 contained within volume 4 of this EIS.

(1) The removal of the geological materials and construction of the *Proposed Road Development* is a certain direct impact on the existing land use during the construction and operational phases. The existing land use is defined by Landcover (2006) as pasture, with pockets of peat bogs, discontinuous urban fabric, land occupied by agriculture and significant areas of natural vegetation, non-irrigated arable land and transitional woodland scrub. The land use is considered to have a high value on a local scale, containing the pasture land of local farmers, and therefore the importance is rated as **high**. The

[81] Geological Survey of Ireland (2004) *Ballymote groundwater body description.*

magnitude of this impact is rated **small adverse**, resulting in loss of a small part of the attribute, and therefore the significance of this impact is rated **moderate/ slight**.

13.4.12 Summary Table of impacts

The Table in Appendix 13.2 and Appendix 13.3 (contained within volume 4 of the EIS) summarises the likely Impacts of the *Proposed Road Development* on the geological aspects of the environment. These are the impacts of the *Proposed Road Development* before mitigation measures are fully established.

13.4.13 Cumulative & indirect type impacts on geology

13.4.13.1 Cumulative impacts

The cumulative impacts of the *Proposed Road Development* are the combination of many minor impacts creating one, larger, more significant impact. The potential impacts of the N4 Collooney to Castlebaldwin *Proposed Road Development* on the geological aspects of the environment must be considered in combination with the potential impacts of the N17 Collooney to Tobercurry Bypass and the N17 Tobercurry Bypass *Proposed Road Developments*. The upgrade to the N17 Collooney to Tobercurry Bypass is approximately 14km in length and the upgrade to the N17 Tobercurry Bypass is approximately 11km in length.

The attribute ratings and potential impacts are considered to remain the same, as these routes are underlain by similar soil, subsoil, bedrock and structural geology, have a similar occurrence of karst features and are underlain by a similar proportion of soft soil material. However no potentially contaminated sites have been identified along these routes.

It is estimated that there is a potential deficit of suitable material generated from material excavated from the road cuts; this deficit is estimated at c. 650,000m³ for road embankments with a further c. 446,000m³ potentially required underneath road embankments, it is expected that some of this material may be won onsite in the Type 1 and Type 02 spoil repositories or if not imported from offsite. The movement of this material is in addition to the material generated within the cut sections which are considered to be suitable for reuse and amounting to c. 560,000m³ of subsoil and c. 27,000m³ Rock.

13.4.13.2 Indirect impacts

The change to the soil structure of soft materials is a likely indirect impact to the soil geology on any lands outside of the CPO which could potentially be used for the disposal/recovery of 'unsuitable' geological materials. Potential sites which are considered to be broadly suitable for such a purpose are described in section 10 of the Spoil Management Report (appendix 4.3 of volume 4) and include adjacent conifer plantations and low lying agricultural lands.

The integration of surplus materials for the purpose of disposal/recovery of 'unsuitable' geological materials may cause compaction of the underlying indigenous topsoil. The importance of this attribute is rated **low**, the magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **slight**.

The change to the soil structure of soft subsoil materials is a likely indirect impact to the soil geology on any lands outside of the CPO used for the disposal/recovery of 'unsuitable' geological materials. The integration of surplus materials for the purpose of disposal/ recovery of 'unsuitable' geological materials may also cause compaction of the underlying indigenous topsoil. The importance of this attribute is rated **medium**, the magnitude of this impact is rated as **moderate adverse**, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated **moderate**.

The change in soil chemistry as a result of the integration of surplus peat materials is a likely indirect impact on the soil chemistry during the construction phase. In particular, the introduction to an area, which does not naturally contain peat may reduce soil pH and increase soil Total Organic Carbon. The importance of the soil geology and subsoil geology is rated **low** and **medium** respectively; the magnitude of this impact is rated as **small adverse**, and therefore the significance of this impact on the soil and subsoil geology is rated **imperceptible** and **slight** respectively. The associated impacts on water quality are discussed in the Hydrological and Hydro-geological Impact Assessment Chapter.

13.5 Mitigation Measures & Environmental Commitments

13.5.1 Mitigation by avoidance

The design is considered the best possible, in terms of minimising the impact to the geological environment. The 'cut and fill' approach has been followed as far as was reasonably practicable emphasising the requirement to utilise excavated suitable material from road cuts in road embankments; however, the earthworks balance has been largely determined by:

- Poor ground conditions;
- The requirement to accommodate over bridges and under bridges;
- Mitigation by avoidance and reduction which was been actively applied to the design primarily as a result of hydrological and hydrogeological impacts and the influence this has on the vertical alignment;
- The requirement to provide suitable cover for drainage culverts;

The result of these requirements is a significant deficit of suitable material and a surplus of unsuitable material generated onsite. However, having regard to the Department of Environment, Heritage and Local Government (DoEHLG) document: *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects*[82] and the NRA Guidelines for *the Management of Waste from National Road Projects*[83] and through the preparation of the Spoil Management Report (Appendix 4.3 contained within volume 4 of this EIS) and the Outline Construction and Demolition Waste Management Plan (Appendix 4.4 contained within volume 4 of this EIS), the design phase included an analysis of the 'spoil' geological materials being generated and expected surplus and geological materials handling procedures. The design adheres to the fundamental principles for the effective management of raw materials and spoil for road construction by prioritising spoil prevention/minimisation, followed by spoil re-use, recycling and finally disposal for materials that cannot be subject to the other options[82].

Any further changes at the detailed design stage (if made) must ensure that there is no increase in the level of impact to the environment.

13.5.2 Mitigation by reduction

13.5.2.1 Materials Re-Use

Referring to article 2 (1)c of the Directive on Waste and an interpretation of the legislation provided to the design team (Spoil Management Report), soil and rock material excavated from within the boundaries of the CPO and used for site engineering purposes are unlikely to fall within the definition of waste.

13.5.2.1.1 *Suitable topsoil & subsoil material*

The recovered volume of suitable topsoil & subsoil material is considered sufficient for landscaping purposes throughout the *Proposed Road Development* and there are no anticipated requirements for the import or disposal of 'topsoil' material. In addition, the recovered volume of suitable subsoil material and bedrock material, processed into general fill, is to be used in embankments, screening bunds and noise barriers. It will be the contractor's responsibility to source the deficit, some of which is likely to be from the Type 1/Type 02 Spoil Repositories/Borrow Pits included within the limits of the *Proposed Road Development,* or, from local licensed quarries, or, from further borrow pits identified by the contractor in the vicinity of the works.

13.5.2.1.2 *Unsuitable topsoil & subsoil material*

An overview of the estimated quantities of unsuitable topsoil & subsoil material generated by the *Proposed Road Development* and the methods for its treatment and handling are outlined in section 4.10.2.2 of this EIS and within the Spoil Management Report contained within appendix 4.3 to this EIS. The general conceptual

[82] Department of Environment, Heritage and Local Government (2006) *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects.*

[83] National Roads Authority (2008) *Guidelines for the Management of Waste from National Road Construction Project*.

approach is to identify options/sites within the vicinity of the *Proposed Road Development* which are considered suitable in principle to accept or use spoil material arising from the *Proposed Road Development*.

The land spreading of excavated soil and subsoil material outside the boundaries of the road project generally requires planning permission but some forms of land reclamation may constitute exempt development under the Planning and Development Regulations. While this is ultimately the ruling of the consent authority, the contractor should satisfy themselves if such an activity is required that planning permission has been obtained or is not required for the offsite management of waste generated on the project.

13.5.2.1.3 *Rock material*

The preliminary design includes for the recovery and appropriate re-use of in the region of 27,000m^3 rock material, excavated at proposed road cuts. This material is to be re-used either in excavated form or processed as aggregates, in embankments, facings, noise barriers, culvert headwalls, gabions, channel linings, buttresses in rock slopes, rock trap bunds and road drainage systems. In addition to this there is potential for rock material to be won on site principally from the Type 02 Spoil Repositories/Borrow Pits No. 01, 02 and 03, this material may be used by the contractor in similar instances to the above.

13.5.3 Soil Disposal

As already discussed in section 13.5.2.1 soil and rock material excavated from within the boundaries of the CPO and used for site engineering purposes are unlikely to fall within the definition of waste.

This volume of 'waste' (which is the material remaining) is to be stockpiled separately to any potentially contaminated 'waste' soil materials. The potential of this volume of 'waste' for reuse is to be explored in preference to offsite disposal. However, should offsite disposal prove the most suitable option, the stockpile is to be examined for non-inert materials such as wood, which are generally not acceptable at permitted waste land spreading sites, and should be removed prior to transport. On inspection, the stockpile is to be removed offsite by a licensed haulier.

The main contractor shall be required to keep full records of all waste collection permits held by subcontractors involved in moving 'waste' soil and subsoil materials from the *Proposed Road Development*, all waste licences, permits and registration certificates covering the destination of the 'waste', details of any exemption from the above requirements and details of the quantities and type of 'waste'. In addition, the contract documents are to ensure that all relevant legislation is complied with and that a waste management plan is prepared in accordance with Department of Environment, Heritage and Local Government document: *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects*.

13.5.4 Soil Handling

13.5.4.1 Topsoil

The handling of excavated 'topsoil' materials is to be managed in such a way to maintain the structure and integrity of the suitable materials for re-use. The following principles are to apply:

- Avoid compaction of 'topsoil' materials by heavy machinery, which could limit vegetation establishment and encourage water-logging
- Stockpile different 'topsoil' types separately
- Shape stockpiles to shed water
- Avoid repeated handling of 'topsoil' material, which could damage the soil structure
- Avoid stockpiling the 'topsoil' material to greater than two meters in height, which could create internal anaerobic conditions and damage the soil structure
- Avoid transport over long distances and movement of 'topsoil' during wet weather
- If quantities of 'topsoil' are limited, mix with subsoil or peat

13.5.4.2 Subsoil

The handling of excavated subsoil materials is also to be managed in such a way to maintain the structure and integrity of the suitable materials for re-use, in particular by minimising the ingress of water. The following principles are to apply:

- Ensure that the vegetation and topsoil are in place for as long as possible
- Avoid excavation and placing of subsoil during wet weather to maintain soil structure
- Avoid stockpiling where feasible
- Compact the subsoil material immediately after placement
- Ensure that gradients on the compacted subsoil minimises the ingress of water
- Remove ruts caused by heavy equipment also to minimise the ingress of water

13.5.4.3 Peat

The handling of excavated peat is more challenging in that the soil structure is less rigid and that stockpiled peat can have adverse effects on surface water bodies reaching the acidic and coloured leachate. Much of the peat excavated from the *Proposed Road Development* will be used to reinstate borrow pits along the *Proposed Road Development* corridor. The details of borrow pit locations, proposed reinstatement fill material characteristics and construction techniques are contained in the Spoil Management Report which is contained in Appendix 4.3 in the EIS. In terms of general handling of peat soils across the site, the following principles are to apply:

- Avoid compaction of soft or peaty materials by heavy machinery, which could limit vegetation establishment and encourage water-logging;
- Ensure that a geotechnical engineer/ engineering geologist is onsite to supervise and manage excavation works where excavation will intercept peat >1m depth;
- Ensure that excavations which may undermine the upslope component of peat are sufficiently supported by buttress, frame or rampart to resist lateral slippage;
- Drain the peat where excavation will intercept >1m depth in advance of excavation activity (1 month in advance where possible) to reduce pore water content and thus instability of the peat substrate;
- Position such drains at an oblique angle, and never parallel, to slope contours to ensure ground stability;
- Ensure that discharge volumes are attenuated prior to discharge (in accordance with the Erosion and Sediment Control Plan) to watercourses by entrapping suspended sediment in gravel or aggregate material at the drain base;
- Avoid stockpiling of peat in close proximity to watercourses, in particular the catotelm layer which is below the vegetated acrotelm layer (>0.3m depth) and behaves like a fluid once disturbed;
- Move any excavated catotelm peat to at least 100m away from drains or streams, where feasible;
- If unavoidable, establish cut-off drainage, sediment percolation through vegetation, gravel at the drain base to entrap suspended solids, stilling ponds and/ or sedimentation ponds to minimise the effects of peat runoff on watercourses;
- Protect riparian zones by restricting construction disturbance within 50m of streams and drains;
- Monitor the drainage and attenuation system during the construction phase (in accordance with the Erosion and Sediment Control Plan), particularly at all upstream and downstream sections relative to stockpiled peat.

13.5.4.4 Erosion & Sediment Control Plan

The disturbance and exposure of soil material during road construction is inevitable; therefore the adoption of erosion and sediment control plans is essential to prevent sediment pollution and to prevent or slow runoff to

allow any suspended solids to settle out in situ[84]. The Outline Erosion and Sediment Control Plan describes the methods that will be employed in this regard and is included as Appendix 4.5 in this EIS.

13.5.5 Soil Chemistry & Water Quality

All fuel and other hydrocarbons stored on site during the construction phase are to be located in an impermeable bunded area designed to contain the volume of fuel stored. All refuelling of vehicles and equipment on site is to take place on an impermeable area and drainage from this area is to be contained and treated appropriately to remove contaminants prior to discharge to the surface water drainage system. All material and equipment on site is to be stored appropriately to minimise the risk of contamination of soil or groundwater. All foul drainage (from toilets, canteens etc) from construction compounds is to be collected in sealed systems and disposed of to the foul sewage network in the area or to an appropriate on-site treatment system. These measures also mitigate the impact of removing soil and subsoil material on groundwater by reducing the protection afforded to underlying groundwater aquifer.

13.5.6 Collapse of karst features

The classification of karst ground conditions by typical morphological assemblages provides guidelines for the encountering of karst features during construction works. The classification suggests that epikarst-type rock head encountered within the study area indicates a 'youthful' or reactivated 'relic' karst system, which is characterised by small 'drop-out' or 'buried' dolines or sinkholes, as identified during the karst survey, and widespread fissuring within a few meters of the surface, as indicated by the identification of an epikarst layer in the geophysical survey[65]. The collapse of soil into pre-existing cavities or voids in the bedrock can be triggered by induced local increases of water input to the soil as a result of inadequate drainage along the *Proposed Road Development* or the lowering of the water table from above to below rock head[73, 80.]

Research shows that drainage control is the key mitigation measure to minimise possible doline or sinkholes failure in a 'youthful' karst system and that the majority of highway related sinkholes identified in US study occurred along unsealed roadside trench drains[73,80]. Preventative strategies and drainage control measures in karst areas, i.e. where karst features have been identified, are to include the use; of sealed drainage, services and ditches, flexible infrastructure lines and sealed joints along the road surface, the backfilling of excavation and trenches with excavated material to ensure the same order of permeability and the discharge of road drainage to an existing stream or to a location some distance away from the highway pavement[73,80]. The collection and conveyance of road runoff in particularly sensitive areas (detailed in Chapter 14 of this EIS), will be included for in the construction methodology. Further details on drainage control are given in the Hydrological and Hydrogeological Impact Assessment Chapter and are to be applied in particular around proposed cuts.

Should collapse occur during construction, the collapse is to be excavated to the bedrock drain, then refilled with inert material graded upward from coarse rocks to finer sediments to allow natural flow through the bedrock drain without the loss of sediments that cause collapse, as recommended by the American Geological Institute (AGL). The use of an additional preventative strategy such as the incorporation of geogrid reinforcement at the base of the structural road pavement in cut areas or within the embankment in fill areas, will be considered, where there is substantial soil cover over bedrock and a history of sinkhole/ doline failures[80]. While this is not the case in the karst areas of this *Proposed Road Development*, this strategy will be considered depending on the geological conditions encountered during construction. All excavation and backfilling work in karst areas is to be supervised by a karst expert whose attendance shall be as determined by the Environmental Project Manager employed by the contractor under the Environmental Operating Plan. The measures to mitigate the impact of collapse of karst features on groundwater are detailed in the Hydrology & Hydrogeology chapter.

13.6 Residual Impacts

The Table in Appendix 13.2 (contained within volume 4 of this EIS) details the residual Impacts of the *Proposed Road Development* on the geological aspects of the environment. These are the final or designed impact, which results after proposed mitigation measures have fully established. The following sections describe these residual impacts.

[84] CIRIA (2006) *Control of water pollution from linear construction projects - Site guide.* CIRIA C649.

13.6.1 Removal of soil, subsoil and rock material

The removal of soil, subsoil and bedrock material from the *Proposed Road Development* is a certain direct impact of the *Proposed Road Development* on the geological attributes. These impacts are inherent to road construction, are unavoidable and are not possible to mitigate. Therefore the impacts remain **residual** and are considered to remain at **slight** for topsoil, **moderate** for subsoil, bedrock and ground conditions and **permanent** in nature.

13.6.2 Change in soil structure

The change in topsoil structure is a likely indirect impact of the *Proposed Road Development* on the geological attributes. However assuming that the mitigation measures detailed above are implemented according to the relevant NRA and Highways Agency guidance and maintained appropriately, these impacts remain **residual** and are considered to reduce to **imperceptible**, resulting in an impact but of insufficient magnitude to affect use or integrity, for both soil and subsoil geology and ground conditions, resulting in a minor impact on the soil structure and **permanent** in nature.

13.6.3 Change in soil chemistry

The change in soil chemistry as a result of an accidental spillage or leak is a possible indirect impact on the soil and subsoil geology during the construction phase. Following implementation and maintenance of mitigation measures, these impacts are considered to remain **imperceptible** for topsoil geology and to reduce to **imperceptible** for subsoil geology and **temporary** in nature.

13.6.4 Reduction in protection to groundwater

The reduction in the level of protection afforded to underlying groundwater resources is a likely indirect impact of the removal of geological materials. Following implementation and maintenance of mitigation measures, this impact is considered to reduce to **imperceptible** and remain **temporary** in nature.

13.6.5 Collapse of karst features

The potential collapse of identified and unidentified karst features is a possible direct impact on the karst features and on the *Proposed Road Development* during the construction phase. The key mitigation measures are the avoidance of lowering the water table below rock head in areas where there is exposed rock at surface or where multiple karst features have been identified and the provision of closed drainage within known karst areas. Following the implementation of mitigation measures and appropriate maintenance, these impacts remain residual and are considered to remain **moderate/slight** on the karst features and on the *Proposed Road Development* and **permanent** in nature.

13.6.6 Change of land use

The removal of the geological materials and construction of the *Proposed Road Development* is a certain direct impact of the *Proposed Road Development* on the existing land use within the CPO and also on any lands used for integration of surplus unsuitable materials. This impact remains residual and is considered **moderate/ slight** and **permanent** in nature.

13.7 Relevant Figures and Appendices

13.7.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of Chapters 13 and 14 and are contained in Volume 3 of the EIS:

Fig. 13.1:	Soil Geology Map;
Fig. 13.2:	Subsoil Geology Map;
Fig. 13.3:	Bedrock Geology Map (including structural and karst features);
Fig. 13.4.1-13.4.8:	Geotechnical overview including road cuts, embankments and lands for infilling of unsuitable surplus material inside the CPO;
Fig. 14.1:	Hydrology, monitoring locations, conservation areas and flooding;

Fig. 14.2: Aquifer classification ground water flow and ground water contours;

Fig. 14.3: Aquifer vulnerability;

Fig. 14.4: Local catchment areas for wetland habitats;

Fig. 13.5: Quarries;

Other relevant figures include:

Fig. 4.1: Design Overview; Plan Mainline; Key Sheets;

Fig. 4.1.1-4.1.8: Design Overview; Plan Mainline.

13.7.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 13.1.: Geophysical Survey;

Appendix 13.2.: Geological Impact Summary;

Appendix 13.3.: Cut and Excavate/Replace Impact Summary;

Appendix 13.4.: Extracts from Preliminary Geotechnical Interpretive Report;

14 Hydrology and Hydrogeology

14.1 Introduction

14.1.1 Overview

The *Proposed Road Development* is part of an upgrade to the existing N4 which passes through Collooney and Castlebaldwin in eastern County Sligo. The proposed road upgrade realigns the existing N4 to pass through the townlands of Collooney, Toberbride, Mullaghnabreena, Cloonamahan, Ardcurley, Doorly, Knocknagroagh, Drumfin, Cloonlurg, Carrowkeel, Carrownagark, Kingsbrook Aghalenane, Ardloy, Springfield, Tawnagh, Cloonymeenaghan, Sheerevagh, Cloongad, Drumderry, Castlebaldwin, Cloghoge Upper and Cloghoge Lower as outlined in Figure 4.1.1 to 4.1.8, Volume 3 of this EIS. The proposed road total length is approximately 14.71km. This detailed study on the hydrology and hydrogeology of the study area forms part of the general Environmental Impact Statement on the proposed route, for a design issued by the National Road Design Department of Sligo County Council in July 2013.

14.1.2 Aim of Study

The aim of this detailed study is to identify the impacts of the construction and operation of the *Proposed Road Development* (*Proposed Road Development*) and associated works on the hydrology and hydrogeology of the study area and to identify possible mitigation measures to minimise these impacts.

The study includes:

- A survey, description, classification and assessment of the existing hydrological and hydro-geological aspects of the environment through which the road is proposed to be built;
- A description and assessment of the likely impacts of the road, both positive and negative, on these aspects of the environment;
- A description and assessment of the possible mitigation measures to minimise these impacts;
- A description and assessment of the residual impacts after mitigation;
- A description and assessment of the impact interactions and cumulative impacts.

14.2 Methodology

14.2.1 Relevant Guidance & Legislation

This detailed study has been prepared using the following guidelines outlined in table 14.1.

Table 14-1: Guidelines Considered

Guidelines
Environmental Protection Agency (2002) *Guidelines on Information to be Contained in an Environmental Impact Statement – March 2002*
Environmental Protection Agency (2003) *Advice Notes on Current Practice (in preparation of Environmental Impact Statements – September 2003*
DG Environment (2002) *Guidelines on the Assessment of Indirect & Cumulative Impacts as well as Impact Interactions*
National Roads Authority (2008) *Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1, November 2008*
National Roads Authority (2008) *Guidelines of Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*
UK Highways Agency (2009) *Road Drainage and the Water Environment HD45/09*
CIRIA (2006) *Control of water pollution from linear construction projects, Technical guidance (C648)*
National Roads Authority (2008) *Guidelines for the Crossing of Watercourses during the*

Guidelines
Construction of National Road Schemes
CIRIA (2000) *Groundwater Control – Design and Practice (C515)*

14.2.2 Desk Study

The proposed road design, road cut and fill depths, details of previous site investigation and water level data from monitoring boreholes installed along the proposed road route were supplied by Sligo County Council. The proposed road design used herein was provided by the design team and is based on a design prepared for the purposes of Phases 3 and 4 of the NRA Project Management Guidelines 2010.

The desk based work items involved the following:

1. Definition of the study area, in accordance with NRA guidelines58 as 250m beyond the landtake boundary of the proposed route and taking account of potentially significant impacts which could arise at a greater distance away;
2. Compilation of all relevant plan maps relating to the study area and *Proposed Road Development*;
3. Acquisition and compilation of all available regional information on the hydrology and hydrogeology of the study area, including:
    - Interrogation of the Geological Survey of Ireland's (GSI) online mapping service, national well and karst feature databases and groundwater body descriptions;
    - Acquisition and examination of the Ordnance Survey of Ireland's (OSI) mapping and aerial photography;
    - Examination of the National Parks and Wildlife Service (NPWS) designations;
    - Examination of the Office of Public Works (OPW) online flood and hydrometric mapping service;
    - Acquisition of climatic data from Met Eireann;
    - Examination of the Water Framework Directive River Basin Management Plans;
    - Examination of the Environmental Protection Agency's (EPA) online hydrological and land use mapping service;
4. Identification of possible karst features on OSI 1:50,000 and 1:10,560 scale maps and aerial photography.
5. Acquisition and compilation of the available borehole logs, trial pitting logs and geotechnical results of site investigations conducted by Priority Geotechnical Limited63;
6. Acquisition and examination of the results of geophysical surveys undertaken along the road realignment;
7. Consultation with statutory consultees and interested organisations, namely the GSI, the Speleological Union of Ireland, the Department of Environment, Heritage and Local Government (DoEHLG), the North Western Regional Fisheries Board (NWRFB) and the Western River Basin District (WRBD);
8. Assessment of proposed road cuts, soft ground areas and borrow pits which require to be excavated during the course of the construction works, which is relative to the hydrology and hydrogeology in the study area;
9. Acquisition and assessment of the hydrogeological investigation of the groundwater levels, groundwater flow directions and catchment areas around the turlough and swallow hole complex at Tawnagh conducted (Appendix 14.1 of volume 4) and which consisted of:
    - Continuous water level monitoring;
    - Topographical surveying of the turlough;
    - Analysis of water level hydrographs;
    - Water balance and hydrogeological mapping approach to catchment delineation.

14.2.3 Field Investigations

Previous site investigations were conducted for the study area which involved drilling, monitoring borehole installation, trial pitting and geotechnical testing. The results of these investigations were made available to this study.

The field investigations conducted for this study involved the following:

1. A walkover survey of the entire *Proposed Road Development* and study area, which extends to 250m beyond the landtake boundary for the proposed route mainline. However this study area was extended to include any hydrological or hydrogeological features of interest or concern, identified in the desk study or in the consultations;
2. Karst feature survey to locate and examine any karst features and to identify where karstified bedrock is located within the study area, which was extended beyond 250m where appropriate;
3. Well audit to locate and examine recorded wells in the GSI national well database within 500m of the proposed road route;
4. Survey and audit of protected water dependent conservation areas;
5. Geophysical surveying was conducted over specific study areas along the *Proposed Road Development* by Minerex Geophysics Limited in February 2006[65]and by Apex Geophysics in 2006 and 2013. This survey involved seismic refraction to map overburden thickness, depth to bedrock and to indicate overburden stiffness and bedrock quality.
6. Baseline surface water and groundwater quality monitoring at locations downstream of all drainage outfalls and at the inflow and outflow points of all lakes or wetlands with the potential to be impacted by the *Proposed Road Development* under both low and high flow conditions;
7. Baseline flow monitoring at all previously ungauged watercourses where it is proposed to discharge road runoff.

14.2.4 Limitations & data gaps

The identification of collapsed karst features or sinkholes buried beneath the subsoil geology often requires historic knowledge of an area, as these features are often not identified on OSI maps. Therefore, the presence of karst features near the proposed road alignment cannot be limited to those identified on a map or found during a site walkover. The findings should rather be taken as an indication of the susceptibility of the study area to karstification. However all practical efforts were made during the route walkover to identify karst features along and near the *Proposed Road Development* and within the study area.

Domestic dwellings in the vicinity of the proposed road alignment are connected to a mains water supply (with the exception of Carrownagark Group Water Supply Scheme). However, numerous domestic/agricultural supply wells exist within 500m of the *Proposed Road Development*. The details of these water supplies are described in this chapter.

14.2.5 Impact Assessment Methodology

The impact assessment compiled for this report is based on the design of the proposed road and revisions to date (July 2013). The design incorporates measures to mitigate impacts by avoidance, such as the raising of the alignment out of sensitive areas and specific geotechnical measures to avoid indirect hydro-geological impacts; for assessment purposes, these measures are considered intrinsic to the *Proposed Road Development*. While the design also incorporates measures to mitigate impacts by reduction, such as the provision of a drainage design system which seeks to adopt SUDS principles through Pre Treatment, Source Control and Site Control as outlined in section 4.8.2 (Chapter 4 of this EIS); for the assessment purposes of this Chapter and for transparency the benefits which these features will provide are not considered during the impact assessment process but rather as mitigation in the proceeding section. The following assessments were undertaken, from the desk and field data acquired, to evaluate the potential impacts of the *Proposed Road Development* on sensitive locations such as The Unshin River, Lough Arrow and the numerous other lakes, the wetland habitats, karst features and groundwater supply wells:

1. Characterise the sites current hydrological / hydrogeological regime based on the topographical, geological, hydrological and hydrogeological data acquired.
2. Estimate the surface and groundwater catchments for The Unshin River and its relevant tributaries and the numerous lakes and wetland habitats within the study area;
3. Determine and estimate any change to these catchments arising from the proposed road;
4. Determine and estimate the impact on groundwater supply wells within 500m of any road cut/ excavation;
5. If impacts are identified, consider measures that would mitigate, re-mediate or reduce the identified impact;
6. Identify any residual impacts that would remain or arise from the mitigation measures identified;
7. Present and report these findings in a clear and logical format that complies with EIS reporting requirements.

The above approach was undertaken following the EPA guidelines[59]. The likely significant impacts were described using the five-tier system presented in the EPA advice notes[60] (*Advice Notes on Current Practice (in preparation of Environmental Impact Statements* – September 2003), by reference to quality of impact, significance of impact, duration of impact and types of impact and using the criteria for rating site attributes and for rating impact significance as presented in the NRA guidelines.

14.3 Existing Environment

14.3.1 Hydrology

14.3.1.1 River Basin District

A river basin district is the management unit for the Water Framework Directive (WFD), which was adopted in 2000, and for which EU member states are required to prepare and implement management plans for those waters.

The *Proposed Road Development* is located wholly with the Western River Basin District (WRBD), which is a largely rural area with many high quality waters and protected sites that depend on water[85]. The WRBD is defined as the physiographical region within hydrometric areas 29-35 that drain in to the Atlantic Ocean, covers an area of 12,193km^2, comprises 89 river catchments with over 14,200km of river and contains the sub-catchments of Unshin River, its sub-catchments and Lough Arrow[85]. The *Proposed Road Development* is entirely located in Hydrometric Area 35[85].

The River Basin Management Plan for the WRBD covers the period 2009-2015 and sets out plans to ensure that the waters achieve at least good status by 2015 and that the existing status does not deteriorate. These include the prioritisation of the protection of high water quality areas, the protection of the Unshin River to maintain high or good status by 2015 and the restoration of the Lough Arrow catchment to high or good status by 2021[85].

14.3.1.2 Catchment areas and drainage

14.3.1.2.1 *Unshin River Catchment*

The *Proposed Road Development* passes wholly through the Unshin River Catchment. Surface water land runoff discharges directly to the Unshin via land drains between circa Ch. -190m to c. Ch. 1,100m and between c. Ch. 2,100m to c. Ch. 3,000m. In other areas it discharges indirectly via various streams and rivers whose cathment areas are described below (See Fig. 14.1 of volume 3). A section to the south discharges to Lough Arrow which is the source of the Unshin.

The surface drainage within this catchment flows in a predominantly north-north easterly direction, before joining with the Owenmore River to form the Ballysadare River. The Office of Public Works (OPW) estimates the Unshin River catchment area to be 202km^2, inclusive of Lough Arrow and the Unshin River.

The proposed road realignment crosses one tributary of the Unshin River in these areas which is labelled as DX1. DX1 is a small stream (land drain) which flows east of the Unshin River near the townland of Mullaghnabreena. This crossing is located along the existing N4 alignment.

Table 14-2: Road crossings occurring directly with the Unshin River Catchment

Crossing ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX1	Ch. 450m	0.5 x 0.5	Silt

The following describes the various sub-catchments of the River Unshin which the *Proposed Road Development* intercepts.

[85] Western River Basin District (2009) *Final River Basin Management Plan for the Western River Basin District in Ireland (2009-2015).*

14.3.1.2.1.1 *Markree Demesne Stream Catchment*

The proposed road realignment crosses two (2 no.) tributaries of the Unshin River, DX2 and DX3. DX3 is the outflow from the Toberscanavan Loughs. These crossings are located along the existing N4 alignment with a catchment which is known as the Markree Demesne Stream Catchment.

Table 14-3: Road crossings in Unshin River Catchment

Crossing ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX2	Ch. 950m	0.5 x 0.5	Gravel
DX3	Ch. 1200m	2 x 1.0	Gravel

14.3.1.2.1.2 *Turnalaydan Stream Catchment*

The *Proposed Road Development* passes through the Unshin River Catchment between c. Ch. 3,300m and c. Ch. 6,500m (Figure 14.1 contained within volume 3 of this EIS). The Turnalaydan Stream drains an area south, west and north of the Boathole Lough and Lough Corran. The stream flows first into the Boathole Lough before draining into Lough Corran and from there flows in a northeasterly direction for 2km before joining the Unshin River 0.5km east of the existing N4 road. The catchment drains an area of approximately 18km$^{2.}$

The *Proposed Road Development* crosses two (2 no.) tributaries of the Unshin River; these crossings are referenced as DX4 and DX5 in Figure 14.1 (volume 3). DX4 crosses the Turnalaydan Stream 400m downstream of Lough Corran to the west of the existing N4. DX5 crosses a small stream to the west of Drumfin crossroads. This stream flows into the Boathole Lough 1km northwest of DX5.

Table 14-4: Road crossings in Turnalaydan Stream *Catchment*

Crossing ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX4	Ch. 4,450m	3.0 x 1.6	Marl
DX5	Ch. 5,550m	1.0 x 1.0	Peat

14.3.1.2.1.3 *Drumfin River Catchment*

The *Proposed Road Development* passes through the Drumfin River catchment between c. Ch 6,500m and c. Ch 8,400m (Figure 14.1, volume 3). The Drumfin River rises in the Bricklieve Mountains and flows in a predominantly north-north easterly direction, before joining with the Unshin River near the Drumfin crossroads. The catchment area is estimated to be 23km^{2}.

The *Proposed Road Development* crosses two (2 no.) tributaries of the Unshin River; these crossings are referenced as DX 6 & 7 in Figure 14.1 (volume 3). DX6 is a small stream which rises from several seepages or springs along the base of the topographical high of Doon Hill and Carrickbanagher. DX7 crosses the Drumfin River itself which rises from several seepages or springs along the northern slopes of the Bricklieve Mountains.

Table 14-5: Road crossings in Drumfin River Catchment

Stream ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX6	Ch. 6,600m	1.0 x 1.4	Marl/Till
DX7	Ch. 7,350m	3.5 x 0.5	Gravel

14.3.1.2.1.4 *Springfield Stream Catchment*

The *Proposed Road Development* passes through the Springfield Stream catchment between c. Ch 8,400m and c. Ch 11,300m (See Figure 14.1 of Volume 3 and appendix 12.2 of volume 4). The Springfield Stream catchment extends from the northern side of the Bricklieve Hills from where it drains into Loughymeenaghan and from

there into a lake at Tawnagh. Springfield Stream then flows in a north easterly direction joining the Unshin River c. 2km north of the lake at Tawnagh. The catchment area is estimated to be in the region of 5.5m^2.

The *Proposed Road Development* crosses one (1 no.) tributary of the Unshin River (Springfield Stream); this crossing is referenced as DX8 in Figure 14.1 (volume 3). DX8 drains Loughymeenaghan in a northerly direction into the lake at Tawnagh.

Table 14-6: Road crossings in Springfield Stream Catchment

Stream ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX8	Ch. 10,800m	2.0 x 2.0	Gravel/Bedrock

14.3.1.2.1.5 *Lissycoyne Catchment*

The *Proposed Road Development* passes through the Lissycoyne catchment between c. Ch 11,300m and c. Ch 13,200m (See Figure 14.1 of Volume 3 and appendix 12.2 of volume 4). The Lissycoyne catchment flows north-northeast before joining the Unshin River 1km east of the lake at Tawnagh. The catchment area is estimated to be in the region of 3.5km^2.

The *Proposed Road Development* crosses one (1 no.) tributary of the Unshin River (Lissycoyne Stream); this crossing is referenced as DX9 in Figure 14.1 (volume 3). DX9 rises along the base of the northern slopes of the Bricklieve Mountains in the townland of Cleavry.

Table 14-7: Road crossings in Lissycoyne River Catchment

Stream ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX9	Ch. 12,250m	1.8 x 0.2	Marl/Till

14.3.1.2.1.6 *Drumderry Stream Catchment*

The *Proposed Road Development* passes through the Drumderry stream catchment between c. Ch 13,200m and the end of the *Proposed Road Development* (Figure 14.1 of volume 3). The Drumderry Stream rises from springs located in the townland of Cloghoge Upper and flows in a predominantly southeasterly direction, crossing the road at c. Ch 13,800m. The catchment area is estimated to be in the region of 4km^2.

The *Proposed Road Development* crosses two tributaries of Lough Arrow (Drumderry Stream and a tributary known as a tributary of the Drumderry Stream. The crossing point is referenced on the Drumderry Stream as DX 10 in Figure 14.1 (volume 3). A tributary of the Drumderry Stream (DX11) rises from a spring along the base of the eastern slopes of the Bricklieve Mountains.

Table 14-8: Road crossings in Drumderry Stream Catchment

Stream ID	Chainage (approx.)	Approx. dimensions Width x height (m)	Substrate
DX10	Ch. 13,800m	1.9 x 0.15	Gravel/Peat/Marl
DX11	Ch 14,220m	1.5 x 1.0	Gravel/Peat/Marl

14.3.1.2.2 *Significance and Sensitivity*

The significance of the drainage network is that the *Proposed Road Development* passes through six (7no.) surface catchment areas (either draining directly to the Unshin River or sub catchments of the Unshin such as the Markree Demesne Stream, the Turnalaydan Stream, the Drumfin River, the Springfield Stream, the Lissycoyne Stream and the Drumderry Stream). The Drumderry Stream is a sub catchment of Lough Arrow which itself is a sub catchment of the Unshin River. The sensitivity of the drainage network lies in the fact that the excavation of the road cuts has the potential to impact flows and surface catchment areas.

14.3.1.3 Conservation sites

According to the National Parks and Wildlife Service (NPWS) mapping, there are four (4 No.) designated conservation sites within the study area, three designated as candidate Special Areas of Conservation (cSAC), all of which are also proposed Natural Heritage Area (pNHA) and one of which is designated as a Special Protection Area (SPA)[76].

A candidate Special Area of Conservation (cSAC) is a habitat of international significance, which has been identified by the Minister (Department of the Arts, Heritage and the Gaeltacht) and submitted for designation to the EU. The significance of this designation is that any project which is likely to have a significant impact on such site and which cannot be shown beyond reasonable scientific doubt not to have an adverse effect on the integrity of the SAC may only be carried out for '*imperative reasons of overriding public interest, including those of a social or economic nature*' (In accordance with the precautionary principle). In the case of a site hosting a priority habitat or priority species, social or economic reasons are insufficient unless pursuant to an opinion of the European Commission.

A Special Protection Area (SPA) is a statutory designation, which has a legal basis under the EU Birds Directive (2009/147/EC)[76]. The primary objective of SPAs is to maintain or enhance the favourable conservation status of the birds for which the SPAs have been designated.

A proposed Natural Heritage Area (pNHA) is also a habitat or site of interest to wildlife, which has been identified by the Minister. Both proposed and designated NHAs require consultation with the NPWS if any development is to impact one[76].

14.3.1.3.1 *Unshin River cSAC and pNHA*

The Unshin River is a designated candidate Special Area of Conservation (cSAC) and a proposed Natural Heritage Area (pNHA) (Code: 001898)[76](See Figure 14.1 of Volume 3 and appendix 12.2 of volume 4). This site consists of a pristine un-managed, un-drained river and its marginal vegetation. Other rivers included within the site are the Owenboy/ Owenbeg and a number of smaller tributaries. To protect the river, natural and semi-natural habitats adjacent to its course have been included; many of these are interesting in their own right[76]. The *Proposed Road Development* does not cross into this designated site but does pass within circa 40m to 60m of its boundary at Doorly, Lackagh and Drumfin which in each case is further away from this designated site than the existing N4 at this point.

The site is a candidate SAC selected for alluvial wet woodlands, a priority habitat on Annex I of the E.U. Habitats Directive. The site is also selected as a candidate SAC for floating river vegetation, also listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Atlantic Salmon and Otter[76].

14.3.1.3.2 *Knockmullin Fen pNHA*

The Knockmullin Fen is a proposed Natural Heritage Area (pNHA) (Code: 001904)[76]. It is a flush type fen and is classified as a groundwater dependent ecosystem[76]. The *Proposed Road Development* does not cross into this designated site and remains at c. 1.5km from its boundary.

14.3.1.3.3 *Lough Arrow cSAC, SPA and pNHA*

Lough Arrow is a designated candidate Special Area of Conservation (cSAC), Special Protected Area (SPA) and a proposed Natural Heritage Area (pNHA) (Code: 001673 and 004050)[76]. Lough Arrow is a large limestone and hard water lake that conforms to a type listed on Annex I of the EU Habitats Directive[76]. The lake is sheltered on three sides by hills and is the source of the Unshin River. It is largely spring-fed and very sheltered for its size, and, as such, is hydrologically different from most lakes. It also supports important numbers of birds, has diverse lakeshore vegetation and protected species, in particular Otter. The *Proposed Road Development* does not cross into this designated site and remains at c. 500m from its boundary.

14.3.1.3.4 *Bricklieve Mountains and Keishcorran cSAC and pNHA*

The Bricklieve Mountains and Keishcorran is a designated candidate Special Area of Conservation (cSAC) and a proposed Natural Heritage Area (pNHA) (Code: 001656)[76]. The site is a large isolated block of carboniferous limestone, reaching a height of approximately 300m and containing typical landscape features associated with karst topography - caves, dry valleys, and limestone pavement[76].

The site is also exceptionally diverse in habitats and species and forms a discrete unit of scenic and amenity value[76]. The most interesting ecological feature of the site is the presence of the orchid-rich calcareous grasslands, an EU Habitats Directive Annex I priority habitat. The site is also of geomorphological, geological and archaeological importance. The *Proposed Road Development* does not cross into this designated site and remains at c. 2.1km from its boundary.

14.3.1.3.5 *Significance & sensitivity*

The significance of these conservation sites is that the *Proposed Road Development* passes within 40m (farther away than the existing N4) of an area designated for protection under Article 6(3) and 6(4) of the Habitats Directive (Unshin River and Lough Arrow). The sensitivity of these conservation sites is that the nearby proposed road cuts, in particular cut 5, have the potential to reduce the groundwater catchment areas to this habitat and the proposed road crossings of streams/ drains entering this site, Streams DX1-DX9 entering the Unshin River cSAC and Stream DX10 and DX11 entering Lough Arrow cSAC, have the potential to increase inflows or to reduce surface water quality.

14.3.1.4 Wetland habitats

14.3.1.4.1 *Knockmullin Fen*

The Knockmullin Fen is a pNHA site. It is a flush type fen and is classified as a groundwater dependent ecosystem[86]. This habitat lies at over 1.5km to the west of the *Proposed Road Development*. The surface or topographical catchment is likely to be a good indicator of its hydraulic or groundwater catchment. The *Proposed Road Development* does not pass through this catchment area.

14.3.1.4.2 *Toberscanavan Loughs*

Toberscanavan Loughs are located immediately west of the online section of the existing N4. The site is a wetland complex with mesotrophic lake, reed swamp, Annex I alkaline fen and priority Annex I alluvial woodland.

The *Proposed Road Development* does not pass through the catchment area of the lake; however the upsizing of an existing culvert (under the existing N4) will influence water levels in the lake. Controls to mitigate against any reduction in the low water or average levels in the lake are described in section 4.8.6.2.1 of this EIS which includes the provision of a weir upstream of the proposed culvert upgrade.

14.3.1.4.3 *Lackagh Fen*

Fens are peat-forming systems fed by ground/surface waters; rich fens are at least mildly base-rich[87]. Lackagh Fen (EIS Chapter 12) is described as a species rich sedge fen and lies immediately east of the *Proposed Road Development*. According to the ecological study carried out as part of this assessment, the road alignment clips a small section of this site where the substrate is very wet cutover fen peat containing some tufa deposits and the habitat is classified as being of very high value and of national importance.

14.3.1.4.4 *Boathole Lough & Lough Corran*

The Boathole Lough and Lough Corran are described (EIS Chapter 12) as lakes with reed swamp and raised bog habitats, have a high floral diversity and are connected to the Unshin River by an outflow river stream. The *Proposed Road Development* passes within 50m (approx.) of these lakes. The ecological study carried out as part of this assessment rates this area as being of high value and of county importance.

14.3.1.4.5 *Carrowkeel wet woodland*

Carrowkeel wet woodland is described (EIS Chapter 12) as wet willow woodland. The *Proposed Road Development* crosses the Drumfin River at this habitat. The ecological study carried out as part of this assessment rates this area as being of high value and of county importance.

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[86] Working Group on Groundwater (2004) *Guidance document GW8: Methodology for risk 14-363haracterization of Ireland's groundwater.*

[87] Compass Informatics and Natura Consultants Limited (2002) *Water Status: Identification and Ranking of Nature Conservation Designated Areas (2002-W-DS-10).*

14.3.1.4.6 *Cuileencroobagh Lough*

Cuileencroobagh Lough is described (EIS Chapter 12) as quaking bog/ fen, characterised by a floating scraw of vegetation and being naturally infilling. The *Proposed Road Development* passes within approximately 60m of this. The ecological study carried out as part of this assessment rates this area as being of high value and of county importance.

14.3.1.4.7 *Aghalenane & Ardloy Loughs fen complex*

Aghalenane & Ardloy Loughs are described (EIS Chapter 12) as lakes with reed swamp, fen and bog, have a high floral diversity and are connected to the Unshin River by a small stream. The Loughs also contain a fen complex through which the *Proposed Road Development* runs adjacent to. The adjacent area includes some calcareous flushes which are part of the feed into the lakes, and which support the rich fen flora in the south site. The ecological study carried out as part of this assessment rates this area as being of extremely high value and of international importance.

14.3.1.4.8 *Turlough and swallow hole complex*

The turlough at Tawnagh and the Tawnagh lake turlough and swallow hole complex (also in Tawnagh) is a pond/marsh complex, providing inputs into local groundwater systems[72]. The ecological study carried out as part of this assessment rates this area as being of very high value and of national importance. The turlough at Tawnagh is small and is both fed and drained exclusively by the groundwater system having no surface water inflow or outflow. The hydrological study carried out on the pond and swallow hole complex concluded that this pond is mainly fed by the surface discharge stream from Loughymeenaghan to the south, although it is likely that there is some groundwater inflow to the lake, especially during high rainfall periods. The lake in Tawnagh discharges to the karstic groundwater system at its northern end, with St. Patrick's well to the north a likely resurgence point for this water. There is evidence from the 1st edition 6 inch maps that this pond/swallow hole complex is a dynamic system and that the location of swallow holes has changed in this pond over the past 170 years due to collapse or clogging as is common in turlough-type karst landforms.

14.3.1.4.9 *Unshin River*

The Unshin River (as described in Chapter 12) is a cSAC with qualifying interests which include alluvial forests, rivers with floating vegetation and Atlantic salmon and otter. The *Proposed Road Development* passes within circa 40m of this habitat.

14.3.1.4.10 *Lough Arrow*

Lough Arrow (as described in Chapter 12) is a cSAC for the Annex I habitat 'Hard oligo-mesotrophic waters'. The lake is largely spring-fed and, as such, is hydrologically different from most lakes[76]. The *Proposed Road Development* passes through the catchment of two of these springs, recorded as 1731SWK009 (GSI Reference, Tobermurly) and 1731SWK008 (GSI Reference, Toberbride) and located within 75m of the *Proposed Road Development* near Castlebaldwin.

14.3.1.4.11 *Significance & sensitivity*

The significance of these wetland habitats is that the *Proposed Road Development* passes through or close to these habitats and that these areas are groundwater dependent terrestrial ecosystems (GWDTE's), using groundwater for survival either partially or completely, and therefore are designated for protection under Article 1 of the Water Framework Directive. The sensitivity of these wetland habitats is that the nearby proposed road cuts, excavate/replace areas and borrow pits particularly in proximity of Lackagh Fen, the Carrowkeel wet woodland, Aghalenane & Ardloy Loughs and swallow hole & turlough complex (at Tawnagh) have the potential to reduce the groundwater catchment areas to these habitats.

14.3.1.5 Surface Water Quality

According to water quality mapping compiled by the EPA, there are five (5 no.) water quality monitoring stations within the study area[88]. The water quality mapping is based on biological quality rating (Q-value), where 1-2 = seriously polluted or bad status, 2-3 = moderately polluted or poor status, 3-4 = slightly polluted

[88] Environmental Protection Agency (EPA) online mapping service – www.epa.ie.

or moderate status and 4-5 = unpolluted or high status. The following table summarises the most recent results available for these locations.

Table 14-9: Surface Water Quality

Station No.	Location	Stream/ River	Water Quality Status	Most Recent Year
353101	Ballygrania Bridge	Unshin River	Q4-5: High Status	2009
354033	Doorly Bridge	Unshin River	Q4: Good Status	2004
3510800	Closkeybeg Bridge	Unshin River	Q4: Good Status	2009
3510500	Kilmorgan Bridge	Drumfin River	Q3-4: Moderate Status	2006
3510100	Bellarush Bridge	Unshin River	Q3-4:Moderate Status	2003

The significance of the surface water quality is the baseline water quality status within the study area is moderate to high and that one of the key objectives of the Water Framework Directive is to achieve good status by 2015. The sensitivity of the surface water quality lies in the fact that no information is available on the surface water hydrochemistry or other potential hazards within the catchment.

14.3.1.6 Surface Water Hydrochemistry

Baseline surface water quality monitoring was carried out downstream of all drainage outfalls and at the inflow and outflow points of all lakes or wetlands with the potential to be impacted by the *Proposed Road Development*. The water samples were submitted to an accredited laboratory for analysis of the test parameters as recommended in the NRA guidance[58]: Temperature, pH, Conductivity, Dissolved Oxygen, Biochemical Oxygen Demand, Ammoniacal Nitrogen, Suspended Solids, Nitrate, Orthophosphate, Total Hardness, Zinc (Total), Copper (Dissolved) and Petroleum Hydrocarbons. In addition, the water samples from lakes were submitted for analysis of Chlorophyll and Transparency. The analytical results of winter and summer sampling in 2011 are detailed in Appendix 14.3 contained within volume 4 of this EIS. The following points summarise these results:

- **Ammonia**: Water from all of the proposed outfall locations and each of the lakes exceed the European Communities (Quality of Salmonid Waters) Regulations S.I. No. 293 of 1988.
  Ammoniacal Nitrogen (NH_4-N): The samples taken at outfalls 8, 9, 10, 11, 12 and 14 remain below the MAC set by Surface Water Regulations S.I. No. 294 of 1989, while samples taken at Outfalls 3, 5, 6 and 13. Lake 1 (Lough Corran), Lake 2 (Toberscanavan Lough) and Lake 3 (Tawnagh lake/Turlough) were above this but below the MAC set by Salmonid Regulations.
- **Biological Oxygen Demand**: All of the samples remain below the limit set by Salmonid Regulations S.I. No. 293 of 1988. Of the mean concentrations calculated from the two sets of results, Outfalls 9, 13 and 14 can be classified as having **high status**, while all remaining outfall locations and lakes with the exception of Outfall 11 can be classified as having **good status** in accordance with Surface Water Regulations S.I. No. 272 of 2009.
- **Emulsified Petroleum Hydrocarbons**: All of the samples remain below the Surface Water Regulations S.I. No. 294 of 1989.
- **Dissolved Oxygen**: Of the samples taken, 3 were within the limits set by the Salmonid Regulations S.I. No. 293 of 1988. 7 were within the allowable range for A1 type waters set by Surface Water Regulations S.I. No. 294 of 1989. 9 were within the range for A2 type waters and 3 were within the range of A3 type waters.
- **Nitrite (NO_2)**: All of the samples remain below the Salmonid Regulations.
- **pH**: All of the samples remain within the Surface Water Regulations S.I. No. 294 of 1989.
- **Phosphate (PO_4):** Samples taken from Outfall 10 exceed the MAC for **high** or **good status** set by Surface Water Regulations S.I. No. 272 of 2009. All of the samples remain below the MAC set by Surface Water Regulations S.I. No. 294 of 1989 for A1 type waters.
- **Total Suspended Solids**: Of the samples taken, Outfalls 9 and 10 were above the MAC for A1 type waters set by Surface Water Regulations S.I. No. 294 of 1989 and the Salmonid Regulations. The remainder were below the MAC set by these regulations.

The significance is that the baseline water quality at various locations to which road runoff is to discharge are contaminated with respect to Ammonia, EPH, Dissolved Oxygen, pH, Phosphate and Total Suspended Solids; the majority of outfalls are discharging to waters classified as having good or moderate status.

14.3.1.7 Surface Water Flows

The following OPW and Sligo County Council hydrometric stations are located within the study area (See Figure 14.1 of Volume 3). No historic information on the surface water flows within the Turnalaydan, Drumfin, Springfield or Lissycoyne River catchments is available to this study.

Table 14-10: Surface Water Flows

Station ID	Body Responsible	Location	Catchment
35003	OPW	Ballygrania	Unshin River
35026	Sligo County Council	Lisconny	Unshin River
35008	Sligo County Council	Riverstown	Unshin River
35030	Sligo County Council	Drumderry	Drumderry Stream
35086	OPW	Lough Arrow	Lough Arrow

Baseline flow measurements were taken at previously ungauged watercourses where it is proposed to discharge road runoff. These measurements were taken in January 2011 and in June 2011, using an EM flow meter where possible. The monthly rainfall totals recorded at the nearest operational meteorological station at Claremorris, Co. Mayo for January and May /early June (1st – 3rd) are 88.6mm and 123.0/0.1mm respectively, suggesting that flow measurements in June represent relatively dry conditions, while flow measurements in January represent relatively wet conditions due to the much lower evapotranspiration which occurs in winter months which means a much higher proportion of rainfall becomes runoff during winter months compared to summer months[89]. The following table summarises these flow measurements.

Table 14-11: Flows in previously ungauged water courses

Stream ID	Chainage (approx.)	Flow (m^3/s) (January 2011) {Nov 2013 for DX11)	Flow (m^3/s) (June 2011)
DX1	Ch. 600	0.0	0
DX2	Ch. 1,100	0.02	0.01
DX3	Ch. 1,300	0.08	0.05
DX4	Ch. 1,500	0.06	0.03
DX4	Ch. 4,450	0.2	0.2
DX5	Ch. 5,550	0	0
DX6	Ch. 6,600	0.005	0.005
DX7	Ch. 7,350	0.273	0.230
DX8	Ch. 10,800	0.02	0.015
DX9	Ch. 12,250	0.012	0.012
DX10	Ch. 13,800	0.01	0.018
DX11	Ch 14,220	0.05	-

The significance and sensitivity of the surface water flows to the *Proposed Road Development* is that the proposed road crossings or cuts have the potential to reduce surface catchment and to impact stream flows.

[89] Met Eireann online climatic data service – www.met.ie.

14.3.1.8 Surface Water Abstractions

According to the Sligo County Council website, there are no public surface water abstractions for drinking purposes within the study area. The Lough Gill and Kinsellagh supply schemes supply drinking water to Sligo town and are located to the north of the study area. There are no known plans to abstract water for drinking purposes from the surface drainage in the study area.

The significance and sensitivity of the surface water abstractions are not considered due to their absence within the study area.

14.3.1.9 Surface Water Discharges

According to the EPA online mapping service, there are no active IPPC licences within the study area. The significance and sensitivity of the surface water abstractions are not considered due to their absence within the study area.

14.3.1.10 Flooding

According to the flood mapping compiled by the OPW, there are several locations within the study area prone to recurring flooding. The following table summarises these locations, of which the majority are along the existing N4 road (Figure 14.1 contained within volume 3). However the *Proposed Road Development* does not cross any of these mapped areas or any known historic floodplains. Computer-based flood risk modelling carried out as part of a Flood Risk Assessment for the *Proposed Road Development* has identified two areas where flooding may occur. One area is located at the outflow of Lough Corran (Turnalaydan Stream) and the other is located around Carrowkeel Wet Woodland at the point where the road alignment crosses the Drumfin River. Additional localised flooding areas were also identified at the Markree Demesne Stream, Springfield Stream, Lissycoyne Stream and the tributary of the Drumderry Stream.

Table 14-12: Recorded areas of recurrent flooding

Stream/ River	Location	Chainage (approx.)	Location relative to proposed road
DX4	Lackagh	Ch. 4,200m	500m to east
Unshin River	Coolbock Bridge	Ch. 5,700m	1.5km to east
Unshin River	Bellarush Bridge	Ch. 13,100m	1.4km to east

The significance of flooding is that streams and rivers which are crossed by the *Proposed Road Development* are prone to recurring flooding in places. The flooding in itself is not considered to be particularly sensitive, apart from the Drumfin River potentially.

14.3.1.11 Fisheries Value

Consultations with the Inland Fisheries Ireland (IFI) were undertaken as part of the ecology chapter to determine the fisheries value of the watercourses intersected by the proposed road. White-clawed Crayfish were recorded in the Unshin River downstream of the *Proposed Road Development* and in the Turnalaydan Stream and the Markree Demesne Stream. Juvenile Brook Lamprey were recorded at the Lough Corran outflow (DX4) and in the Markree Demesne Stream, and Juvenile Salmon were recorded at two sites investigated on the Drumfin River (DX7), at the Lough Corran outflow (Turnalaydan Stream) (DX4), and in the Markree Demesne Stream. The entire Ballysadare catchment is of international importance to salmon, which is listed under Annexes II and V of the EU Habitats Directive[90].

14.3.1.12 Climatic Data

Based on rainfall data recorded over 30 years (1961-1990), the annual average rainfall for the area, obtained from the nearest Met Éireann meteorological station, which is located in Ballymote, approximately 9km to the east of the site, is 1,061mm/ year. This figure is adjusted to account for the predicted 20% increase in rainfall levels across Ireland as a result of climate change and equates to 1,273mm/ year[91].

[90] Working Group on Groundwater (2004) *Guidance on the application of groundwater risk assessment sheets SWRA1-6 and GWDTERA1-9 to areas designated for the protection of habitats and species.*

[91] Office of Public Works, (2003) Report of the Flood Policy Review Group.

Based on potential evapotranspiration data recorded over 30 years (1961-1990), the annual average potential evapotranspiration for the area, obtained from the station in Claremorris, Co. Mayo, is 407.4mm/ year[92]. Actual evapotranspiration is estimated at 387mm/ year using methodology used by the Geological Survey of Ireland as 95% of potential evapotranspiration for the area to allow for moisture deficits for part of the year. Using the above figures, the effective rainfall is calculated as rainfall (1,273mm/ year) – actual evapotranspiration (387mm/ year) = 886mm/ year.

The significance of climatic data is that recharge and runoff can be estimated from this data based on subsoil type and thickness.

14.3.2 Hydrogeology

14.3.2.1 Groundwater Body Status

The Oakport Limestone Formation forms part of the Ballygawley groundwater body (GWB) the management unit of the Water Framework Directive defined by groundwater abstractions or groundwater terrestrial dependent ecosystems[93]. The Lisgorman Shale forms part of the Lavagh-Ballintougher groundwater body and the Bricklieve Limestone forms part of the Ballymote groundwater body (GWB) the management unit of the Water Framework Directive defined by groundwater abstractions or groundwater terrestrial dependent ecosystems.

According to interim classification work carried out as part of the Water Framework Directive, the Lavagh-Ballintougher GWB is classified as having good status in terms of quality and quantity, while Ballymote and Ballygawley GWB's are classified as having good status in terms of quantity but poor status in terms of quality. In addition, the characterisation and risk assessment work suggests that the Ballygawley and Ballymote groundwater body is thought to be at risk of not achieving good status by 2015, while the Lavagh-Ballintougher GWB is expected to achieve good status by 2015.

The significance and sensitivity of the groundwater body status is that the *Proposed Road Development* passes through three (2 no.) groundwater bodies, which has the potential to impact water quality and groundwater flows.

14.3.2.2 Aquifer Classification

According to the bedrock aquifer mapping compiled by the GSI, the Bricklieve Limestone Formation lower and the Oakport Limestone are classified as regionally important karstified bedrock aquifers, characterised by conduit flow (Rkc). The Bricklieve Limestone upper and the Lisgorman Shale Formation are classified as locally important aquifers, which is moderately productive only in local zones (Ll).

The Ballygawley, Lavagh-Ballintougher (Lisgorman Shale) and Ballymote groundwater body (Bricklieve Upper and Lower) descriptions give the following area specific values for transmissivity and storage in each aquifer bedrock type[93].

Table 14-13: Aquifer Properties

Aquifer	Aquifer Classification	Transmissivity	Storage
Oakport Limestone	RKc	Variable – 1 to >2,000m2/ day	Low – 1-2%
Bricklieve Lower	RKc	Variable – 1 to >2,000m^2/ day	Low – 1-2%
Bricklieve Upper	Ll	Variable – 1 to >2,000m^2/ day	Low – 1-2%
Lisgorman Shale	Ll	Low – 2 to 15m^2/ day	Low - <0.5%

The significance and sensitivity of the aquifer classification is that it is reflective of the extensive karstification in the Bricklieve Limestone and Oakport Limestone Formations and distinctive hydraulic functioning of this type of bedrock aquifer.

[92] Met Eireann (1961-1990) *Mean Monthly Pot Evapotranspiration & monthly & annual rainfall 1961-1990.*

[93] Geological Survey of Ireland (2004) Ballymote /Lavagh-Ballintougher & Ballygawley groundwater body descriptions – www.gsi.ie.

14.3.2.3 Aquifer Vulnerability

Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities[66]. The vulnerability of groundwater depends on the connectivity between the land surface and the aquifer, therefore it is a function of subsoil permeability, subsoil depth and recharge type i.e. diffuse or point recharge.

The following table summarises the GSI vulnerability ratings based on subsoil type, thickness and proximity to karst features.

Table 14-14: Aquifer Vulnerability Ratings

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability & Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/ gravel)	Moderate permeability (e.g. sandy subsoil)	Low permeability (e.g. clayey subsoil, peat)	(Sand/ gravel aquifers only)	(<30m radius)
Extreme (E)	0-3.0m	0-3.0m	0-3.0m	0-3.0m	-
High (H)	>3.0m	3.0-10.0m	3.0-5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0-10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

According to the interim aquifer vulnerability mapping compiled by the GSI, the *Proposed Road Development* is underlain by areas mapped as having high to low vulnerability (H to L), with pockets of extreme vulnerability where bedrock is at or near the surface near Ch. -190m to Ch. 400m, Ch. 8,300m to Ch. 9,400m, Ch. 10,400m to Ch. 10,600m and Ch. 13,800m to Ch. 13,900m.

The site specific information shows subsoil thickness to range from 0.8m and 14.7m along the *Proposed Road Development* (refer to figure 13.4.1-13.4.8 of volume 3). However, there is insufficient definitive depth to bedrock data along the *Proposed Road Development* to map the site specific aquifer vulnerability.

The significance of the aquifer vulnerability is that it is reflective of the protection afforded by the subsoil geology to groundwater contamination. The sensitivity of the aquifer vulnerability lies in the fact that the excavation and filling of road cuts has the potential to increase or decrease aquifer vulnerability.

14.3.2.4 Groundwater Flow

The Bricklieve Limestone upper and lower formations forms part of the Ballymote groundwater bodies, the management unit of the Water Framework Directive as defined by groundwater abstractions or groundwater terrestrial dependent ecosystems[93]. According to the groundwater body description compiled by the GSI, these rocks are generally devoid of inter-granular permeability with groundwater flow through fissures, faults, joints and bedding planes. These openings are enlarged by karstification in places, significantly enhancing the rock permeability. While groundwater flow directions in karst environments can be across surface water catchment divides and beneath surface water channels, overall groundwater flow is likely to be towards the rivers and lakes, generally to the north. The lack of groundwater encountered during site investigation drilling and subsequent slow filling of the monitoring boreholes corresponds with this conceptual model of groundwater flow.

Karstification often results in a landscape characterised by largely underground drainage and a high degree of interconnection between groundwater and surface water, with groundwater often discharging as large springs, apparent from the various springs identified and recorded in the GSI national karst database. In addition, the description states that flow velocities can be rapid and variable, both spatially and temporally and flow path lengths can be up to a several kilometres in length.

The monitored groundwater levels suggests that groundwater flow within the study area is dominated by the areas of high ground, with flow generally in a north-westerly direction across the study area and flow generally in a south-easterly direction towards Lough Arrow at the southern end of the alignment.

The Lisgorman Shale Formation forms part of the Lavagh-Ballintougher Groundwater Body, which describes groundwater flow as predominantly shallow and is concentrated in fractured and weathered zones[93]. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres. Groundwater flow directions are expected to follow topography and groundwater is expected to discharge rapidly to nearby streams and small springs.

The significance of the groundwater flow is that regional and local flow directions are broadly coincident with surface topography, with regards to the Unshin River catchment, Lough Arrow catchment, Drumderry Stream, Springfield Stream, Drumfin River, Lissycoyne Stream and Turnalaydan Stream catchments. The sensitivity of the groundwater flow lies in the fact that the excavation of road cuts has the potential to impede subsurface drainage and to change the boundaries of groundwater catchments.

14.3.2.5 Groundwater strikes

There are twenty six (26 no.) groundwater monitoring boreholes installed along the *Proposed Road Development* to allow for groundwater level monitoring (see Figure 13.4.1-13.4.8 contained in volume 3 of this EIS). The following table summarises the water strikes and the horizon in which groundwater was encountered during drilling at the locations[63].

Table 14-15: Groundwater Strikes

Borehole ID	Chainage (approx.)	Catchment	Water strike (mbGL)	Horizon
BH105	Ch. 2,250m	Unshin River	3	clay
RC105	Ch. 2,250m	Unshin River	5.7	Bedrock
BH02	Ch. 2,800m	Unshin River	2.5	gravel
BH107	Ch. 4,400m	Turnalaydan Stream	1.8	silt
RC107	Ch. 4,400m	Turnalaydan Stream	5.5	gravel
BH09	Ch. 5,500m	Turnalaydan Stream	3.6	clay
BH10	Ch. 5,550m	Turnalaydan Stream	1.5	silt
BH301	Ch. 6,200m	Turnalaydan Stream	4.8	silt
BH302	Ch. 6,500m	Turnalaydan Stream	3.1	silt
RC302	Ch. 6,500m	Turnalaydan Stream	4.7	gravel
BH14	Ch. 6,700m	Drumfin River	2.5	gravel
BH108	Ch. 7,250m	Drumfin River	0.6	peat
RC109	Ch. 7,400m	Drumfin River	8.2	gravel
RC16	Ch. 8,100m	Drumfin River	Drilled dry	Bedrock
RC21	Ch. 8,600m	Springfield Stream	Drilled dry	Bedrock
RC22	Ch. 8,600m	Springfield Stream	Drilled dry	Bedrock
RC25	Ch. 9,250m	Springfield Stream	Drilled dry	Bedrock
RC26	Ch. 9,300m	Springfield Stream	Drilled dry	Bedrock
BH27	Ch. 9,450m	Springfield Stream	1.5	gravel
BH28	Ch. 9,600m	Springfield Stream	1	peat
BH31	Ch 10,200m	Springfield Stream	4.5	clay
RC31	Ch. 10,200m	Springfield Stream	Drilled dry	Bedrock

Borehole ID	Chainage (approx.)	Catchment	Water strike (mbGL)	Horizon
BH32	Ch. 10,300m	Springfield Stream	3.8	Cobbles
RC32	Ch. 10,300m	Springfield Stream	Drilled dry	Bedrock
BH112	Ch. 10,400m	Springfield Stream	Drilled dry	Bedrock
BH35	Ch. 10,600m	Springfield Stream	2	clay
BH36	Ch. 10,700m	Springfield Stream	3.5	clay
BH36	Ch. 10,700m	Springfield Stream	3.5	clay
BH113	Ch. 10,750m	Springfield Stream	3.5	peat
RC38	Ch. 10,800m	Springfield Stream	Drilled dry	Bedrock
BH303	Ch. 11,600m	Lissycoyne Stream	5	silt
BH45	Ch. 12,300m	Lissycoyne Stream	3.1	clay
RC45	Ch. 12,300m	Lissycoyne Stream	Drilled dry	Bedrock
BH304	Ch. 13,350m	Drumderry Stream	4	silt
RC51	Ch. 13,500m	Drumderry Stream	Drilled dry	Bedrock
RC52	Ch. 13,600m	Drumderry Stream	Drilled dry	Bedrock
BH115	Ch. 13,900m	Drumderry Stream	1.8	silt

The significance of water strikes is that groundwater is encountered only in the subsoil horizon. The monitoring boreholes installed in bedrock filled up slowly after drilling suggesting that the bedrock drilled is of low permeability. The water strikes in themselves are not considered to be particularly sensitive, but rather indicate the geological horizons to be potentially sensitive to changes in water levels.

14.3.2.6 Groundwater levels

The water levels in the groundwater monitoring boreholes were monitored by Sligo County Council between 2006 and 2013. The following table summarises the monitoring borehole locations and the range and average of water levels during this period.

Table 14-16: Groundwater Levels

Borehole ID	Chainage (approx.)	River Catchment	Horizon Monitored	Range (maOD)	Average (maOD)
BH102	Ch. 400m	Unshin River	Lisgorman Shale	33.2– 33.2	33.23
BH104	Ch. 1,550m	Markree Demesne Stream	Lisgorman Shale	30.9 – 31.3	33.91
RC05	Ch. 4,000m	Turnalaydan Stream	Bricklieve Lower	43.5 – 45.71	44.87
RC06	Ch. 4,100m	Turnalaydan Stream	Bricklieve Lower	43.7 – 47.16	45.89
RC107	Ch. 4,400m	Turnalaydan Stream	Bricklieve Lower	40.2 – 40.6	41.47
RC09	Ch. 5,500m	Turnalaydan Stream	Bricklieve Lower	42.3 – 43.5	42.59
RC10	Ch. 5,550m	Turnalaydan Stream	Bricklieve Lower	42.2 – 43.3	42.44
RC301	Ch. 6,200m	Turnalaydan Stream	Bricklieve Lower	65.2 – 70.3	71.42
RC302	Ch. 6,500m	Turnalaydan Stream	Bricklieve Lower	63.3 – 63.9	66.35
RC13	Ch. 6,650m	Drumfin River	Bricklieve Lower	49.2 – 50.9	49.81

Borehole ID	Chainage (approx.)	River Catchment	Horizon Monitored	Range (maOD)	Average (maOD)
RC14	Ch. 6,700m	Drumfin River	Bricklieve Lower	50.1 – 51.0	50.43
RC109	Ch. 7,400m	Drumfin River	Bricklieve Upper	50.0 – 50.3	50.35
RC16	Ch. 8,100m	Drumfin River	Bricklieve Upper	50.8 – 53.2	51.59
RC110	Ch. 8,200m	Drumfin River	Bricklieve Upper	62.0 – 72.8	78.95
RC21	Ch. 8,600m	Springfield Stream	Bricklieve Upper	54.1 – 55.3	54.41
RC22	Ch. 8,600m	Springfield Stream	Bricklieve Upper	54.3 – 55.3	54.47
RC25	Ch. 9,250m	Springfield Stream	Bricklieve Upper	55.6 – 56.4	55.88
RC26	Ch. 9,300m	Springfield Stream	Bricklieve Upper	55.6 – 56.5	55.99
RC31	Ch. 10,200m	Springfield Stream	Bricklieve Upper	59.6 – 60.2	59.77
RC32	Ch. 10,300m	Springfield Stream	Bricklieve Upper	59.4 – 60.4	59.66
RC112	Ch. 10,400m	Springfield Stream	Bricklieve Upper	67.3 – 71.1	7.26
RC38	Ch. 10,800m	Springfield Stream	Bricklieve Lower	61.9 – 62.7	62.25
RC303	Ch. 11,600m	Springfield Stream	Bricklieve Lower	71.8 – 75.6	78.38
RC45	Ch. 12,300m	Lissycoyne Stream	Bricklieve Lower	64.4 – 65.0	64.71
RC51	Ch. 13,500m	Drumderry Stream	Bricklieve Lower	72.0 – 73.5	72.55
RC52	Ch. 13,600m	Drumderry Stream	Bricklieve Lower	64.3 – 65.7	64.66

The monitored groundwater levels suggest that regional groundwater flow is to the north and the Unshin River and that the water table is relatively continuous in both the Bricklieve Limestone lower and upper formations. The monitored groundwater levels show that the Bricklieve Limestone lower is confined beneath the overlying clayey subsoil but that the Bricklieve Limestone upper remains unconfined. There are no groundwater monitoring boreholes installed in the Lisgorman Shale Formation or Oakport Limestone Formation.

Water level contours were drawn from the monitored water levels on August 2009, which are generally the highest water levels recorded during the monitoring period of December 2006 and July 2013 and on the conceptual model of the surface catchments being broadly coincident with the hydraulic or groundwater catchments. These contours are illustrated in Figure 14.2 contained within volume 3.

The significance of the monitored water levels is that the water table is generally less than 3m below the surface, that regional groundwater flow is to the north and that the Bricklieve Limestone lower is confined. The sensitivity of the water levels lies in the fact that excavation of road cuts has the potential to impact on water levels, particularly in the karstified bedrock.

14.3.2.7 Aquifer properties

The permeability of the limestone bedrock was estimated from in-situ permeability tests (rising head tests) conducted in June 2011 and from analysis on this data using AqteSolv. The boreholes are located within 60m of each other adjacent to the deepest proposed cut on the N4 realignment. The results highlight the heterogeneous nature of karstic limestone aquifers, where permeability commonly varies over relatively short distances. The following table summarises these results and compares them to literature values and the appropriate geological material. Published, proven permeabilities in the limestone aquifers along the proposed route range from <1 to 2000m/day but the higher velocities relate to large conduits/cave systems located away from the realignment route.

Table 14-17: In-situ Test Results

ID	Horizon tested	Result	Literature value[94]
RC 31	Limestone bedrock	0.311 x m/ day	Low end of range for karst limestone (0.08 to 1,728m/ day)
RC 32	Limestone bedrock	0.99m/ day	Low end of range for karst limestone (0.08 to 1,728m/ day)

14.3.2.8 Karst Features

Karstification is the process whereby limestone is slowly dissolved away by percolation waters and results in landscapes characterised by largely underground drainage[66]. The Bricklieve Limestone Formation is extensively karstified with numerous karst features evident at the surface. The national karst feature database, compiled by the GSI, has records for 14 karst features within 2.5km of the *Proposed Road Development* (Figure 13.3 of volume 3). In addition, the karst feature survey identified 43 possible karst features on the ground, not recorded in the national karst database (Figure 13.3 of volume 3). The following table summarises the GSI records and the survey findings.

Table 14-18: Identified karst Features

ID	Type/ Name/ GSI ID	Easting	Northing	Townland	Approx. distance from road (m)
1	Possible doline	568357	825258	Toberbride	50
2	Spring	568378	825271	Toberbride	50
3	Possible doline	568504	825075	Toberbride	190
4	Possible doline	569345	822898	Doorly	20
5	Spring	569416	823056	Doorly	100
6	Possible doline	569647	822866	Doorly	280
7	Possible doline	569662	822810	Doorly	280
8	Spring	569907	821908	Knocknagroagh	140
9	Spring	570457	821158	Lackagh	500
10	Spring	570954	820191	Drumfin	360
11	Spring (Tobernacreevagh)	573418	818357	Knockadoo	250
12	Spring (St. Patricks Well)	573736	817958	Tawnagh	250
13	Possible doline	571932	819203	Carrowkeel	530
14	Possible doline	571753	818829	Carrowkeel	150
15	Spring	572365	817889	Kingsbrook	0
16	Possible doline	570413	817426	Turlaghyraun	1,800
17	Spring (Tobernaglashy)	574277	818370	Tobernaglashy	1,500
18	Possible doline	572455	817831	Carrownagark	30
19	Possible doline	572057	817270	Kingsbrook	560
20	Possible doline	572257	817021	Kingsbrook	450
21	Possible doline	572999	816968	Aghanlenane	120
22	Possible doline	573045	817037	Aghalenane	70
23	Possible doline	573064	817105	Aghalenane	0
24	Possible doline	573107	817049	Aghalenane	0
25	Possible doline	573119	817084	Aghalenane	0

[94] Schwartz, F.W. & Zhang, H. (2003) *Fundamentals of Groundwater.*

ID	Type/ Name/ GSI ID	Easting	Northing	Townland	Approx. distance from road (m)
26	Possible doline	573231	817009	Aghalenane	0
27	Turlough	573704	817374	Tawnagh	160
28	Turlough	573673	817443	Cloonymeenaghan	160
29	Spring	573865	817514	Tawnagh	170
30	Possible doline	573890	817472	Tawnagh	170
31	Possible doline	573879	817488	Tawnagh	170
32	Spring	573854	817481	Tawnagh	170
33	Possible doline	573880	817490	Tawnagh	170
34	Swallow hole	573869	817442	Tawnagh	170
35	Turlough/ swallow hole	573816	817279	Tawnagh	160
36	Spring	574156	816859	Cloonymeenaghan	10
37	Possible doline	575318	815242	Drumderry	0
38	Possible doline	575368	815172	Drumderry	0
39	Possible doline	575443	815212	Drumderry	0
40	Spring	575483	815524	Drumderry	250
41	Possible doline	574055	816563	Cloonymeenaghan	150
42	Spring	574235	818362	Tobernglashy	1,500
43	Possible doline	574931	814564	Cleavry	650
44	Possible doline	573662	812710	Treanmacmamurtagh	2,500
45	Possible doline	573963	820448	Riverstown	2,700
46	Turlough	573933	820629	Riverstown	2,700
47	Turlough/ swallow hole	573816	817279	Tawnagh	160
48	Spring (Toberbride)	575568	814356	Castlebaldwin	0
49	Spring (Tobermahon)	576098	813386	Drumdoney	100
50	Spring (Tobermahon)	576089	813413	Drumdoney	100
51	Spring/ well (Tobernaveen)	573279	812981	Treanmacmamurtagh	2,600
52	Possible doline/ turlough	573662	812710	Treanscabbagh	2,400
53	Turlough 1731SWK031	573690	812662	Treanscabbagh	2,400
54	Spring	573502	812740	Treanmacmamurtagh	2,400
55	Spring	573493	812728	Treanmacmamurtagh	2,400
56	Spring (Tobermurly)	575526	814289	Castlebaldwin	0
57	Spring (Toberpatrick)	575546	814269	Castlebaldwin	0

The majority of these features are mapped as being underlain by the Bricklieve Limestone (upper). The clean, thick-bedded nature of the formation, along with the presence of abundant chert renders them very susceptible to karstification. The presence of chert in the limestone acts to concentrate flow into pathways around the highly resistant chert material, thereby enhancing the process of karstification[93]. The remainder of these features are mapped as being underlain by the Lisgorman Shale and the Bricklieve Limestone (lower). These records are considered to represent only a portion of those actually on the ground.

14.3.2.8.1 *Turloughs and turlough-type lakes*

A turlough can be defined as 'a topographic depression in karst which is intermittently inundated on an annual basis, mainly from groundwater, and which has a substrate and/ or ecological community's characteristic of wetlands'[86,70,95]. According to the Natura Interpretation Manual of European Union Habitats, turloughs are

[95] Working Group on Groundwater, Sub-committee on Turloughs (2004); Guidance Document GW9: *Guidance on the assessment of pressures and impacts on groundwater dependent terrestrial ecosystems* – www.wfdireland.ie.

defined as 'temporary lakes principally filled by subterranean waters and particular to karstic limestone areas'[96].

- Two lakes that drain via swallow holes, numerous springs and 2 swallow holes were identified at approximately 160m north of Ch 10,600m. The turloughs or turlough type lakes were observed to be very full of water during the site visit in November 2009, with water spreading out onto the adjacent road and fence posts to be almost submerged. No calcareous deposits or water markings on the grass were observed. The largest of the lakes is fed by a surface stream which flows from Loughymeenaghan in the south. The area containing these turloughs / turlough-type lakes is likely to flood extensively during periods when the water table is higher than the land surface following periods of heavy rainfall. Two of the lakes appear to be surface expressions of the watertable during flood events, while the largest of the lakes appears to be a surface water feature with a relatively minor inflow of groundwater during dry periods. During flood events it is likely that groundwater contributes to the lake as the swallow holes at the north of the lake function as estavelles due to a localised rise in the water table.

14.3.2.8.2 *Springs*

A spring can be defined as *'a point where underground water emerges onto the surface'*[66].

- A spring was identified at approximately 80m east of Ch. 200, which is recorded in the GSI national karst feature database as Toberbride. Despite heavy rainfall, there was no flow observed from the spring during the site visit in November 2009. A possible doline was identified at approximately 200m east of Ch. 400, which was observed to be dry during the site visit in November 2009. The possible doline contained outcrops of pale grey karstified limestone with Karren and chert.
- A spring well exists by the east site of the existing N4 at the point where the road is crossed by the Markree Demesne Stream (Toberscanavan Lough outflow). This spring well is housed in a modern concrete structure and is located approx. 1m below the existing road level.
- A spring was identified at approximately 350m east of Ch. 3,800m, which feeds an area of wetland to the west of the existing N4 and passes under the road to join a tributary of the Unshin River to the east of the existing N4. The water level was observed to be at approximately 1.5m below the existing N4 road surface during the site visit in November 2009.
- A spring was identified at approximately 400m east of Ch. 4,500m, which feeds an area of wetland to the east of the existing N4. The water level was observed to be at approximately 0.1m below the existing N4 road surface during the site visit in November 2009.
- A spring was identified at approximately 500m east of Ch. 5,700m, which was observed to form a ponded area bound by rushes and wetland vegetation. The depth of ponded water was observed to be 0.3m during the site visit in November 2009.
- A small spring was identified along the route of the *Proposed Road Development* at Ch. 8,600 in a low lying field.
- A spring was identified at approximately 80m north of Ch. 10,900m, which was observed to form a ponded area within a woodland area, which flowed downhill at approximately 1-2l/s. The depth of ponded water was observed to be 0.1m during the site visit in November 2009.
- A small spring was identified at the bottom of the hill slope 270m east of Ch. 12,600m in a field.
- A spring was identified at approximately 100m west of Ch. 13,750m, which is recorded in the GSI national karst feature database as Toberbride. Despite heavy rainfall, there was little flow observed from the spring into the adjacent ditch during the site visit in November 2009. No outcropping bedrock was observed.

14.3.2.8.3 *Swallow holes*

A swallow hole is described as *'a natural depression in the surface topography caused by the removal of soil or bedrock by water'* and which in some cases 'swallow' surface stream flows[95]. A stream exits the northern margin of the lake at Tawnagh and discharges into a swallow hole at approximately 80m from the northern boundary of the lake. A second swallow hole was identified on historic maps at the western boundary of the lake but no trace of this feature was located on the ground.

[96] Natura (2007) *Interpretation Manual of European Union Habitats.*

14.3.2.8.4 *Significance & sensitivity*

The significance of the karst features identified is that the study area is susceptible to karstification and more unidentified subsurface features may exist. The significance of the possible dolines identified is that these areas may be susceptible to subsidence. The significance of the turlough complex at Tawnagh is that the *Proposed Road Development* has the potential to impact the hydraulic or groundwater catchment area to the turlough. The features recorded as springs identified are not considered significant in themselves. The sensitivity of the karstified bedrock lies in the fact that it can be susceptible to subsidence and that the excavation of road cuts has the potential to impact on unidentified subsurface karst features.

14.3.2.9 Groundwater Supply Wells

According to the national well database compiled by the GSI, there are no public or private wells located or source protection areas delineated or located within 500m of the *Proposed Road Development*. The water supply for Castlebaldwin town is sourced from Lough Arrow, located at circa 900m east of the *Proposed Road Development*.

A well survey was conducted within 500m of proposed road cuts to take account of the typical zone of influence for a domestic supply well. The well survey identified five public or private wells located within 500m of the *Proposed Road Development*. These wells are; the artesian Carrownagark spring well, a private borehole located near Ardloy Lough used for domestic and agricultural supply, a borehole at Doorly west of the existing N4, a borehole at Doorly east of the existing N4 and a spring well at Toberscanavan.

According to the EPA groundwater quality monitoring network, there is a spring located at approximately 150m from Ch. 7,800m which is used for the Carrownagark group water scheme. The abstraction rate is approximately 23m^3/ day, and is used to supply 11 houses. There are no details of this well in the national well database.

A bored (6" diameter) well is located 70m west of the existing N4 at Doorly (Ch 2,700). This well is 31.91m deep and the water level was recorded on 23/8/13 as 7.07mgbl (40.09maOD). The precise usage volume and yield of this well is unknown. The *Proposed Road Development* will pass approximately 10m to the east of this well.

A spring is located 110m east of the existing N4 at Doorly (Ch 2,700) with a small pumphouse built over it. This spring is used to supply 1 person in one house and the water level of the spring on 23/8/13 was 35.41maOD. The *Proposed Road Development* will pass approximately 130m to the west of this well.

A bored (6" diameter) well is located 300m west of the existing N4 at Ardloy (Ch 9,200). This well is 41.90m deep and the water level was recorded on 23/8/13 as 4.49mgbl (55.86maOD). The yield of the well is unknown but it is currently used to supply drinking water for 65-70 head of cattle. The *Proposed Road Development* will pass approximately 70m to the east of this well but a realigned road will pass beside or possibly over this well.

A spring well is located at the existing roadside at Ch. 1,050m. This well was relocated to this position when the N4 was last widened at this point.

The significance of this information is that the low number of supply wells suggests poor well yields and low bedrock permeabilities across much of the study area. The significance of the identified group water scheme located beside the *Proposed Road Development* is that it is spring fed. The sensitivity of the identified supply well lies in the fact it is likely to be highly sensitive to water level and water quality changes.

14.3.2.10 Groundwater Hydrochemistry

According to the Ballymote Groundwater Body description, the groundwater is expected to have a $CaHCO_3$ signature, similar to the adjoining Ballymote groundwater body, with high alkalinity, electrical conductivity and hardness[93]. According to EPA groundwater quality monitoring data (2004-2006), the average faecal coliform count at Carrownagark Group Water Scheme, located circa 150m northeast of Ch. 7,800m, is 22 and the average nitrate concentration is 6.9mg/l. The drinking water limit for faecal coliform is zero and for nitrate is 50mg/l.

Baseline groundwater quality testing was carried out at Carrownagark private supply scheme. This is the only known drinking water well in use currently. The sample was taken from a tap in a shed belonging to a member of the group water scheme at Grid Ref. 571780, 818428. The water samples were submitted to an accredited laboratory for analysis of the main test parameters indicated by Table C, Part 1 of the Schedule to the

European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. No. 278 of 2007): Aluminium (Total), Ammoniacal Nitrogen, Electrical Conductivity, E.Coli, Iron (Total), Nitrite and pH. This monitoring was undertaken in early February 2011. The analytical results of sampling are detailed in Appendix 14.3 contained within volume 4. The following points summarise these results:

- **Aluminium**: The analytical results at Carrownagark public supply scheme are within the limit set by Drinking Water Regulations S.I. 278 of 2007.
- **Ammoniacal Nitrogen**: The analytical results at Carrownagark public supply scheme are within the limit set by Drinking Water Regulations S.I. 278 of 2007.
- **Total Iron**: The analytical results at Carrownagark public supply scheme are within the limit set by Drinking Water Regulations S.I. 278 of 2007.
- **Nitrite**: The analytical results at Carrownagark public supply scheme are within the limit set by Drinking Water Regulations S.I. 278 of 2007.
- **Total Coliforms, Faecal Coliforms and Clostridium Prefringens**: The analytical results at Carrownagark public supply scheme exceed the limit set by Drinking Water Regulations S.I. 278 of 2007 for all bacteriological parameters as 156 MPN/100mlfaecal coliform, 1732 MPN/100ml total coliform and 1 cfu/100ml clostridium prefringens was detected in the sample.

The significance of the groundwater hydrochemistry is that there is some localised contamination with respect to faecal coliform. The sensitivity of the groundwater hydrochemistry lies in the fact that the construction of the proposed road has the potential to cause localised groundwater contamination.

14.3.2.11 Groundwater Dependent Terrestrial Ecosystems

Groundwater Dependent Terrestrial Ecosystems (GWDTE's) are defined as ecosystems which use groundwater for survival, either partially or completely, and are designated for protection under Article 1 of the Water Framework Directive[90]. The NPWS list of GWDTE's includes turloughs, active raised bog, degraded raised bog capable of regeneration, blanket bog, transition mire/ quaking bog, calcareous & alkaline fens, bog woodland and alluvial forests.

There are six (6 no.) groundwater dependent terrestrial ecosystems (GWDTE's) identified within the study area, namely Lackagh Fen, Boathole Lough & Lough Corran, Carrowkeel wet woodland, Cuileencroobagh Lough, Aghalenane & Ardloy Loughs and the swallow hole complex at Tawnagh (See Figure 14.1 of Volume 3 and appendix 12.2 of volume 4).

14.3.2.11.1 *Lackagh Fen*

Fens are peat-forming systems fed by ground/surface waters; rich fens are at least mildly base-rich (Chapter 12 of this EIS). Lackagh Fen lies immediately east of the *Proposed Road Development*. According to the ecological study carried out as part of this assessment, the substrate is very wet cutover fen peat separated from the core fen area by drains and the habitat is classified as being of very high value and of national importance.

14.3.2.11.2 *Boathole Lough & Lough Corran*

The Boathole Lough and Lough Corran are described (Chapter 12 of this EIS) as lakes with reed swamp and raised bog habitats, have a high floral diversity and are connected to the Unshin River by an outflow river stream. The road realignment passes within 50m to the east of these lakes. The ecological study carried out as part of this assessment rates this area as being of high value and of county importance. The edges of the lake beds were observed to be composed mainly of lime marl during the site walkovers. This suggests that these lakes receive significant groundwater discharge. The proposed route is on an embankment as it passes to the east of these lakes for all except a small section between the two lakes which runs through a small cut.

14.3.2.11.3 *Wet woodland at Carrowkeel*

The road realignment crosses the Drumfin River at this habitat. The ecological study carried out as part of this assessment rates this area as being of high value and of county importance. The road runs through the centre of this woodland continuing on an embankment south through the majority of the woodland.

14.3.2.11.4 *Cuileencroobagh quaking bog/ fen*

Cuileencroobagh Lough is described as quaking bog/ fen, characterised by a floating scraw of vegetation and being naturally infilling. The road realignment passes within approximately 60m of this. The ecological study

carried out as part of this assessment rates this area as being of very high value and of county importance. The road will run on an embankment as it passes the bog.

14.3.2.11.5 *Aghalenane & Ardloy fen/ peatland*

Aghalenane & Ardloy Loughs are described as lakes with reed swamp, fen and bog, have a high floral diversity and are connected to the Unshin River by a small stream. The loughs also contain a fen complex and the proposed road realignment passes adjacent to this site in the south west. The ecological study carried out as part of this assessment rates this area as being of extremely high value and of international importance. The road will run directly past the western and southern boundary of this habitat and will be elevated on an embankment along this chainage.

14.3.2.11.6 *Swallow hole/ turlough complex at Tawnagh*

The swallow hole complex at Tawnagh is a pond/ marsh complex, providing inputs into local groundwater systems. The ecological study carried out as part of this assessment rates this area as being of very high value and of national importance. The hydrological study carried out on the pond and swallow hole complex concluded that this pond is mainly fed by the surface discharge stream from Loughymeenaghan to the south. The lake at Tawnagh discharges to the karstic groundwater system at its northern end, with St. Patrick's well to the north a likely resurgence point for this water. The road passes within approximately 160m of this lake and passes through a cut in the drumlin to the southwest of the habitat.

14.3.2.11.7 *Significance & sensitivity*

The significance and sensitivity of the GWDTE's is that the *Proposed Road Development* passes immediately adjacent to five (5 no.) GWDTEs – Lackagh Fen, The Boathole and Lough Corran, Carrowkeel Wet Woodland, Cuileencroobagh and the Aghalenane & Ardloy fen/peatland, and through six (6 no.) local surface catchment areas, which are broadly coincident with the hydraulic or groundwater catchments and that the excavation of road cuts has the potential to impact both surface and groundwater flows and catchment areas.

14.4 Description of Likely Impacts

The following sections detail the potential Impacts of the *Proposed Road Development* on the hydrological and hydrogeological aspects of the environment. These potential impacts are the impacts of the *Proposed Road Development* before mitigation measures including the consideration of the drainage design.

14.4.1 "Do Nothing" Scenario

Should the *Proposed Road Development* not be built, the wetland habitats and GWDTE's would most likely experience more extended but less frequent wet and dry periods and warmer water temperatures, due to current environmental trends. The Office of Public Works has employed estimates of an increase in average peak flood levels of 20% over the coming years as a result of climate change[97]. The figure of 20% is also recommended by the UK Highways Agency publication *Road Drainage and the Water Environment HA216/06*. These changes over several decades, may lead to a reduction in biodiversity, as more sensitive species become marginalized.

The existing N4 road has no attenuation, containment for accidental spillages or petrol interceptors. Therefore the existing N4 road has a lower capability to attenuate increased volumes of rainfall and therefore road runoff and therefore a greater potential to pollute nearby surface and groundwater bodies.

14.4.2 Impacts on Hydrology

14.4.2.1 Impacts on Drainage, Surface Water Flows & Quality

The likely impacts of the *Proposed Road Development* on the existing drainage regime are as follows and are further described in Appendix 14.2 contained within volume 4 of this EIS.

[97] Office of Public Works, (2003) Report of the Flood Policy Review Group.

14.4.2.1.1 *Construction phase*

(1) There is a possible risk of a reduction in water quality in streams receiving runoff from the proposed road, in particular around road crossings and in areas of soft ground material to be removed and in the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 posed by the *Proposed Road Development* on the existing drainage regime during the construction phase. The main potential contaminant during the construction phase is Suspended Solids, which with the deposition of silt in water bodies can reduce oxygen levels available for salmonid or lamprey spawning. The drainage design includes for the discharge of road runoff into the Markree Demesne Stream, the Unshin River via the Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and Drumderry Stream (including its tributary), therefore these streams are considered here. The importance of the surface water quality is rated as **high** for the streams receiving runoff from the outfalls as they flow into the Unshin River and Lough Arrow which are classified by the EPA as having good status; the magnitude is rated **small adverse** as a minor loss of fishery may occur; and therefore the significance is rated **moderate/ slight** for the outfall locations on the scheme.

(2) The re-sectioning or re-aligning of stream channels at road crossings is a certain direct impact of the *Proposed Road Development* on the existing drainage regime during the construction phase. This may result in changes to the existing geomorphological processes, indirectly impacting water quality or fisheries value of the watercourse. There are ten (10 no.) proposed stream/river crossings DX1-DX10 (as opposed to smaller field drains which have not been assigned a DX number) in addition to a tributary (DX11) of the Drumderry Stream which is also crossed. The importance of the surface water quality is rated as **high** for each of the stream crossing locations as they all ultimately flow into the Unshin River or Lough Arrow which, as stated above is classified by the EPA as having good status; the magnitude of this impact is rated as **small adverse**, as a minor loss of fishery may occur; and therefore the significance is rated as **moderate/ slight**.

(3) The disturbance of existing field drainage systems is a certain direct impact of the *Proposed Road Development* and works carried out in the spoil treatment sites including including sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 on the drainage during the construction phase. This is likely to lead to impaired drainage in the period of time between initial disturbance and final reinstatement of such drainage works. The importance of the existing field drainage is rated **low**, as the drains are of low quality on a local scale; the magnitude of this impact is rated as **small adverse**, as a minor impact on the integrity of the overall drainage may occur; and therefore the significance of this impact is rated **imperceptible**.

(4) At all identified spoil infill sites within the CPO including sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 there is the possibility that water quality would be adversely affected as a result of material washing into surface drains in and around the treatment locations. This could lead to an increase in suspended solids, nutrients, and other contaminants if the deposited material is not stabilised and the surface drainage system adequately protected. The main potential contaminant during the construction phase is Suspended Solids, which with the deposition of silt in water bodies can reduce oxygen levels available for salmonid or lamprey spawning. Also of potential concern is the hydrochemistry of water draining from peat, which can often contain elevated concentrations of Total Organic Carbon, Suspended Solids and low values of pH, which can potentially mobilise heavy metals into solution. The importance of the surface water quality is rated as **high**; the magnitude is rated **small adverse** as a minor loss of fishery may occur; and therefore the significance is rated **moderate/ slight**. As the surface water drainage network will not be modified at the identified sites and no additional permanent impermeable surfaces will be created, it is unlikely that there will be any effect on flow volumes or flooding regimes in the surface water drainage network at the identified sites.

(5) Soil stabilisation using lime will be carried out across the development site. Lime soil conditioning is widely carried out in road construction projects. This activity will be carried out within strict guidelines contained within the Erosion and Sediment Control Plan and as a result, no impact is forseen as a result of lime soil conditioning.

14.4.2.1.2 *Operational*

(1) The reduction in water quality in streams receiving routine runoff from the proposed road is a possible indirect impact of the *Proposed Road Development* on the drainage during the operational phase. The assessment of pollution impacts from routine runoff to surface waters is conducted following guidance in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09,* which recommends using HAWRAT (Highways Agency Water Risk Assessment Tool) to assess the short-term risks related to the intermittent nature of road runoff. Step 1 of HAWRAT allows an initial check to assess the quality of the direct highway runoff against the toxicity thresholds assuming no in-river dilution and no treatment or attenuation, while Step 2 takes account of the diluting capacity of the watercourse which receives the road runoff and the likelihood and extent of sediment-bound pollutants. These assessments were carried out focusing on the natural watercourse into which each outfall receiving road runoff ultimately discharges, using the low flow measurements taken during the site investigations and the results are summarised in the following table.

Table 14-19: Impact Assessment of Routine Runoff on Surface Water Quality

Outfall ID	Receiving watercourse	Step 1	Step 2
Outfall 1	Tributary of Unshin River	Pass	Pass
Outfall 2	Markree Demesne Stream	Pass	Pass
Outfall 3	Unshin River Tributary	Pass	Pass
Outfall 4	Lackagh Fen drain	Pass	Pass
Outfall 5	Turnalaydan Stream	Pass	Pass
Outfall 6	Turnalaydan Stream	Pass	Pass
Outfall 7	Turnalaydan Stream	Pass	Pass
Outfall 8	Drumfin River tributary	Pass	Pass
Outfall 9	Drumfin River	Pass	Pass
Outfall 10	Cuileencroobagh Lough	Pass	Pass
Outfall 11	Ardloy and Aghalenane Loughs (outflow)	Pass	Pass
Outfall 12	Ardloy and Aghalenane Loughs	Pass	Pass
Outfall 13	Springfield Stream	Pass	Pass
Outfall 14	Lissycoyne Stream	Pass	Pass
Outfall 15	Drumderry Stream	Pass	Pass

It should also be noted that under existing conditions runoff from the existing road flows unattenuated into the Unshin River via its tributaries. As the new road would not directly lead to an increase in traffic volumes, it must be borne in mind that the increase in pollutants generated along the new road corridor will be mirrored by a similar reduction in pollutant load along the existing road. The importance of the surface water quality is rated as **high**; the magnitude of this impact is rated as **negligible** resulting in an impact of insufficient magnitude to affect use or integrity of receiving watercourses; and therefore the significance of this impact is rated **imperceptible**.

(2) The increased risk to surface water as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the drainage during the operational phase. The probability can be assessed by examining the probability of a serious accidental spillage in one year over a given road length and is calculated using a formula from the UK Highways Agency publication *Road Drainage and the Water Environment HD45/09,* which is based on the road length in kilometres (14.71km), serious spillage rates as reported by the UK Highways Agency *Design Manual for Roads and Bridges* (0.45 per billion HGV km/ year), annual average daily traffic (10900 based on volumes from the traffic modelling report), percentage of Heavy Goods Vehicles (10%) based volumes from the traffic modelling report) and the risk reduction factor, depending on emergency response times (0.6

for surface water and 0.3 for groundwater in rural settings). The acceptable risk of a serious pollution incident occurring will be where the annual probability is predicted to be less than 1%; however where road runoff discharges within 1 km of a designated wetland cSACs, such as The Unshin River or Lough Arrow within 0.5km of the *Proposed Road Development*, 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%. The probability that a spillage will cause a pollution incident remains well below the acceptable risk level and are detailed in the table below.

Table 14-20: Calculated Probabilities of a Serious Accidental Spillage

Catchment ID	Surface Water	Groundwater
Unshin River/Lough Arrow	0.006064	0.004042

The importance of the surface water quality is rated as **high** for all streams flowing to the Unshin River, as per above; the magnitude of this impact is rated as **negligible** as the calculated risk of a serious pollution incident is <0.5% annually; and therefore the significance of this impact is rated **imperceptible**.

(3) The increase in the volume and rate of surface runoff discharging from the catchments as a result of an increase in impervious area is a certain indirect impact of the *Proposed Road Development* on the drainage during the operational phase. However, the area of impervious surface is insignificant compared to the upstream catchment areas, resulting in an insignificant increase in peak flows discharging to the receiving waters. The following table summarises these areas.

Table 14-21: Paved Road Area compared to catchment area

Outfall ID	Receiving water	Approx. upstream catchment area (m2)	Approx. road area (m2)	Road area as % of catchment area
1-14	Unshin River	48,000,000	278,000	0.58
15	Lough Arrow	1,900,000	10,000	0.53

The importance of the surface water quality is rated as **high** for streams flowing into the Unshin River and Lough Arrow as per above; the magnitude of this impact is rated as **negligible**, resulting in a negligible change in predicted peak flood level; and therefore the significance of this impact is rated **imperceptible**.

14.4.2.2 Impacts on Conservation Areas

The likely impacts of the *Proposed Road Development* on the conservation areas are as follows and are further described in Appendix 14.2. contained within volume 4 of this EIS.

14.4.2.2.1 *Construction phase*

(1) The reduction in water quality in streams receiving runoff from the proposed road, which feed into the conservation areas, is a possible indirect impact of the *Proposed Road Development* and activity at the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, BP/SR Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 during the construction phase. The importance of the conservation areas is rated **extremely high**; the magnitude of this impact is rated as **negligible** for Lough Arrow cSAC SPA resulting in an impact of insufficient magnitude to affect use or integrity and **moderate adverse** for the Unshin River cSAC pNHA having a moderate sensitivity to changes in water quality; and therefore the significance of this impact is rated **imperceptible** for Lough Arrow cSAC SPA and **potentially significant** for the Unshin River cSAC pNHA. No impact is anticipated on the Bricklieve Mountains & Keshcorran cSAC pNHA as the *Proposed Road Development* does not pass through their catchment areas.

(2) The disturbance of existing field drainage systems feeding into the conservation areas is a certain direct impact of the *Proposed Road Development* and activity at the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 during the construction phase. This is likely to lead to impaired drainage in the period of time between initial disturbance and final reinstatement of such drainage works. The importance of the Lough Arrow cSAC SPA and Unshin River

cSAC pNHA conservation areas is rated **extremely high**; the magnitude of this impact is rated as **negligible**; and therefore the significance of this impact is rated **imperceptible**. No impact is anticipated on the Bricklieve Mountains & Keshcorran cSAC pNHA as the *Proposed Road Development* does not pass through their catchment areas.

14.4.2.2.2 *Operational*

(1) The reduction in water quality in streams receiving routine runoff from the proposed road, which feed into the conservation areas, is a possible indirect impact of the *Proposed Road Development* on the drainage during the operational phase. An assessment of pollution impacts from routine runoff to surface waters was conducted following guidance in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09,* the results of which are detailed in section 14.4.2.1.2. The importance of the conservation areas is rated **extremely high**; the magnitude of this impact is rated as **negligible** resulting in an impact of insufficient magnitude to affect use or integrity of the conservation areas; and therefore the significance of this impact is rated **imperceptible**.

(2) The increased risk to surface and groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the conservation areas during the operational phase. As per above, the probability is calculated using a formula from in the UK Highways Agency publication *Road Drainage and the Water Environment HD45/09.* The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the conservation areas is rated **extremely high**; the magnitude of this impact is rated as **negligible**; and therefore the significance of this impact is rated **imperceptible**.

(3) The increase in the volume and rate of surface runoff feeding into the conservation areas as a direct result of increased impervious areas is a possible indirect impact of the *Proposed Road Development* during the operational phase. This impact is calculated to represent a worst-case scenario and as an unmitigated impact. In order to quantify the increase in surface runoff within the catchment areas, the effective rainfall is calculated and the recharge and runoff contributions are estimated using a methodology devised by the Working Group on Groundwater[90]. The aquifer vulnerability in the Unshin River and Lough Arrow catchments varies from extreme to low; however for the most part the aquifer vulnerability is high, based on 3-5m of low permeability clay subsoil. On this basis, an overall recharge coefficient of 30% of effective rainfall is considered appropriate for the catchment area. Therefore the runoff rate is the remaining 70% of effective rainfall and equates to 0.886m/ year, based on effective rainfall calculations. The *Proposed Road Development* will increase the impervious area in the surface catchments and therefore increase the runoff rate by 30% from 70% to 100% over these areas and denying groundwater recharge. The following table summarises these increases for the Unshin River and Lough Arrow catchments.

Table 14-22: Potential increases in surface runoff to concentration areas

Conservation site	Road Chainage (approx.)	Approx. upstream catchment area (m^2)	Approx. paved road area (m^2)	Paved road % catchment area	Increased runoff (m^3/ year)
Unshin River cSAC pNHA	Ch -190m to 13,900m	48,000,000	288,000	0.6	108,6660
Lough Arrow cSAC SPA	Ch13,900- 14,520m	1,900,000	10,000	0.53	3,797

According to the Working Group on Groundwater guidelines[90], the impact potential of <2% reduced recharge as a % of the average recharge is negligible in rivers/ lakes in a bedrock aquifer. This is considered appropriate for the opposite i.e. increased runoff. The importance of the conservation areas is rated **extremely high**; the magnitude of this impact is rated as **negligible**; and therefore the significance of this impact is rated **imperceptible**.

14.4.2.3 Impacts on Wetland Habitats

The likely impacts of the *Proposed Road Development* on the wetland habitats are as follows and are further described in Appendix 14.2 contained within volume 4 of this EIS

14.4.2.3.1 *Construction phase*

(1) The reduction in water quality in streams receiving runoff from the proposed road and activity at the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, BP/SR Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03, which feed into the wetland habitats, is a possible indirect impact of the *Proposed Road Development* on the wetland habitats during the construction phase. Currently the Carrowkeel wet woodland, the Ardloy Loughs, and the lake at Tawnagh and swallow hole complex all receive unattenuated and untreated road runoff from the existing N4 and/or local roads. The importance of the wetland habitats is rated **high** (Toberscanavan Lough, Boathole Lough, Lough Corran, Cuileencroobagh and Carrowkeel woodland**), very high** (Lackagh Fen, and Tawnagh) **and extremely high** (Ardloy & Aghalenane Loughs), based on the ecological study carried out as part of this assessment which rates these areas as being of high value on a county, national and international scale; the magnitude of this impact is rated as **negligible** resulting in an impact of insufficient magnitude to affect use or integrity of receiving watercourses; and therefore the significance of this impact is rated **imperceptible**.

(2) The disturbance of existing field drainage systems feeding into the wetland habitats is a certain direct impact of the *Proposed Road Development* and activity at the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 during the construction phase. This is likely to lead to impaired drainage in the period of time between initial disturbance and final reinstatement of such drainage works. Field drainage flowing into parts of Lackagh Fen, The Boathole & Lough Corran, Cuilencroobagh Lough, Aghalenane & Ardloy Lough and Fen, and into the lake at Tawnagh and swallow hole complex will be affected to some degree by the road corridor. The importance of the wetland habitats is rated **high**, as per above; but the magnitude of this impact is rated as **small adverse**, resulting in minor impact on the integrity of the site; and therefore the significance of this impact is rated **moderate/ slight**.

14.4.2.3.2 *Operational*

(1) The increased risk to surface and groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the wetland habitats during the operational phase. As per above, the probability is calculated using a formula from in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09.* The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the wetland habitats is rated **high**, as per above; the magnitude is rated **negligible** as the calculated risk of a serious pollution incident is <0.5% annually; and therefore the significance of this impact is rated **imperceptible**.

(2) The potential increase in the volume and rate of surface runoff feeding into the wetland habitats as a direct result of increased impervious areas is a possible indirect impact of the *Proposed Road Development* during the operational phase. This impact calculated to represent a worst-case scenario and as an unmitigated impact. As detailed above, the *Proposed Road Development* passes through or close to the following wetland habitats; Toberscanavan Lough, Lackagh Fen, the Boathole & Lough Corran, Carrowkeel wet woodland, Cuileencroobagh Lough, Aghalenane and Ardloy Loughs. The result of this will be that the *Proposed Road Development* will increase the impervious area in the surface catchments and therefore increase the runoff rate by c. 30% from 70% to 100% over these areas and denying groundwater recharge.

According to the Working Group on Groundwater guidelines[90], the impact potential of <5% reduced recharge as a % of average recharge is low for a GWDTE with high dependency on groundwater, such as a Fen, and for a GWDTE with potentially extreme dependency on groundwater, such as a bog woodland. This is considered appropriate for the opposite i.e. increased runoff. The following table summarises these increases for the wetland habitat catchments, which were calculated as part of this study. The importance of the wetland habitats is rated **high** (Boathole Lough, Lough Corran, Cuileencroobagh and Carrowkeel woodland**), very high** (Lackagh Fen and Tawnagh) **and extremely high** (Ardloy & Aghalenane Loughs) as per above; the magnitude of this impact is rated as **small adverse**; and therefore the significance of this impact is rated **moderate** except for Ardloy & Aghalenane Loughs which are rated as **significant.**

Table 14-23: Potential increases in surface runoff to wetlands

Catchment ID	Approx. catchment area (m^2)	Approx. increase in paved road area draining to (m^2)	Paved road area % catchment area	Increased runoff (m3/ year)
Toberscanavan Lough	6,900,000	0	0	0
Lackagh Fen	447,000	18525	4.1	7,033
Boathole & Lough Corran	14,980,000	65,833	0.45	24,995
Carrowkeel wet woodland	995,000	0	0	0
Cuileencroobagh Lough	170,000	37,994	22.32	14,423
Aghalenane & Ardloy Lough and fen	534,000	12,315	2.3	4,675
Lake and swallow hole complex at Tawnagh	1,900,000	0	0	0

14.4.2.4 Impacts on Flooding

The significance of flooding is that streams which are crossed by the *Proposed Road Development* are prone to recurring flooding in places.

According to the flood mapping compiled by the OPW, there are several locations within the study area prone to recurring flooding. The following table summarises these locations, of which the majority are along the existing N4 road (Figure 14.1 contained within volume 4). However the *Proposed Road Development* does not cross any of these mapped areas. Computer-based flood risk modelling carried out as part of the Flood Risk Assessment (FRA) for the *Proposed Road Development* has identified two areas where flooding may occur. One area is located at the outflow of Lough Corran and the other is located around Carrowkeel Wet Woodland at the point where the road alignment crosses the Drumfin River.

Table 14-24: Recorded areas of recurrent flooding

Stream/ River	Location	Road Chainage	Location relative to proposed road
Lackagh Fen drain	Lackagh	Ch 4,200m	330m to east
Unshin River	Coolbock Bridge	Ch 5,700m	1.5km to east
Unshin River	Bellarush Bridge	Ch 13,100m	1.4km to east

The existing N4 near Lackagh is low lying and a spring which feeds an area of wetland to the west of the existing N4 passes under the existing road there. The recurring flooding here is considered to be a result of poor road drainage on the existing N4, with flooding occurring after heavy rainfall. Therefore no impact is anticipated as a result of the *Proposed Road Development* located to the west. The areas mapped as prone to recurring flooding at Coolbock Bridge and at Bellarush Bridge are located at approximately 1.5km from the *Proposed Road Development*, therefore no impacts are anticipated.

The computer modelling results carried out as part of the FRA indicates that there may be an impact on flooding at the point where the alignment crosses the Turnalaydan Stream and the Drumfin River. It is proposed to mitigate this impact by the inclusion of drainage pipes at the base or the road embankment at both of these locations. Other more localised flooding issues were also identified at the Markree Demesne Stream, the Springfield Stream, the Lissycoyne Stream and a tributary of the Drumderry Stream where measures such as the provision of under embankment culvert and clearance of dense vegetation. These measures are described in section 4.8.6 of this EIS. The resulting increase in flood level will be negligible.

Table 14-25: Existing and required outfall capacities

Without Attenuation							
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
1	0.729	0.721	0	0.425	1.146	0.425	0.425
2	3.028	1.62	2.12	0.961	3.081	1.461	1.461
3	4.567	1.807	1.807	0.418	2.225	0.418	0.418
4	0.698	0.916	0.916	0.179	1.095	0.179	0.179
5	0.509	0.118	0.118	0.013	0.131	0.013	0.013
6	40.894	18.167	18.095	1.144	19.239	1.072	1.072
7	5.055	17.833	17.752	0.575	18.327	0.494	0.494
8	4.560	1.685	1.500	0.381	1.881	0.196	0.196
9	2.824	24.940	24.940	0.174	25.114	0.174	0.174
10	0.358	0.747	0.634	0.334	0.968	0.221	0.221
11	0.742	0.924	0.885	0.193	1.078	0.154	0.154
12	2.097	1.232	1.232	0.043	1.275	0.043	0.043
13	3.062	4.700	4.619	0.079	4.697	-0.003	-0.003
14	3.083	4.129	4.056	0.675	4.731	0.602	0.602
15	2.193	4.903	4.806	0.423	5.229	0.326	0.326

With Attenuation							
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Attenuated Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
1	0.729	0.721	0	0.024	0.024	-0.705	-0.705
2	3.028	1.620	2.120	0.193	2.313	0.693	0.693
3	4.567	1.807	1.807	0.082	1.888	0.082	0.082
4	0.698	0.916	0.916	0.032	0.948	0.032	0.032
5	0.509	0.118	0.118	0.002	0.120	0.002	0.002

With Attenuation							
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Attenuated Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
6	40.894	18.167	18.095	0.222	18.317	0.150	0.150
7	5.055	17.833	17.752	0.115	17.867	0.033	0.033
8	4.560	1.685	1.500	0.073	1.573	-0.112	-0.112
9	2.824	24.940	24.940	0.030	24.970	0.030	0.030
10	0.358	0.747	0.634	0.066	0.700	-0.047	-0.047
11	0.742	0.924	0.885	0.033	0.918	-0.006	-0.006
12	2.097	1.232	1.232	0.018	1.249	0.018	0.018
13	3.062	4.700	4.619	0.014	4.633	-0.067	-0.067
14	3.083	4.129	4.056	0.137	4.193	0.064	0.064
15	2.193	4.903	4.806	0.085	4.891	-0.012	-0.012

The importance of these areas is rated **low**, due to the remoteness from residential or commercial properties; the magnitude of this impact is rated **moderate** to **large adverse**, as detailed above; and therefore the significance of this impact is rated **slight** to **slight/ moderate**.

14.4.2.5 Impacts on Fisheries Value

The likely impacts of the *Proposed Road Development* on fisheries value are as follows and are further described in Appendix 14.2 contained within volume 4

14.4.2.5.1 *Construction phase*

(1) The reduction in water quality in streams receiving runoff from the proposed road, in particular around road crossings and areas of soft ground material to be removed (see chapter 13, Geology) and activity at the spoil treatment sites; SR-LI-01, SR-LI-02, SR-LI-03, LS-MI-04, SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03, is a possible indirect impact of the *Proposed Road Development* on the fisheries value during the construction phase. The main potential contaminant during the construction phase is Suspended Solids, which with the deposition of silt in water bodies can reduce oxygen levels available for salmonid spawning (typically November to March) or lamprey spawning period (typically March to May). The majority of outfall locations flow into the Unshin River cSAC/pNHA. The importance of the fisheries value of these streams is rated **medium**; the magnitude of this impact is rated as **small adverse**, as a minor loss of fishery may occur; and therefore the significance of this impact is rated **slight**.

(2) The re-sectioning or re-aligning of stream channels at road crossings is a certain direct impact of the *Proposed Road Development* on the fisheries value during the construction phase. This may result in changes to the existing geomorphological processes, indirectly impacting water quality or fisheries value of the watercourse. The rivers of fisheries value are the Markree Demesne Stream, Turnalaydan Stream, Drumfin River, Lissycoyne Stream, Springfield Stream, Drumderry Stream and the tributary of the Drumderry Stream at the southern end of the project.. The importance of the fisheries value of

these streams is rated **medium**[98]; the magnitude of this impact is rated as **small adverse**, as a minor loss of fishery may occur; and therefore the significance of this impact is rated **slight**.

14.4.2.5.2 *Operational phase*

(1) The reduction in water quality in streams receiving routine runoff from the *Proposed Road Development* (not considering the drainage design) is a possible indirect impact of the *Proposed Road Development* on the fisheries value during the operational phase. An assessment of pollution impacts from routine runoff to surface waters was conducted following guidance in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09,* the results of which are detailed in section 14.4.2.1.2. The importance of the surface water quality is rated as **high** for stream DX1-DX10 as per above; the magnitude of this impact is rated as **negligible**; and therefore the significance of this impact is rated **imperceptible**.

(2) The increased risk to surface and groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the drainage during the operational phase. The probability is calculated using a formula from the UK Highways Agency publication *Road Drainage and the Water Environment HD45/09*. The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the fisheries value is rated **medium**; the magnitude of this impact is rated as **negligible**, as the calculated risk of a serious pollution incident is <0.5% annually; and therefore the significance of this impact is rated **imperceptible.**

The increase in the volume and rate of surface runoff discharging from the catchments as a result of an increase in impervious area is a certain indirect impact of the *Proposed Road Development* on the fisheries value during the operational phase. The importance of the fisheries value is rated **medium**; the magnitude of this impact is rated **negligible**, resulting in a negligible change in predicted peak flood level; and therefore the significance of this impact is rated **imperceptible.**

14.4.3 Impacts on Hydrogeology

14.4.3.1 Impacts on Groundwater Body Status

The likely impacts of the *Proposed Road Development* on the groundwater body (GWB) status are as follows and are further described in Appendix 14.2 contained within volume 4 of this EIS.

14.4.3.1.1 *Construction phase*

(1) The reduction in groundwater quality receiving runoff from the proposed road, in particular around road cuttings and areas of soft ground material to be removed (see geology chapter), and activity at borrow pit sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 is a possible indirect impact of the *Proposed Road Development* on the local hydrogeology during the construction phase. The main potential contaminant during the construction phase is Suspended Solids; however the infiltration of runoff to ground is likely to naturally mitigate this potential impact. However where exposed during development, the karstified bedrock will be extremely vulnerable to contamination and has the potential to rapidly transmit contamination in the subsurface to connected springs or to surface water bodies. The importance of the groundwater bodies is rated **high**, the magnitude of this impact is rated as **moderate adverse**, resulting in an impact on the integrity or moderate changes to the aquifer or unsaturated zone; therefore the significance of this impact is rated **significant/moderate**.

14.4.3.1.2 *Operational phase*

(1) The reduction in groundwater quality receiving routine runoff discharges to the ground from the proposed road is a possible indirect impact of the *Proposed Road Development* during the construction phase. The assessment of pollution impacts from routine runoff to groundwater is conducted following guidance in UK Highways Agency publication *Road Drainage and the Water*

[98] CIRIA (2000) Groundwater Control – Design and Practice (C515).

Environment HD45/09. The importance of the groundwater bodies is rated **high**; the magnitude of this impact is rated as **moderate adverse**, resulting in medium risk to groundwater; and therefore the significance of this impact is rated **significant/ moderate**.

(2) The increased risk to groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the groundwater body status during the operational phase. The probability is calculated using a formula from the UK Highways Agency publication *Road Drainage and the Water Environment HD45/09*. The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the groundwater bodies is rated **high**; the magnitude of this impact is rated as **negligible**, as the calculated risk of serious pollution incidence is <0.5% annually; and therefore the significance of this impact is rated **imperceptible**.

(3) The potential reduction in groundwater body status with regard to water quantity is a possible indirect impact of the *Proposed Road Development* during the operational phase. The *Proposed Road Development* will increase the impervious area in the surface catchments and therefore increase the runoff rate by 30% from 70% to 100% over these areas and thereby denying groundwater recharge. The following table summarises these reductions for the Ballymote, Ballygawley and Lavagh-Ballintougher groundwater bodies and the relative paved road area to groundwater body area. The importance of the groundwater bodies is rated **high**; the magnitude is rated as **negligible** in accordance with Working Group on Groundwater *Methodology for risk characterisation of Ireland's groundwater*[99] whereby impacts of <2% of groundwater abstractions on average recharge to groundwater bodies are rated as having no impact potential; and therefore the significance of the impact is rated **imperceptible**.

Table 14-26: Estimated reductions in recharge to groundwater body

GWB ID	Road length (m)	Paved Road width (m)	Road area (m^2)	Paved road % groundwater body	Reduction in recharge (m^3/ year)
Ballymote	11,400	16.5	188,100	0.066	67,151
Lavagh-Ballintougher	2,300	16.5	37,950	0.091	13,585
Ballygawley	700	16.5	11,550	0.03	4,123

14.4.3.2 Impacts on Aquifer Vulnerability

The likely impacts of the *Proposed Road Development* on aquifer vulnerability are as follows and are further described in Appendix 14.2. (Volume 4). The significance of the aquifer vulnerability is that it is reflective of the protection afforded by the subsoil geology to groundwater contamination. The sensitivity of the aquifer vulnerability lies in the fact that the main earthworks activities has the potential to increase or decrease aquifer vulnerability.

14.4.3.2.1 *Construction phase*

(1) The reduction in the level of protection afforded to underlying groundwater resources is a likely indirect impact of the removal of geological materials during the construction phase. The excavation of road cuts and removal of geological materials and activity at the borrow pit sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 has the potential to increase aquifer vulnerability to groundwater contamination. The proposed excavations are likely to reduce the subsoil thickness to less than 3m in places and therefore increase the aquifer vulnerability from high to extreme. However this impact is considered to remain localised at these proposed excavations and temporarily, exposing the subsoil during the construction phase only. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **small adverse**, resulting in the removal of a small proportion of the aquifer, and therefore the significance of this impact is rated **moderate**.

[99] Working Group on Groundwater (2005) *Methodology for risk 14-388characterization of Ireland's groundwater, GW8.*

14.4.3.2.2 *Operational phase*

(1) The increase in the level of protection afforded to underlying groundwater resources is a certain indirect impact of the placement of embankments and an impervious cover along the *Proposed Road Development*. However this impact is considered to remain localised at or along the proposed road. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **minor beneficial**, and therefore the significance of this impact is rated **minor beneficial**. The material emplaced in the type 2 repositories represents a minor negative impact to the groundwater resource in the vicinity of these areas.

14.4.3.3 Impacts on Groundwater Flow

The likely impacts of the *Proposed Road Development* on groundwater flow are as follows and are further described in Appendix 14.2. (Volume 4). The significance of the groundwater flow is that regional and local flow directions are broadly coincident with surface topography, with regards to the catchments of Unshin River and its tributaries the Markree Demesne Stream, Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and the Drumderry Stream catchment discharging to Lough Arrow. The sensitivity of the groundwater flow lies in the fact that the excavation of road cuts has the potential to impede subsurface drainage and to change the boundaries of groundwater catchments.

14.4.3.3.1 *Construction phase*

(1) The potential interception of shallow groundwater flow at proposed road cuts is a possible direct impact of the *Proposed Road Development* during the construction phase. The proposed road cut 12 may extend into saturated, karstified bedrock in places while cuts 3, 5, 7 and 12 may extend into saturated glacial till. To conservatively estimate the volume of groundwater that could be intercepted in the cuts a permeability value of 0.99m/day which was recorded in RC32 is considered appropriate for use at all of the cuts.

The volume of groundwater likely to be intercepted during construction in subsoil is estimated using Darcy's equation, Q= K.A.I., where Q = flow (m^3/ day), K = hydraulic conductivity/ permeability (m/ day), A = area (m^2) and I = hydraulic gradient [94]. However the volume of groundwater likely to be intercepted during construction in bedrock cannot be estimated with any degree of certainty in this karst environment. These estimates are conservatively calculated and are thus likely to overstate the likely volume of groundwater that will be encountered at individual sites. The online road section involves some modification of existing road cuts but these modifications will not lead to lowering of the watertable of measurable increases in groundwater discharge.

- The proposed road cut 1 does not extend into saturated subsoil or bedrock;
- The proposed road cut 2 does not extend into saturated subsoil or bedrock;
- The proposed road cut 3 extends up to 0.3m into saturated subsoil (the average depth intercepted will be 0.15m though), the cut length is 310m and a hydraulic gradient similar to the surface topography gradient of 0.02 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (0.15 m x 310m) x 0.02 = 1m^3/ day;
- The proposed road cut 4 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 5 extends up to 12m into saturated subsoil, the cut length is 886m and a hydraulic gradient similar to the surface topography gradient of 0.05 is considered appropriate (the average depth intercepted will be 6m though). Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (6m x 886m) x 0.05 = 263m^3/ day;
- The proposed road cut 6 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 7 extends 6.35m into saturated subsoil based on the nearest available site investigation data (the average depth intercepted will be 3.2m though). Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (3.2m x 267m) x 0.03 = 25m^3/ day

- The proposed road cut 8 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 9 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 10 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 11 does not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cut does intersect the water table but there is currently no data indicating that this will be the case.
- The proposed road cut 12 extends up to 9.7m into saturated subsoil and bedrock (the average depth intercepted will be 4.8m though), the cut length is 1000m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (4.8m x 1000m) x 0.04 = 192m^3/ day, although in practice this is likely to be lower than this figure;

The total volume of groundwater likely to be intercepted during construction in subsoil and bedrock is estimated at potentially up to 481m^3/ day or 6 l/s (worst case scenario). The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **negligible** and therefore the significance of this impact is rated **moderate**.

The volume of groundwater likely to be intercepted during construction in karstified bedrock cannot be estimated with any degree of certainty using Darcy's equation. On the basis that the Bricklieve Limestone is estimated to have storativity values of 1-2%, it is considered appropriate to assume open fractures comprise 1-2% of the bedrock encountered in a proposed cut, and that groundwater volumes actually encountered during construction are likely to be smaller than the estimates provided above.

(2) The potential interception of shallow groundwater flow at areas of soft ground to be removed and activity at the borrow pit sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03is a possible direct impact of the *Proposed Road Development* during the construction phase. The following table summarises the locations, depth of soft ground material to be removed and if groundwater was encountered in the soft ground during borehole drilling and trial pitting. The water strikes indicate the horizons potentially sensitive to changes in water levels and do not necessarily indicate the static water levels.

Table 14-27: Groundwater occurrence in areas of soft ground material to be removed.

Approx. Road Chainage (m)	Approx. Depth of material to be removed (m)	SI point	Description	Water strike (m)	Cut depth into saturated zone (m)
2,120m-2,360m	2m	BH 105	Very soft peat and clay	2.5	0
3,430-3,730	0.5-2.4	-	Very soft peat and grey-white silt (marl)	No data	No data
4,250-4,770	0.9-5.0	BH 107	Very soft peat	1.7	3.3
5,000-5,760 (and the L5502-0)	0.7-4.1	BH10	Very soft peat	1.5	2.6
6,760-7,690	0.7-4.5	RC13	peat	0.08	1
10,080-10,280	1.0-1.0	BH113	Very soft peat and marl	3	0
10,650-10,900	4.7-6.3	RC38	Soft organic clay and peat	0	6.3
11,900-12,420	0.7-2.8	RC45	Very soft peat and alluvial clay	0.5	2.3

Approx. Road Chainage (m)	Approx. Depth of material to be removed (m)	SI point	Description	Water strike (m)	Cut depth into saturated zone (m)
13,660-13,980	2.5-4.5	-	Sandy silt & clay with some very soft peat and organic silt (marl)	No data	No data

The subsoil intercepted at all of the areas of soft ground is described either as peat, organic clay or sandy gravelly clay. A hydraulic conductivity value of 1.485 x 10^{-4}m/ day calculated from slug tests results in glacial till installations in similar environmental setting in County Sligo is within the lower end of the range of typical values for glacial till (or sandy gravelly clay) and is considered appropriate for use where sandy gravelly clay was encountered. A hydraulic conductivity value of 1.6 x 10^{-6}m/ day calculated from slug tests results in phreatic peat installations in Co. Mayo and which corresponds with the lower end of the range of typical values for clay, is considered appropriate for use in the areas underlain by peat or organic clay.

The volume of groundwater likely to be intercepted during construction in subsoil is estimated using Darcy's equation, Q= K.A.I., where Q = flow (m^3/ day), K = hydraulic conductivity/ permeability (m/ day), A = area (m^2) and I = hydraulic gradient. Where no standing water level data was available a figure of 0.5mbgl was used for the minimum height of the standing water level in the soft ground excavations for the purposes of calculating the amount of groundwater likely to be intercepted.

- The area of soft ground between c. Ch 3,430m-3,730m potentially extends 2.4m into saturated peat and marl subsoil, the area length is 300m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (2.4m x 300m) x 0.04 = 0.0000461 m^3/ day;
- The area of soft ground between Ch 4,250m-4,760m potentially extends 3.3m into saturated peat subsoil, the area length is 480m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (3.3m x 480m) x 0.04 = 0.0001014 m^3/ day;
- The area of soft ground between Ch 5,000m-5,760m potentially extends 2.6m into saturated peat subsoil, the area length is 860m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (2.6m x 860m) x 0.04 = 0.0001431 m^3/ day;
- The area of soft ground between Ch 6,750m-7,690m potentially extends 1m into saturated peat subsoil, the area length is 930m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (1m x 930m) x 0.04 = 0.0000595 m^3/ day;
- The area of soft ground between Ch 10,080m-10,280m potentially extends 1m into saturated peat and marl subsoil, the area length is 150m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (1m x 150m) x 0.04 = 0.0000096 m^3/ day;
- The area of soft ground between Ch 10,650m-10,900m potentially extends 6.3m into saturated peat and marl subsoil, the area length is 200m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (6.3m x 200m) x 0.04 = 0.0000806 m^3/ day;
- The area of soft ground between Ch 11,900m-12,420m potentially extends 2.3m into saturated peat and marl subsoil, the area length is 520m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (2.3m x 520m) x 0.04 = 0.0000765 m^3/ day;
- The area of soft ground between Ch 13,660m-13,980m potentially extends 4.5m into saturated peat and marl subsoil, the area length is 320m and a hydraulic gradient similar to

the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 1.6 x 10^{-6}m/ day x (4.5m x 320m) x 0.04 = 0.0000922 m^3/ day;

- The proposed borrow pit Type 01-04 extends up to 10m into saturated subsoil and bedrock, the borrow pit circumference is 470m and a hydraulic gradient similar to the surface topography gradient of 0.03 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (10m x 470m) x 0.03 = 139m^3/ day;
- The proposed borrow pit Type 02-01 extends up to 19.5m into saturated subsoil and bedrock, the borrow pit circumference is 270m and a hydraulic gradient similar to the surface topography gradient of 0.01 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (19.5m x 270m) x 0.02 = 104m^3/ day;
- The proposed borrow pit Type 02-02 extends up to 19.5m into saturated subsoil and bedrock, the borrow pit circumference is 760m and a hydraulic gradient similar to the surface topography gradient of 0.01 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (19.5m x 270m) x 0.02 = 293m^3/ day;
- The proposed borrow pit Type 02-03 extends up to 16.5m into saturated subsoil and bedrock, the borrow pit circumference is 330m and a hydraulic gradient similar to the surface topography gradient of 0.04 is considered appropriate. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (16.5m x 330m) x 0.03 = 161m^3/ day;

The total volume of groundwater likely to be intercepted during soft ground excavation and borrow pit construction in subsoil is estimated at 697m^3/ day or 8 litres/second. Note that these figures are calculated using Darcy's law and assumes that there are no preferential groundwater flow pathways in the subsoil cuts or significant karst fissures or conduits in the bedrock borrow pits. If such preferential pathways are encountered then inflows will be higher. The importance of the groundwater within the subsoils which is in hydraulic connectivity with the bedrock aquifer, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **negligible** and therefore the significance of this impact is rated **imperceptible**.

14.4.3.3.2 *Operational phase*

There are no anticipated impacts of the *Proposed Road Development* on groundwater flow during the operational phase.

14.4.3.4 Impacts on Groundwater Levels

The likely impacts of the *Proposed Road Development* on groundwater levels are as follows and are further described in Appendix 14.2. (Volume 4). The significance of the monitored water levels is that the water table is generally less than 3m below the surface, that regional groundwater flow is to the north and that the Bricklieve Limestone lower is confined. The sensitivity of the water levels lies in the fact that excavation of road cuts has the potential to impact on water levels, particularly in the karstified bedrock.

14.4.3.4.1 *Construction phase*

(1) The likely impact of the *Proposed Road Development* on groundwater levels is the potential localised lowering of water table for the construction of road cuts, of which there are twelve (12 no.) and at the borrow pit sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03. This impact is considered with reference to the highest water levels recorded in the monitoring boreholes between 2006 and 2013 and based on the conceptual model of the Unshin River including its tributaries; the Markree Demesne Stream, the Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and Drumderry Stream (Lough Arrow Catchment) surface catchments being broadly coincident with the hydraulic or groundwater catchments.

- The proposed road cuts 4, 5, 6, 7, 9, 10, and 11 do not intercept the water table according to site investigation results. Therefore, no impact on groundwater levels is anticipated in these cuts.

- The proposed road cuts 3, 5, 7, 11 and 12 are likely to intercept the water table. The importance of the groundwater is rated **high**, as the study area is underlain by a regionally important aquifer; the magnitude of this impact is rated as **negligible** at road cuts resulting in an impact on groundwater levels is of insufficient magnitude to affect either its use; and therefore the significance of this impact is rated **imperceptible to slight**.

Table 14-28: Impacts of proposed road cuts on groundwater levels

Cut or Borrow Pit ID	Cut depth into saturated Overburden (m)	Maximum Cut depth into saturated rock (m)
1	0	0
2	0	0
3	.3	0
4	0	0
5	12	0
6	0	0
7	6.35	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	9.7
BP 01-01	0	0
BP 01-02	0	0
BP 01-03	0	0
BP 01-04	1.5	8.5
BP 02-01	3	16.5
BP 02-02	3	16.5
BP02-03	0	0

(2) The potential localised lowering of the water table in areas where soft ground material is to be removed is a certain direct impact of the *Proposed Road Development* during the construction phase should excavate/replace be the construction option. No potential impact on groundwater levels is anticipated in the areas where groundwater is not encountered in the soft ground material. However the potential impact on groundwater levels in the areas where groundwater is encountered is considered to be the localised lowering of the water table either side of the road by up to the depth of the excavation. The areas of soft ground material to be removed are peat, silt or organic clay and are considered to have low to very low permeability values. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **negligible**, and therefore the significance of this impact is rated **imperceptible**.

14.4.3.4.2 *Operational phase*

(1) The potential localised backing up of the water table on the up-gradient side of the road cuts, of which there are twelve (12 no.), is a possible impact of the *Proposed Road Development* on groundwater levels during the operational phase. The emplacement of material of different

permeability within road cuts may cause the backing up of groundwater levels. The importance of the groundwater is rated **high**, as the study area is underlain by a regionally important aquifer; the magnitude of this impact is rated as **negligible**, as the impact on groundwater levels is of insufficient magnitude to affect either its use or integrity; and therefore the significance of this impact is rated **imperceptible.**

(2) The potential localised backing up of the water table on the upgradient side of the areas of soft ground material to be removed and where groundwater is encountered is not anticipated as it is likely that higher permeability material will be in the place of low to very low permeability material removed from these areas. The importance of the groundwater is rated **high**, as the study area is underlain by a regionally important aquifer; the magnitude of this impact is rated as **negligible**, as the impact on groundwater levels is of insufficient magnitude to affect either its use or integrity; and therefore the significance of this impact is rated **imperceptible.**

(3) The potential long-term reduction of the water table at the proposed road cuts where groundwater is intercepted is a possible impact of the *Proposed Road Development* on groundwater levels during the operational phase. Groundwater levels are anticipated to rebound to original levels (or close to their original levels) after road cut excavation and construction is completed. Therefore where unsealed grassed surface water channels are to be installed, and where proposed road cuts are likely to intercept the water table, the rebound of groundwater levels post road cut excavation and construction may intercept these open drains so narrow filter drains may be installed in such areas to drain any such groundwater discharge. However no transfer of groundwater between catchments is anticipated to occur and therefore no impact is anticipated.

14.4.3.5 Impacts on Karst Features

The likely impacts of the *Proposed Road Development* on karst features are as follows and are further described in Appendix 14.2. (volume 4). The significance of the karst features identified is that the study area is susceptible to karstification and more unidentified subsurface features may exist. The significance of the possible dolines identified is that these areas may be susceptible to subsidence. The significance of turlough complex at Tawnagh is that the *Proposed Road Development* has the potential to impact the hydraulic or groundwater catchment area to the turlough. The features recorded as springs identified are not considered significant in themselves. The sensitivity of the karstified bedrock lies in the fact that it can be susceptible to subsidence and that the excavation of road cuts has the potential to impact on unidentified subsurface karst features.

14.4.3.5.1 *Construction phase*

(1) The potential localised flooding of land in the vicinity of identified possible dolines is a possible indirect impact of the *Proposed Road Development* on the karst features and on land use during the construction phase. The possible dolines identified along the *Proposed Road Development* are likely to provide a rapid mechanism for overland surface flow to enter the underlying shallow epikarstic layer of bedrock, which possibly connects into solutionally-enlarged conduits. Any excavation or construction works preventing flow through either the shallow epikarstic layer of bedrock or such conduits is likely to result in flooding around the area of these dolines. The land use is considered to have a high value on a local scale, containing the pasture land of local farmers, and therefore the importance is rated as **high**; the magnitude of this impact is rated **small adverse**, resulting in minor change to the unsaturated zone or loss of a small part of the attribute, and therefore the significance of this impact is rated **moderate/ slight**.

(2) The potential entry and rapid transfer of contaminants in the subsurface is a possible indirect impact of the *Proposed Road Development* on the karst features during the construction phase. The main potential contaminant during the construction phase is Suspended Solids, with the deposition of silt; the infiltration of runoff to ground is likely to naturally mitigate this potential impact. However, where exposed during development and where exposed naturally at the base of possible dolines or swallow holes, the karstified bedrock will be extremely vulnerable to contamination and has the potential to rapidly transmit contamination in the subsurface to connected springs or to surface water bodies. The importance of the karst features is rated **high**; the magnitude is rated as **moderate adverse**, resulting in an impact on the integrity or loss of part of the attribute; and therefore the significance of the impact is rated **significant/ moderate**.

(3) The potential collapse of identified or unidentified karst features is a possible direct impact of the *Proposed Road Development* on the karst features during the construction phase. Dewatering of unconsolidated subsoil deposits on karst is the most important cause of induced doline or sinkhole formation where the buoyant support of water is removed weakening mechanical stability, which is required for the construction of proposed road cuts in saturated bedrock. The results of site investigation drilling identified a layer of weathered and possibly karstified bedrock underlying the subsoil in RC04-06, RC14-15, RC31, RC35, RC38, RC40, RC49, RC52, RC112 indicative of an epikarstic layer mentioned in the groundwater body description although some of the geobores recorded glacial till it is unclear whether this material is actually glacial till or weathered limestone[63]. The site investigation drilling also encountered cavities, most likely solutional karst cavities in RC16-17 and RC49-50, generally within the top 6-8m of bedrock but at 23m in RC17. No other evidence of karst was noted during the site investigation drilling; however there is always the possibility of encountering further subsurface features during excavation. All practical efforts were made to identify surface and subsurface karst features along and near the *Proposed Road Development*; however there always remains a possibility of encountering subsurface karst features during excavation work in karst environments. The magnitude of this impact on the karst features is rated **small adverse**, resulting in loss of a small part of the karst features, and therefore the significance of this impact is rated **moderate/ slight**.

(4) The surface catchments are considered to be broadly coincident with the hydraulic or groundwater catchments. This is based on monitored groundwater levels, on the identified layer of weathered and possibly karstified bedrock underlying the subsoil, indicative of an epikarstic layer described in the groundwater body description, and therefore on a conceptual model of diffuse karst flow. On this basis, the identified turlough complex in Tawnagh is considered to operate as epikarstic flow turloughs, as described and classified by the Working Group on Groundwater[95]. Epikarstic flow turloughs are described as developing where groundwater flow occurs in the weathered upper zone of the karst aquifer. Groundwater flow, in these catchments, is noted to occur at a shallow level across the turlough driven by the hydraulic gradient of the water table, which may be completely disconnected from groundwater flowing at depth within the karst system[95]. The *Proposed Road Development* passes through the surface and groundwater catchment of the identified turlough and lake complex, which is at an elevation of approximately 60maOD, and the nearest proposed road cut 9 is to extend to 68.5maOD. The proposed road cut depth remains above the elevation of the identified turlough complex and above the highest recorded level of the water table, it is possible that this cut will intercept the water table during flood periods and could lead to a slight reduction in the groundwater contributions to the complex. However, if groundwater discharge which enters cut 9 is diverted back into the lake at Tawnagh via the drainage outfall and the surface stream entering the lake, then there should be no loss or recharge to the turlough and therefore no impact.

14.4.3.5.2 *Operational phase*

(1) There are no anticipated impacts of the *Proposed Road Development* on the karst features during the operational phase.

14.4.3.6 Impacts on Groundwater Supply Wells

The significance of this information is that, notwithstanding the fact that the underlying bedrock is classified as a regionally important aquifer, the low number of supply wells suggests poor well yields and low bedrock permeabilities are evident across much of the study area. The significance of the identified group water scheme located beside the *Proposed Road Development* is that it is spring fed. The sensitivity of the identified supply wells situated in karst limestone lies in the fact that they are likely to be highly sensitive to water level and water quality changes.

The likely impact of the *Proposed Road Development* on the identified groundwater supply wells is (1) the potential interception of shallow groundwater flow to the wells and (2) the increased risk of contamination reaching the wells from road runoff.

14.4.3.6.1 *Carrownagark well*

(1) The abstraction rate at the Carrownagark group water scheme is approximately 23m^3/ day or 8,395m^3/ year. Based on the subsoil type, thickness, aquifer vulnerability, GSI assigned permeability and corresponding GSI recharge coefficient of 65% for this area, the zone of contribution or

groundwater catchment area for this abstraction rate is in the region of 14,577m^2. This area is likely to extend up the northern slopes of the topographical high in Carrownagark and equate to an area potentially 400m x 40m, although the exact location of the zone of contribution to the spring is difficult to accurately establish. The nearest proposed road cut is located at approximately 300m to the south and the *Proposed Road Development* is not considered to pass through this groundwater catchment area; therefore no impact to the Carrownagark group water scheme is anticipated.

(2) The *Proposed Road Development* is not considered to pass through the zone of contribution or groundwater catchment area to the Carrownagark group water scheme; however the spring-fed well is located at approximately 100m from the proposed road. The importance of protecting the groundwater supply at Carrownagark is rated as **high**, the magnitude of this impact is rated as **slight,** and therefore the significance of this impact is rated as **slight/imperceptible**.

14.4.3.6.2 *Toberscanavan well*

(1) The *Proposed Road Development* will obliterate the spring well at Toberscanavan. The importance of protecting the groundwater supply at Carrownagark is rated as **medium**, the magnitude of this impact is rated as **large,** and therefore the significance of this impact is rated as **significant**.

14.4.3.6.3 *Doorly well (west)*

(1) The abstraction rate from the Doorly (west) well is unknown. The recharge area for this well is likely to extend southwest towards the top of the hill in Doorly townland. The nearest proposed road cut does not intercept the water table; therefore no impact to the Carrownagark group water scheme is anticipated.

(2) The *Proposed Road Development* does pass through the zone of contribution or groundwater catchment area to the Doorly well (west); The importance of protecting the groundwater supply at Doorly well (west) is rated as **high**, the magnitude of this impact is rated as **slight,** and therefore the significance of this impact is rated as **slight/imperceptible**.

14.4.3.6.4 *Doorly well (east)*

(1) The spring flow rate at the Doorly well (east) is approximately 0.2m^3/ day. Based on the subsoil type, thickness, aquifer vulnerability, GSI assigned permeability and corresponding GSI recharge coefficient of 65% for this area, the zone of contribution or groundwater catchment area for this abstraction rate is in the region of 126m^2. This area is likely to extend up towards the existing N4 at Doorly and would equate to an area of less than 20x20m, although the exact location of the zone of contribution to the spring is difficult to accurately establish. The *Proposed Road Development* is not considered to pass through this groundwater catchment area; therefore no impact to this spring well is anticipated.

(2) The *Proposed Road Development* passes through the zone of contribution or groundwater catchment area to this well.. The importance of protecting this groundwater supply is rated as **high**, the magnitude of this impact is rated as **slight,** and therefore the significance of this impact is rated as **slight/imperceptible**.

14.4.3.6.5 *Kingsbrook well*

(1) The abstraction rate from the Kingsbrook well is unknown but the well is used to supply approximately 70 head of cattle with drinking water. The recharge area for this well is likely to extend west towards the top of the hill in Kingsbrook townland. The nearest proposed road cut does not intercept the water table but the road does pass through the contributing area for the well; therefore no significant impact to the Carrownagark group water scheme is anticipated.

(2) The *Proposed Road Development* does pass through the zone of contribution or groundwater catchment area to the Kingsbrook well; The importance of protecting the groundwater supply at Kingsbrook well is rated as **high**, the magnitude of this impact is rated as **small,** and therefore the significance of this impact is rated as **slight**.

14.4.3.7 Impacts on Groundwater Quality

The likely impacts of the *Proposed Road Development* on groundwater quality are as follows and are further described in Appendix 14.2. (Volume 4).

14.4.3.7.1 *Construction phase*

(1) The reduction in groundwater quality receiving runoff from the proposed road, in particular around road crossings, and in the vicinity of the borrow pits; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03 is a possible indirect impact of the *Proposed Road Development* on the drainage during the construction phase. The main potential contaminant during the construction phase is Suspended Solids, with the deposition of silt; the infiltration of runoff to ground is likely to naturally mitigate this potential impact. However, where exposed during development and where exposed naturally at the base of possible dolines or swallow holes, the karstified bedrock will be extremely vulnerable to contamination and has the potential to rapidly transmit contamination in the subsurface to connected springs or to surface water bodies. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **moderate adverse**; therefore the significance of this impact is rated **significant/ moderate**.

14.4.3.7.2 *Operational phase*

(1) The reduction in groundwater quality receiving routine runoff discharges to the ground from the proposed road is a possible impact of the *Proposed Road Development* during the operational phase. The assessment of pollution impacts from routine runoff to groundwater is conducted following guidance in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09,* which examines source-pathway-receptors components to assess the risk of impact on groundwater. Firstly, the source is rated based on low risk associated with an AADT of <50,000, high risk for the annual average rainfall volume of >1,060mm/ year and medium risk for the uneven rainfall intensity. Secondly, the pathway is rated based on low risk associated with surface water channels, high risk associated with shallow water table (<5m), high risk associated with fracture type flow, low risk associated with low effective grain size (clay and silt) and low risk associated with lithology containing approximately >15% clay minerals. The overall score is 210, which equates to a medium risk of impact. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated as **moderate adverse**, resulting in medium risk to groundwater, and therefore the significance of this impact is rated **significant/ moderate**.

Table 14-29: Risk of pollution to groundwater from routine runoff

No.		Weighting factor	Parameter	Rating	Scoring
1	Source	15	Traffic density	Low = 1	15
2		15	Rainfall volume & intensity	High = 3	45
3	Pathway	15	Soakaway geometry	Low = 1	15
4		20	Unsaturated zone	High = 3	60
5		20	Flow type	High = 3	60
6		7.5	Effective grain size	Low = 1	7.5
7		7.5	Lithology	Low = 1	7.5
Total scoring					210

(2) The increased risk to groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the groundwater quality during the operational phase. The probability is calculated using a formula from in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09*. The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the groundwater, as a regionally important aquifer, is rated **high**, the magnitude of this impact is rated **negligible**, as the calculated risk of serious pollution incidence is <0.5% annually; and therefore the significance of this impact is rated **imperceptible**.

14.4.3.8 Impacts on GWDTE's

The likely impacts of the *Proposed Road Development* on groundwater dependent terrestrial ecosystems (GWDTE's) are as follows and are further described in Appendix 14.2. (volume 4).

14.4.3.8.1 *Construction phase*

(1) The reduction in groundwater quality receiving runoff from the proposed road, in particular around road crossings and the borrow pit sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03, is a possible indirect impact of the *Proposed Road Development* on the drainage during the construction phase. The main potential contaminant during the construction phase is Suspended Solids, with the deposition of silt; the infiltration of runoff to ground is likely to naturally mitigate this potential impact. However, where exposed during construction and where exposed naturally at the base of possible dolines or swallow holes, the karstified bedrock will be extremely vulnerable to contamination and has the potential to rapidly transmit contamination in the subsurface to connected springs or to surface water bodies. The importance of the wetland habitats is rated high (Boathole Lough, Lough Corran, Cuileencroobagh and Carrowkeel woodland), very high (Lackagh Fen and Tawnagh Swallow Hole Complex) and extremely high (Ardloy & Aghalenane Loughs), based on the ecological study carried out as part of this assessment which rates these areas as being of high value on a county, national and international scale; the magnitude of this impact on the GWDTE's is rated as **small adverse**; therefore the significance of this impact is rated **Moderate** for Lackagh Fen, the Boathole and Lough Corran, Cuileencroobagh and Carrowkeel wet woodland, and the lake at Tawnagh and swallow hole complex, and **significant** for the Ardloy & Aghalenane Loughs.

(2) The potential interception of shallow groundwater flow is a possible direct impact of the *Proposed Road Development* during the construction phase. The proposed road cut 3 passes adjacent to the south western edge of Lackagh fen, cut 5 passes by the north western part of Carrowkeel wet woodland, cut 6 passes adjacent to Cuileencroobagh Lough and cut 9 passes to the south of the Aghalenane & Ardloy Loughs and the lake and swallow hole complex at Tawnagh. The Boathole and Lough Corran will not be impacted by road cuts. The volume of groundwater likely to be intercepted during construction is estimated using Darcy's equation, Q= K.A.I., where Q = flow (m^3/ day), K = hydraulic conductivity/ permeability (m/ day), A = area (m^2) and I = hydraulic gradient[94].

- The proposed road cut 2 extends up to 1.1m into saturated subsoil and bedrock, the cut length is 190m and a hydraulic gradient similar to the surface topography gradient of 0.05 is considered appropriate. Therefore the volume of groundwater likely to be removed from the Lackagh Fen catchment as a result of construction of this cut is calculated as Q = 0.99m/ day x (1.1m x 107m) x 0.05 = 6m^3/ day. A length of 180m of the proposed road cut 3 which extends up to 0.3m into saturated subsoil, has a hydraulic gradient similar to the surface topography gradient of 0.02 is located in the Lackagh Fen catchment. Therefore the volume of groundwater likely to be intercepted during construction is calculated as Q = 0.99m/ day x (0.3 m x 310m) x 0.02 = 1.2m^3/ day. This could mean that up to 7.2 m^3/day of groundwater could be removed from the fen catchment by the road cut. According to the Working Group on Groundwater guidelines[90], the impact potential of 5-10% reduction in recharge and >20% reduction in groundwater recharge is **high** for GWDTE's with high dependency on groundwater, such as Lackagh fen. The importance of the wetland habitats is rated **very high,** as per above; the magnitude of this impact is rated as **small adverse** for Lackagh fen; and therefore the significance of this impact is rated as **moderate**.
- The proposed road cuts 4 and 5 do not extend into saturated subsoil based on the nearest available site investigation data. It is possible that the road cuts do intersect the water table but there is currently no data indicating that this will be the case. The borrow pits SR/BP Type T2-01 and T2-02 are located in the Boathole Lough and Lough Corran Catchment. Combined dewatering volumes for these borrow pits at maximum extent is calculated as 397m^3/day and this represents approx. 2% of the calculated recharge for this catchment. The importance of the Boathole Lough and Lough Corran is rated **high**; the magnitude is rated **negligible** as the impact potential of <5% reduced recharge as a % of average recharge is **very low** for GWDTE's with high dependency on groundwater; and therefore the significance of this impact is rated **imperceptible**.

- There are no road cuts planned in the Carrowkeel wet woodland catchment and therefore no impact is anticipated.
- The proposed road cut 8 does not extend into saturated bedrock. The entire length of cut 8 is within the Cuileencroobagh catchment and thus some groundwater could be diverted via the road cut. However, the outfall located in the Cuileencroobagh catchment means that this diverted groundwater would remain in the catchment. Thus the volume of water in the catchment will not be reduced by the construction of the road. The importance of the Cuileencroobagh Lough is rated **high**; the magnitude is rated **small adverse** as the impact potential of <20% reduced recharge as a % of average recharge is **moderate** for GWDTE's with high dependency on groundwater; and therefore the significance of this impact is rated **slight/moderate**.
- Approximately 120m of cut 9 is located within the Ardloy and Aghalenane Loughs catchment. The proposed road cut 9 does not extend into saturated subsoil or bedrock based on the nearest and most up to date available site investigation data. It is possible that the road cut does intersect the water table periodically but there is currently no data indicating that this will be the case. The importance of the the Aghalenane & Ardloy Loughs habitats is rated extremely **high**; the magnitude is rated **negligible** as the impact potential of <5% reduced recharge as a % of average recharge is **low** for GWDTE's with high dependency on groundwater; and therefore the significance of this impact is rated **imperceptible**.
- Approximately 130m of cut 9 and all of cut 10 is located within the lake and swallow hole complex catchment (Tawnagh). The proposed road cuts 9 and 10 do not extend into saturated subsoil or bedrock based on the nearest and most up to date available site investigation data. It is possible that the road cuts do intersect the water table at least periodically but there is currently no data indicating that this will be the case. The importance of the lake and swallow hole complex (at Tawnagh) habitat is rated **very high;** the magnitude is rated **negligible** as the impact potential of <5% reduced recharge as a % of average recharge is low for GWDTE's with high dependency on groundwater; and therefore the significance of this impact is rated **imperceptible.**

The importance of the wetland habitats is rated **high** (Boathole Lough and Lough Corran, Carrowkeel wet woodland and Cuileencroobagh)**, very high** (Lackagh Fen, Tawnagh lake/turlough complex) **and extremely high** (Ardloy and Aghalenane Loughs); the magnitude of this impact on the wetland habitats is rated as **moderate adverse** for the Lackagh fen habitat and **negligible** for the Boathole and Lough Corran, Carrowkeel wet woodland, Cuileencroobagh, Aghalenane & Ardloy Loughs, and the lake and swallow hole complex (Tawnagh), where either no proposed cuts extend into bedrock or there will not be a significant reduction in the volume of groundwater discharging to the surface drainage system within the catchment; therefore the significance of this impact is rated **imperceptible** for the Boathole and Lough Corran, Carrowkeel wet woodland, Cuileencroobagh, Aghalenane & Ardloy Loughs, and the lake and swallow hole complex (Tawnagh) habitats, and potentially **significant** for the Lackagh fen habitat.

14.4.3.8.2 *Operational phase*

(1) The reduction in groundwater quality receiving routine runoff discharges to the ground from the proposed road is a possible indirect impact of the *Proposed Road Development* on the GWDTE's during the operational phase. The assessment of pollution impacts from routine runoff to groundwater, conducted following guidance in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09*, results in an overall score of 210, which equates to a **medium risk** of impact. The importance of the wetland habitats is rated as **high**; the magnitude of this impact is rated as **moderate adverse**, resulting in medium risk to groundwater, and therefore the significance of this impact is rated **significant/ moderate**.

(2) The increased long-term risk to groundwater as a result of a serious accidental spillage is a possible indirect impact of the *Proposed Road Development* on the wetland habitats during the operational phase. As per above, the probability is calculated using a formula from in UK Highways Agency publication *Road Drainage and the Water Environment HD45/09.* The probabilities that a spillage will cause a pollution incident remain well below the acceptable risk level of 0.5%. The importance of the wetlands is rated as **high**, as per above; the magnitude is rated **negligible** as the calculated risk of a serious pollution incident is <0.5% annually; and therefore the significance of this impact is rated **imperceptible**.

(3) The increase in the volume and rate of surface runoff feeding into the wetland habitats as a direct result of increased impervious areas is a possible indirect impact of the *Proposed Road Development* during the operational phase. This impact is calculated to represent a worst-case scenario. The *Proposed Road Development* will increase the runoff rate to 100% over impervious areas and denying groundwater recharge. According to the Working Group on Groundwater guidelines[90], the impact potential of <5% reduced recharge as a % of average recharge is **low** for a GWDTE with a high dependency on groundwater. The importance of the wetland habitats is rated **high, very high and extremely high**, as per above; the magnitude of this impact is rated as **negligible** for all of the wetland habitats with the exception of Cuileencroobagh for which it is rated as **moderate adverse**; and therefore the significance of this impact is rated **imperceptible** for all of the wetlands except Cuileencroobagh which is rated **moderate**.

(4) The potential long-term reduction in groundwater contributions to the Lackagh fen, the Boathole and Lough Corran, Carrowkeel wet woodland, Cuileencroobagh Lough, Aghalenane & Ardloy Loughs, and the lake and swallow hole complex (Tawnagh) habitats is a possible indirect impact of the *Proposed Road Development* during the operational phase. The *Proposed Road Development* will increase the impervious area in the groundwater catchment areas, increasing the runoff rate to 100% over this area and denying groundwater this volume. The following table summarises the reduced recharge volume calculated for each catchment, and the relative paved area to catchment area. According to the Working Group on Groundwater guidelines[99], the impact potential of <5% reduced recharge as a % of average recharge is **low** for GWDTE's with high dependency on groundwater. The importance of the wetland habitats is rated **high**, as per above; the magnitude of this impact is rated as **negligible** for all of the wetland habitats; and therefore the significance of this impact is rated **imperceptible** for all of the wetland habitats.

Table 14-30: Estimated reductions in groundwater contributions

Catchment ID	Approx. catchment area (m^2)	Approx. paved road area (m^2)	Paved road area % catchment area	Reduction in recharge (m^3/ year)
Lackagh Fen	447,000	22,000	4.9	7,854
Boathole & Lough Corran	14,980,000	34,000	0.23	12,138
Carrowkeel wet woodland	995,000	20,000	2.01	7,140
Cuileencroobagh Lough	170,000	8,000	4.7	2,856
Aghalenane & Ardloy Lough and fen	534,000	22,000	4.11	7,854
Lake and swallow hole complex at Tawnagh	1,900,000	17,000	0.09	6,069

(5) The potential long-term reduction of the water table at the proposed road cuts where groundwater is intercepted is a possible indirect impact of the *Proposed Road Development* on the wetland habitats during the operational phase. However where unsealed grassed surface channels or swales are to be constructed, no transfer of groundwater between catchments is anticipated at these locations. Therefore no impact is anticipated.

14.4.4 Complex type impacts

14.4.4.1 Cumulative impacts

The removal of soil and subsoil material to increase the aquifer vulnerability from high to extreme at proposed road cuts 1, 2, 6, 9 and 10, at the spoil treatment sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03, and the potential introduction of contaminants during construction are considered to have a cumulative impact on the water quality in the streams and feeding into the wetland habitats. These impacts are considered **negligible** and **imperceptibl**e in nature.

Section 10 of the Spoil Management Report (appendix 4.3 of volume 4) considers that although unlikely there is some potential that the deposition of materials offsite may be required. In order to consider such an activity;

numerous sites are identified in the aforementioned section of the Spoil Management Report to be broadly suitable for such a purpose and are considered in terms of both cumulative and indirect impacts.

Potential sites which are considerd to be broadly suitable for such a purpose are described in section 10 of the Spoil Management Report (appendix 4.3 of volume 4) and include adjacent conifer plantations and low lying agricultural lands. These impacts are considered **negligible** and **imperceptibl**e in nature.

14.4.4.2 Indirect impacts

The indirect impacts of the proposed road alignment on the Hydrological environment are considered to be (1) the increased risk of contaminated runoff reaching groundwater as a result of soil and subsoil removal and the exposure of bedrock in places and (2) the increased traffic flow, dust, noise, dirt and vibration as a result of sourcing materials for road construction. Also to be considered as described above is the possible waste soils activity which may be required offsite.

(1) The removal of soil and subsoil material to increase the aquifer vulnerability from high to extreme at proposed road cuts 1, 2, 8, 11 and 13, at the spoil treatment sites; SR/BP Type 01-01, SR/BP Type 01-02, SR/BP Type 01-03, SR/BP Type 01-04, SR/BP Type 02-01, SR/BP Type 02-02, and SR/BP Type 02-03, and the potential introduction of contaminants during construction and the deposition of surplus soil in sites located outside the CPO area are considered to have a cumulative impact on the water quality in the streams and feeding into the wetland habitats. These impacts based on the potential *Range of Options* (LD CP01, 04, 05 & 06 and LD AG 01 & 02) identified in the *'*Spoil Management Report*'* are considered **temporary, negligible** and **imperceptible** in nature.

(2) The likely impact of the transport of large volumes of subsoil material for road construction is to increase traffic flow, dust, dirt, noise and vibration on the existing N4 and other nearby routes used for access to quarries. It is estimated that 653,000m3 of material will be required to be sourced for road construction either from adjacent borrow pits or quarries. These impacts are considered **adverse, slight** and **moderate/slight** in nature, impacts relating to noise and air quality as a result of these movements are considered further in the relevant chapters. These impacts are further described in Appendix 14.2. (Volume 4).

14.5 Mitigation Measures & Environmental Commitments

14.5.1 Mitigation by avoidance

The design is considered the best possible, in terms of minimising the impact to the hydrological and hydro-geological environment. Mitigation by avoidance has been actively applied to the alignment design as the Impact Assessment progressed. This includes changes made to the road design as potential impacts became apparent which are discussed in Chapter 3 of this EIS (Consideration of Alternatives).

14.5.2 Mitigation by reduction

14.5.2.1 Design Phase

The current road alignment is considered the best possible design, in terms of minimising the impact to the hydrological and hydrogeological environment through mitigation by avoidance and mitigation by reduction (as described in Chapters 3 and 4 of this EIS). Any further changes at the detailed design stage (if made) must ensure that there is no increase in the level of impact to the environment.

14.5.2.1.1 *Drainage Design*

A drainage system is an integral part of the *Proposed Road Development* design and includes containment for accidental spillages at each outfall, petrol/ oil interceptors, and attenuation ponds in the form of constructed wetlands. The drainage system is designed so that surface runoff, as far as is practicable, remains in the same surface catchment area as under pre-construction conditions, that surface runoff flows through suitable attenuation infrastructure where necessary before flowing into catchments or streams and that surface runoff flows in sealed drainage for the section of the development that crosses or encounters any active karst conduits. The increased attenuation and containment of the proposed drainage system is a certain indirect impact of the *Proposed Road Development* on the existing drainage regime during the operational phase, by attenuating road runoff and by containing accidental spillages where the existing N4 road has no attenuation,

containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the surface water quality is rated as **high** for the streams receiving runoff from the outfalls as they flow into the Unshin River and Lough Arrow which are classified by the EPA as having good status, as per above; the magnitude of this impact is rated as **minor beneficial**, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated **minor beneficial**.

The increase in the volume and rate of surface runoff discharging from the catchments as a result of an increase in impervious area is a certain indirect impact of the *Proposed Road Development* on the existing drainage regime during the operational phase. The attenuation balancing ponds are designed to accommodate a 100-year return period flow and are designed to have adequate storage to allow a permissible outlet flow similar to the maximum existing flow from the catchment in accordance with UK Highways Agency publication *Vegetative Treatment Systems For Highway Runoff HA103/06* and UK Highways Agency (2009) *Surface and Sub-surface Drainage Systems for Highways HD33/06*. The importance of the surface water quality is rated as **high** for streams flowing into the Unshin River and Lough Arrow as per above; the magnitude of this impact is rated as **negligible**, resulting in a negligible change in predicted peak flood level; and therefore the significance of this impact is rated **imperceptible**.

The design of embankments at Lackagh Fen (as described in the Geotechnical section of Chapter 4) includes a drainage layer at the base of the embankment, sheetpiles where soft ground is encountered during excavations, rockfill below the water table to allow the through flow of groundwater, and vertical hydraulic barriers to stop groundwater from flowing along the embankment. These measures will reduce the hydrogeological impacts on the fen as a result of the development.

The design of embankments at Boathole and Lough Corran (as described in the Geotechnical section of Chapter 4) includes sheetpiles where soft ground is encountered during excavations, rockfill below the water table to allow the through flow of groundwater, and vertical hydraulic barriers to stop groundwater from flowing along the embankment. These measures will reduce the hydrogeological impacts on the Loughs as a result of the development.

The design of embankments at Ardloy and Aghalenane Loughs and adjacent to the Boathole Lough (as described in the Geotechnical section of Chapter 4) incorporates a drainage layer at the base of the embankment and vertical hydraulic barriers to prevent groundwater movement along the embankment. Also provided at Ardloy and Aghalenane Loughs is traverse embankment drainage measures. These measures will reduce the hydrogeological impacts on the site as a result of the development.

The increased attenuation and containment of the proposed drainage system is a certain indirect impact of the *Proposed Road Development* on the conservation areas during the operational phase, by attenuating road runoff and by containing accidental spillages where the existing N4 road has no attenuation, containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the conservation areas is rated **high, very high and extremely high**; the magnitude of this impact is rated as **minor beneficial**, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated **minor beneficial**.

Flow monitoring of streams DX1 to DX11 is to be undertaken prior to construction, in order to provide accurate baseline data for comparison during the construction and operation phases.

14.5.2.2 Water Quality

Engineering controls for calculated storm runoff volumes will be provided for the artificial road catchment and the attenuation and release of this water to the natural catchment. Attenuation of storm runoff and sediment settlement is particularly important for all drainage on the development as all parts of the road ultimately drain into either the Unshin River cSAC (c. Ch 00-190mm-13,200m) or the Lough Arrow cSAC (c. Ch13,200m-14,400m). To minimise the impact on surface water and groundwater quality, the following mitigation measures are to be adopted:

- Streams DX1 to DX11 and selected groundwater monitoring boreholes are to be monitored prior to construction, in order to provide accurate baseline data for comparison during the construction and operations phases;

- As outlined in the drainage design (as discussed in Chapter 4 and appendix 4.1 (volume 4) of this EIS), petrol interceptors and containment (and settlement) facilities are to be constructed at each outfall to mitigate for the risk of pollution from road runoff and accidental spillages;
- Verges within the design incorporate grassed surface water channels where the design standards permits to reduce soil erosion and suspended matter in runoff;
- A strict procedural approach to groundwater pumping (if required) and surface runoff, which conforms to best industry practice, is to be agreed upon, prior to construction (see the Emergenecy Response section in the Outline Erosion and Sediment Control Plan).;
- Grassed surface channels where used are to be sealed at locations where the bedrock aquifer is classified as extremely vulnerable, i.e. where less than 3m of subsoil is present. Current information predicts that such conditions may be encountered at c. Ch. 2,800m-3,175m, c. Ch 3,875m-4,175m and c. Ch. 10,300m-10,540m.
- The Grassed surface Water Channels if used shall be sealed where possible karst features have been identified, current information predicts these locations to be from c. Ch 9,500m to c. Ch10,500m, although more locations may be identified during construction.

14.5.2.3 Construction Phase

14.5.2.3.1 *Material Handling*

Of significance during the construction phase of the project is the excavated materials handling, storage and re-use. There is potential for direct and indirect negative impacts on ground stability and water quality. Control of surface water runoff from the site during the construction phase and operational phase of the *Proposed Road Development* will be required in order to manage potential runoff of contaminants into the streams.

14.5.2.3.2 *Hydrology*

To minimise the impact on drainage during construction, the following mitigation measures are to be adopted:

- Flow monitoring of streams DX1 to DX10 is to be undertaken during construction on a monthly basis and for up to one year after construction, in order to ensure the impact on baseline flows is minimised.

14.5.2.3.3 *Water Quality*

To minimise the impact on surface water and groundwater quality during construction a detailed operating procedure is contained in the Outline Erosion and Sediment Control Plan (Appendix 4.5 to this EIS) and the following general mitigation measures are to be adopted:

- Streams DX1 to DX10 and selected groundwater monitoring boreholes are to be monitored during construction on a monthly basis and for up to one year after construction, in order to minimise the impact on baseline hydrochemistry;
- Strict adherence to an agreed approach to pumping and surface runoff and the emergency spill plan is to be operated during construction;
- Fuels, oils and chemicals are to be stored on impermeable bases, away from drains and watercourses;
- Refuelling of plant and vehicles is to be done on impermeable surfaces, away from drains and watercourses;
- Silt traps, settlement lagoons, wetlands or hydrocarbon interceptors are to be placed at sensitive outfalls.

14.5.2.3.4 *Groundwater Levels*

To monitor and minimise the impact on groundwater levels during construction, the following mitigation measures are to be adopted:

- Groundwater level monitoring is to be undertaken at all available groundwater monitoring boreholes during construction on a monthly basis and for up to one year after construction and compared to the available pre-construction monitoring data.

14.5.2.3.5 *Groundwater Flow*

To minimise the impact on groundwater flow during construction, the following mitigation measures are to be adopted:

- Where the proposed road cut extends to bedrock, all construction activity is to be closely monitored by a karst expert to identity any subsurface karst collapse features or active karst conduits in the unlikely event of encountering such features;
- If such active karst conduits are found, additional drainage of sufficient capacity is to be incorporated into the existing drainage design for the road, in order to allow the water to flow freely during periods of high precipitation, thus preventing flooding potential;
- Should active karst conduits be encountered, a system of sealed drainage is to be provided in order to intersect the proposed road alignment, consisting of a pipe of suitable dimension for floodwaters to route the water beneath the road. This closed drainage is to be independent of the road drainage, which has the potential to intercept and carry contaminated road runoff into karst bedrock features.

14.5.2.3.6 *Groundwater Supply Wells*

To minimise the impact on groundwater supply wells, the following mitigation measures are to be adopted:

- Groundwater levels are to be monitored in the identified spring-fed well of Carrownagark group water scheme well at c. Ch. 7,900m during the construction phase. Should the well be impacted by the *Proposed Road Development*, the replacement or access to an equivalent water supply is to be dealt with as part of the accommodation works.

14.5.2.4 Operation Phase

14.5.2.4.1 *Drainage*

The potential increase in the volume and rate of surface runoff discharging from the catchments as a direct result of increased impervious areas and the potential change in the hydraulic behaviour of local streams receiving the increased surface runoff are considered to have a slight impact on the Unshin River, its tributaries the Markree Demesne Stream, Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and Drumderry Stream (Lough Arrow Catchment) surface catchment areas overall. However to minimise the impact on drainage during operation, the following mitigation measures will be adopted:

- Drainage outfalls are designed to be served by suitably sized constructed wetlands or interceptor ponds which will limit the runoff rate to that of existing Greenfield runoff (based on QBAR) rates for the site at all of the outfalls;
- Attenuation of surface runoff is designed to be served by suitably sized holding ponds to reduce impact on stream flow.

14.5.2.4.2 *Water Quality*

To minimise the impact on surface water and groundwater quality during the operational phase, the following mitigation measures are to be adopted in accordance with the drainage design described in chapter 4: Spill containment measures and constructed wetlands[100] will be constructed at all outfalls. In addition hydrocarbon interceptors will be constructed at all outfalls from the mainline (national primary) carriageway.

The existing N4 road has no attenuation, containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the fisheries value is rated **medium**; the magnitude of this impact is rated as **minor beneficial**, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated **minor beneficial.**

14.5.2.4.3 *Groundwater flow*

The potential interception of shallow groundwater flow is considered to have a slight impact on the Unshin River, its tributaries the Markree Demesne Stream, the Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and Drumderry Stream (sub catchment of Lough Arrow) surface catchment areas overall and a potentially significant impact on the Lackagh Fen catchment. In the case of the Lackagh Fen catchment,

[100] Except in the case of outfall 01, where existing attenuation facilities will be utilised.

attenuated runoff from road outfalls will balance the volume of groundwater potentially lost from the road cuts in so far as is practicable. As a result the actual impact on these habitats will be slight.

14.6 Residual Impacts

The table in Appendix 14.2 (volume 4) details the residual impacts of the *Proposed Road Development* on the hydrological and hydrogeological aspects of the environment. These are the final or designed impact, which results after proposed mitigation measures have fully established. The following sections describe these residual impacts.

14.6.1 Impacts on Hydrology

14.6.1.1 Reduced surface water quality

The reduction in water quality in streams receiving construction runoff from the proposed road is a possible indirect impact of the *Proposed Road Development* on local hydrology, on conservation areas, on wetland habitats, on fisheries value and on flooding. Following implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain residual but to remain at or reduce to **imperceptible**, resulting in an impact but of insufficient magnitude to affect use or integrity, and **temporary** in nature. The impacts of the reduction in water quality in streams receiving routine runoff and the increased risk to surface water as a result of a serious accidental spillage on local hydrology, on conservation areas and on wetland habitats are considered to remain **residual**, **imperceptible** and **permanent**.

14.6.1.2 Re-sectioning of stream channels

The re-sectioning of stream channels is a certain direct impact of the *Proposed Road Development* on the existing drainage regime, on flooding and on fisheries value. Following the implementation and maintenance of mitigation measures detailed in this chapter and in the Erosion and Sediment Control Plan, these impacts are considered to remain residual, **moderate/ slight** and **permanent** in nature. The impacts on flooding are considered to remain residual, **slight** to **slight/ moderate** and **permanent** in nature, while the impacts on fisheries value are considered to remain **residual**, **slight** and **permanent** in nature.

14.6.1.3 Disturbance of field drainage

The disturbance of field drainage systems is a certain direct impact of the *Proposed Road Development* on the existing drainage regime, on conservation areas, on wetland habitats and flooding. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts on drainage, conservation areas and wetland habitats are considered to remain **residual**, **imperceptible** and **permanent** in nature and on flooding are considered to remain **slight** to **slight/ moderate** and **permanent** in nature.

14.6.2 Increased attenuation & containment

The increased attenuation and containment is a certain indirect impact of the *Proposed Road Development* on the existing drainage regime, on conservation areas, on flooding and on fisheries value. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **minor beneficial** and **permanent** in nature.

14.6.3 Increased surface water contributions

14.6.3.1.1 *Conservation areas*

The collection and conveyance of road runoff via surface water channels and constructed Wetlands attenuation ponds or other treatment methods is to attenuate the increase in surface runoff to the Unshin River and Lough Arrow conservation areas, which in both cases will be generated from an increase of <5% in the impervious surface area of their catchments. On this basis, the indirect impact of the *Proposed Road Development* by increasing runoff within the surface water catchment area is mitigated by ensuring that runoff is attenuated before being discharged into the same catchment from which it was derived. The importance of the Unshin River and Lough Arrow conservation areas is classified as **extremely high**; the magnitude of this impact is reduced by the proposed mitigation measures to **negligible**; and therefore the significance of this impact is **imperceptible**. The impact is considered to remain **imperceptible** and **permanent**.

14.6.3.1.2 *Wetland habitats*

The collection and conveyance of road runoff via surface water channels and attenuation ponds or other treatment methods is to attenuate the increase in surface runoff to the wetland habitats, which in all cases will be generated from an increase of <5% in the impervious surface area of their catchments. On this basis, the indirect impact of the *Proposed Road Development* by increasing runoff within the surface water catchment area is partially mitigated by ensuring that runoff is attenuated before being discharged into the same catchment from which it was derived, albeit downstream of the lakes in the case of Toberscanavan Lough, the Boathole Lough and Lough Corran and Ardloy and Aghalenane Loughs. The importance of the wetland habitats is rated as **high, very high and extremely high** (Ardloy and Aghalenane Loughs); the magnitude of this impact is reduced by the proposed mitigation measures to **slight/imperceptible**; and therefore the significance of this impact is reduced from **significant/ moderate** to **slight/imperceptible**. The impact is considered to remain **slight/imperceptible** and **permanent**.

14.6.4 Impacts on Hydrogeology

14.6.4.1 Reduction in groundwater body status

The reduction in groundwater contributions is a possible indirect impact of the *Proposed Road Development* on groundwater body status. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **imperceptible** and **permanent** in nature.

14.6.4.2 Reduction in level of protection

The reduction in the level of protection afforded to groundwater resources is a possible indirect impact of the *Proposed Road Development* on aquifer vulnerability. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **moderate** and **temporary** in nature. The impacts of increased level of protection by the placement of embankments and an impervious cover are considered to remain **residual**, **minor beneficial** and **permanent** in nature.

14.6.4.3 Interception of shallow groundwater flow

The potential interception of shallow groundwater flow at proposed road cuts is a possible direct impact of the *Proposed Road Development* on groundwater flow. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **moderate** and **temporary** in nature. The impacts of increased level of protection by the placement of embankments and an impervious cover are considered to remain residual, **minor beneficial** and **permanent** in nature.

14.6.4.4 Localised lowering of water table

The potential localised lowering of the water table for the construction of road cuts and for the removal of areas of soft ground is a certain indirect impact of the *Proposed Road Development* on groundwater flow. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **imperceptible** for the cuts and the areas of soft ground.

14.6.4.5 Localised backing up of water table

The potential localised backing up of the water table on the upgradient side of road cuts and for the removal of areas of soft ground is a possible indirect impact of the *Proposed Road Development* on groundwater flow. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **imperceptible** and **temporary** in nature.

14.6.4.6 Long term reduction of water table

The potential long-term reduction of the table at the road cuts where groundwater is intercepted is a possible indirect impact of the *Proposed Road Development* on groundwater flow. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **imperceptible** and **temporary** in nature.

14.6.4.7 Localised flooding at dolines

The potential localised flooding of land in the vicinity of dolines is a possible indirect impact of the *Proposed Road Development* on karst features. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **moderate/ slight** and **temporary** in nature.

14.6.4.8 Entry & rapid transfer of contaminants

The potential entry and rapid transfer of contaminants in the subsurface is a possible indirect impact of the *Proposed Road Development* on karst features. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain **residual**, **moderate** and **temporary** in nature.

14.6.4.9 Collapse of identified or unidentified karst features

The potential collapse of identified or unidentified karst features is a possible indirect impact of the *Proposed Road Development* on karst features and on the *Proposed Road Development*. Following the implementation and maintenance of mitigation measures detailed in this chapter, these impacts are considered to remain at or reduce to **residual**, **moderate/ slight** for karst features and for the *Proposed Road Development* and **temporary** in nature.

14.6.4.10 Reduced groundwater contributions

The collection and conveyance of groundwater (if any) encountered in the cuts within the wetland catchments has been offset by the contribution of attenuated road runoff to the catchments and there is unlikely to be a significant change in the net water flow into any of these catchments as a result. The importance of the wetlands are rated high to very high to extremely high; the magnitude of the groundwater impact is reduced by the proposed mitigation measures from **moderate adverse** to **small adverse** in the worst cases; and therefore the significance of this impact is reduced from **significant/ moderate** to **moderate/ slight**. The magnitude of the surface water impact is reduced from **moderate adverse** to **negligible**; and therefore the significance of this impact is reduced from **significant/ moderate** to **imperceptible**. The impact is considered to remain **residual, imperceptible** and **permanent**.

14.7 Relevant Figures and Appendices

14.7.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes Chapters 13 and 14 and are contained in Volume 3 of the EIS:

Fig. 13.1:	Soil Geology Map;
Fig. 13.2:	Subsoil Geology Map;
Fig. 13.3:	Bedrock Geology Map (including structural and karst features);
Fig. 13.4.1-13.4.8:	Geotechnical overview including road cuts, embankments and lands for infilling of unsuitable surplus material inside the CPO;
Fig. 14.1:	Hydrology, monitoring locations, conservation areas and flooding;
Fig. 14.2:	Aquifer classification ground water flow and ground water contours;
Fig. 14.3:	Aquifer vulnerability;
Fig. 14.4:	Local catchment areas for wetland habitats;

Other relevant figures include:

Fig. 4.1:	Design Overview; Plan Mainline; Key Sheets;
Fig. 4.1.1-4.1.8:	Design Overview; Plan Mainline.

14.7.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 14.1.: Hydrological and Hydrogeological Study of Tawnagh Lake, Tawnagh, County Sligo;

Appendix 14.2.: Hydrological and Hydrogeological Impact Summary;

Appendix 14.3.: Hydrochemistry Results;

Section C; Material Assets

This section of the Environmental impact Statement examines the impacts of the *Proposed Road Development* on Material Assets including:

- Impacts on **Architectural, Archaeological and Cultural Heritage**

15 Archaeology, Architecture and Cultural Heritage

15.1 Introduction

The *Proposed Road Development* that is the subject of this report travels through a generally undulating landscape, more level at the northern end, hillier at the southern end. The wider landscape through which the proposed route passes has a varied topography containing mountains, drumlins, wetlands, lakes, rivers and farmland. Along the proposed route the present agricultural land use is dominated by mainly small farms with beef grazing and lesser numbers of mixed livestock farms. Fields are separated by hedgerows, earthen banks, drainage ditches and stone walls. Some of the wetland areas along the proposed route have recent conifer plantation.

The *Proposed Road Development* is approximately 14.71km in length and its physical characteristics are as described in Chapter 4 of this EIS. The areas identified for Spoil Repositories (or Borrow Pits) (SR-LI-01, SR-LI-02, SR/BP Type 02-02, SR-LI-03, SR-LI-04, SR/BP Type 2-03, SR/BP Type 1-01, SR/BP Type 1-02, SR/BP Type 1-03, SR/BP Type 1 -03, SR/BP Type 1-04, LS), the proposed Constructed Wetlands/Attenuation Ponds and the Landscape Mitigation Sites (LS. Mit-01, LS. Mit-02) are located along the margins of the *Proposed Road Development* and fall within the CPO. The topography of these areas varies from the low-lying lands of Lackagh fen in the north to areas of wetland grassland and cutover bog further south. The soil in these areas generally varies between topsoil and peat.

15.2 Methodology

The methodology employed in this Built Heritage Impact Assessment was twofold. It entailed an initial desktop study of RMP archaeological sites within 2km of the *Proposed Road Development*, all other built heritage features within 1km and a subsequent field survey of all identified built heritage sites within 0.5km of the *Proposed Road Development*. Any National Monuments or sites of significant importance within 3km of the *Proposed Road Development* were visited in 2009 and the proposed locations of realignments, link roads, spoil management areas and Constructed Wetlands/Attenuation Ponds were inspected during additional field work undertaken at various times between 2011 and 2013.

15.2.1 Desk Based Study

15.2.1.1 Documentary Research

Various published sources, including local and national journals, were consulted to establish a historical background for the *Proposed Road Development*.

15.2.1.2 National Monuments and Record of Monuments and Places

An archaeological monument may be a National Monument if it is in the care or ownership of the Minister or a Local Authority or is the subject of a preservation order. Previously a list of National Monuments in the care or ownership of the Minister was available from the www.heritagedata.ie website. Although this list has now been removed from the site and is now superseded by lists available on the www.archaeology.ie website both data sets were used to ensure that all potential National Monuments in the vicinity of the *Proposed Road Development* were recorded.

The Record of Monuments and Places (RMP) was established under the National Monuments Acts (1930-94). It is based upon the older Sites and Monuments Record and information from county archaeological inventories. The RMP data is compiled from the files of the Archaeological Survey, which combines cartographic sources and all published, and publicly available documentary sources including periodicals, the records of the National Museum of Ireland (NMI) and the aerial photographs of the Geological Survey of Ireland (GSI). The RMP consists of a numbered list, organized by county and subdivided by 6" map sheets showing the location of each site.

15.2.1.3 The Topographic Files of the National Museum of Ireland

The topographical files of the National Museum of Ireland (hereafter NMI) identify all recorded finds held in the NMI archive that have been donated to the state in accordance with National Monuments legislation. The files sometimes include reports on excavations undertaken by NMI archaeologists in the early 20th century. Valuable information that can be gleaned might include the exact location, ground type, depth below ground level and condition when found, of each find. However, the amount and the usefulness of the information available on each find can vary considerably. The topographical files are listed by county and townland and/or street name.

15.2.1.4 Previous Archaeological Work

The Excavations Bulletin, published each year, and its online database (http://excavations.ie) contains summary accounts of all the excavations carried out in Ireland – North and South – from 1970 to 2009 (currently the latest edition). It has been compiled from the published Excavations Bulletins from those years, with a similar format. The number of excavations carried out annually in Ireland has increased enormously during this period. To illustrate, Excavations 1970 has 41 reports, while Excavations in 2006 and 2007 contains over 2000. The database gives access to almost 15,000 reports and can be browsed or searched over the internet using multiple fields, including Year, County, Site Type, Grid Reference, Licence No., Sites and Monuments Record No. and Author.

The NRA archaeological database (http://archaelogy.nra.ie) contains a description of the results of excavations carried out in advance of various road schemes. This database was searched for excavations carried out in the vicinity of the *Proposed Road Development*.

15.2.1.5 Cartographic Research

Analysis of historic mapping shows how the landscape has changed over time. The comparison of different editions of historic maps can show how some landscape features have been created, altered or removed over a period of time. All three editions of the Ordnance Survey 6" Maps (1837, 1885, 1913/4) were examined. The maps were sourced from the Trinity College Map Library, Dublin and were viewed on line (http://osi.ie).

15.2.1.6 Toponyms

Townland names are a valuable source of information as they can indicate, for example, the type of topography or archaeological sites that have long since been forgotten. They can be a rich source of information for the land use, history, archaeology and folklore of an area. The placename can have a variety of language origins such as, Irish, Viking, Anglo-Norman and English. The online database of Irish placenames (www.logainm.ie) was consulted, as were a number of relevant placename books (Joyce 1995; Flanagan and Flanagan 1994).

15.2.1.7 Aerial Photographs

Aerial photographs are useful because they allow for a different perspective, 'the distant view'. Archaeological sites may show up on the ground surface, depending on their state of preservation, by light and shadow contrasts (shadow marks), tonal differences in the soil (soil marks) or differences in height and colour of the cultivated cereal (crop marks).

15.2.1.8 Architectural Heritage

The Record of Protected Structures (hereafter RPS) 2011-17[101] for County Sligo was examined to ascertain whether there were any protected structures within the vicinity of the *Proposed Road Development*.

The meaning of the term structure includes the interior of the structure, the land lying within the curtilage of the structure, any other structures lying within that curtilage and their interior, all fixtures and features which form part of the interior or exterior of that structure. The protection also extends to any features specified as being in the attendant ground.

[101] Included in County Development Plan for County Sligo http://www.sligococo.ie/cdp/.

Each Planning Authority has a statutory responsibility, under Section 51 of the Planning and Development Acts of 2000-2010, to include a RPS in its Development Plan. The effect of Protected Structure Status is to seek to retain the special character and features that make these structures significant. Therefore any works that would have a material effect on the character of a protected structure requires planning permission. The Act also places an obligation on owners and occupiers of a protected structure to ensure that it or any element of it is not endangered.

The National Inventory of Architectural Heritage (hereafter NIAH) database was also consulted http://buildingsofireland.ie.

15.2.2 Field Inspection

An archaeological field inspection survey seeks to verify the location and extent of known archaeological features and to record the location and extent of any newly identified features. A field inspection also endeavours to identify any areas of archaeological potential with no above ground visibility (e.g. wetland areas, river crossings, areas between concentrations of upstanding features).

The field survey entailed visits to all built heritage sites within 0.5km of the *Proposed Road Development*. The Carrowkeel Passage tomb cemetery (Nat. Mon. No. 518) is located 2.5km to the south of the *Proposed Road Development*. This area was also visited.

15.2.3 Inventory

The Inventory details all those built heritage sites, monuments and areas of potential significance on or adjacent to the proposed area of works. An individual cultural heritage constraint number (CHC) has been given to each site or area of potential identified for the purpose of this report and they are marked as such on the accompanying mapping. The Constraints Inventory is contained in Appendix 15.5 of volume 4.

15.2.4 Appraisal Methodology

15.2.4.1 Assessment of significance and impacts

The National Roads Authority's *Practical Guide* (NRA 2008) on assessing development impacts follows the *Guidelines* and *Advice Notes* of the Environmental Protection Agency (EPA 2002, 2003) and relevant legislation. In characterising impacts these guidelines are especially concerned with magnitude, intensity, duration, probability and loss of integrity. The significance of impacts is rated on a spectrum ranging from imperceptible ('without noticeable consequences') to 'profound' ('obliterates sensitive characteristics'). In addition to the more general guidelines, there are dedicated guidelines—published by the National Roads Authority and the Department of Environment, Heritage and Local Government—for archaeological and architectural heritage that are particularly relevant here, and key points in these are summarised briefly below.

15.2.4.1.1 *Archaeology*

The National Roads Authority *Guidelines* (NRA 2005a, 25) are broadly consistent with guidelines of other statutory bodies but, with reference to archaeological sites and monuments, are especially concerned with 'direct' and 'indirect' impacts: a direct impact would remove part or all of a site or monument; an indirect impact would leave the feature intact but would have a potential impact on its setting or amenity potential. The *Guidelines* (NRA 2005a, Appendix 2) give a list of characteristics for assessing significance similar to those of the National Monuments Service (above), including legal protection status, condition, documentation and/or historical associations, group value, rarity, visibility in the landscape, vulnerability and amenity value. Unlike the companion architectural heritage guidelines (NRA 2005b), however, they do not specify any ranking scale for affected features (e.g. local, regional, national), but focus on the degree of the impact rather than the significance of the affected feature.

15.2.4.1.2 *Architecture*

In assessing the special significance of built heritage, the *Architectural Heritage Protection Guidelines for Planning Authorities* (DEHLG 2004, 22–23) and *National Inventory of Architectural Heritage Handbook* (DEHLG 2006; following the 1999 Act) specify categories of special interest as: architectural, historical, archaeological,

artistic, cultural, scientific, technical and social. Both authorities advocate a ranking scheme of: 'record only', local, regional, national and international.

The National Roads Authority *Guidelines* (2005b, 33–36) are concerned with the potential outcomes of direct and indirect impacts and, as with the companion archaeological guidelines, recommend a scale of impacts ranging from 'imperceptible' to 'profound', corresponding with Environmental Protection Agency *Advice Notes* (EPA 2003). Unlike the archaeological heritage guidelines, however, the architectural guidelines do specify a ranking scheme for affected features as (NRA 2005b, 32): local, regional, national and international—following the example of the National Inventory of Architectural Heritage. The *Guidelines* also recommend a matrix (Table 15-1 below) where the magnitude or degree of the impact is calibrated against the significance of the affected feature to gauge the significance of the impact (2005b, 32). In simple terms, a direct impact on a feature of local interest might amount to a slight or moderate impact; whereas the same direct impact on a feature of national importance would amount to a severe or profound impact.

15.2.4.2 Significance criteria in this report

In addition to criteria described above, loss of fabric (direct impact) and change of setting (indirect impact)—including severance of groups of features—were the principal criteria for the assessment of the potential impacts of the *Proposed Road Development*. The significance of all architectural heritage features in the study area was rated on a scale of nil, local, regional, national or international. The magnitude of impact was calibrated against the significance of the affected features to gauge the significance of the impact, as proposed by the National Roads Authority Architectural Heritage *Guidelines* (2005b, 32) and schematised here in Table 15-1 below. Impacts were rated nil, slight, moderate, severe or profound.

Table 15-1: Architectural Heritage Impact Assessment Matrix: Matrix of degree of impact and significance of affected feature for assessing significance of impact

Magnitude of Impact	Significance of affected feature			
	Local	Regional	National	International
Very high	Moderate	Severe	Profound	Profound
High	Moderate	Severe	Severe	Profound
Medium	Slight	Moderate	Severe	Severe
Low	Slight	Slight	Moderate	Severe
Type of impact	Positive or Negative or Residual			

Regarding the archaeological heritage, the types of impact are generally categorised as direct impact, indirect impact or no predicted impact. A direct impact is where a feature or site of archaeological heritage merit is physically located in whole or in part within the footprint of the *Proposed Road Development*. An indirect impact is where a feature or site of archaeological heritage merit or its setting is located in close proximity to the footprint of the *Proposed Road Development*. No predicted impact is where the *Proposed Road Development* does not adversely or positively affect an archaeological heritage site.

The significance of the impact can be profound, significant, moderate, slight or imperceptible. The quality of the impact can be positive or negative. A profound impact is where mitigation would be unlikely to remove adverse effects. This category is reserved for adverse negative effects only. These effects arise where an archaeological site is completely and irreversibly destroyed by a proposed development. A significant impact is one that alters an important aspect of the environment. This would be where part of a site would be permanently impacted upon, leading to a loss of character and integrity. A moderate impact is where a change to the environment is noticeable, but the archaeological integrity of the site is not compromised. A slight impact is where changes are caused to the environment but which are not significant or profound and do not affect an archaeological feature or site. An imperceptible impact is one that is capable of measurement but without noticeable consequences.

Where sites are deemed to be of potential merit only, in that it is not known in advance of further surveys whether there are any archaeological remains present or not at these locations/sites then, these impacts have been deemed to be 'potential'.

15.3 Built Heritage in the Receiving Environment

15.3.1 Archaeological and Historical Background

15.3.1.1 General Topography

County Sligo has a varied topography of mountains, peatland, lakes, rivers and farmland of varying quality. Approximately 30% of the county comprises of mountain and lowland bog suitable only for rough grazing or tree plantation. The topography of the county is shaped by the underlying geology. The Ox Mountains run southwest-northeast across the county between the borders with County Mayo and County Leitrim, dividing the peatlands and fertile plains of west Sligo from the drumlin country of central, south and southeast Sligo. This drumlin country, extending towards Collooney, consists of small hillocks separated by poorly drained soils, small lakes and seasonal wetland. The centre of the county is drained by the Unshin, Owenmore and Owenbeg rivers which join together at a gap in the Ox Mountains near Collooney. The south-eastern part of the county is overlooked by the Curlew Mountains which form the border between Sligo and Roscommon and the Bricklieve Mountains, a limestone plateau which runs northwards from the Curlews (Egan, Byrne & Sleeman 2005, ix).

15.3.1.2 Prehistoric Period

There is archaeological evidence for human settlement in Ireland from the Early Mesolithic period (c. 7000 - 5500 BC) onwards. At Lough Boora in County Offaly, an occupation site recorded beneath peat cover has been dated to the Early Mesolithic period (McDermott 1998, 11). In the northwest of the country, a site dating to the Late Mesolithic (c. 5500 -4000 BC) has been identified in the Inishowen peninsula, County Donegal. Excavations of raised beach gravels along the Ulster coast have produced typical later Mesolithic flint assemblages (Waddell 2000, 18). On the border between Counties Sligo and Roscommon, Mesolithic activity around the shore of Lough Gara has been confirmed by radiocarbon analysis, (Fredengren 2002), where large quantities of later Mesolithic worked chert have also been recorded (Waddell 2000, 23).

County Sligo possesses an impressive range of monuments dating to the Neolithic period (c. 4000 – 2400 BC) with two major passage tomb cemeteries, located at Carrowmore and Carrowkeel. The former is located in the Knocknarea Peninsula southwest of Sligo town and there are about 30 recognisable monuments here. These are mostly boulder circles and are mainly located within an area measuring 1000m by 500m. The Carrowkeel Cemetery, located at the northern end of the Bricklieve Mountains overlooking Lough Arrow, includes over a dozen round cairns some of which contain passage tombs. A cluster of at least 40 circular hut sites dated to the Neolithic period is situated at Mullaghfarna, adjacent to the Carrowkeel Cemetery (Waddell 2000, 68). During excavations carried out as part of the N4 SIRR project the possible remains of a megalithic tomb were excavated in Caltragh townland (Danaher, 2007, 61). A Neolithic causewayed enclosure was also excavated as part of this project in Magheraboy townland (Danaher, 2007, 89).

The Early Bronze Age (c. 2400 – 1500 BC) saw the appearance of another archaeological site type: mounds of heated burnt stone and associated troughs called *fulacht fiadh* that are found close to water sources, in many cases in or at the edges of bogs or wetland (Mitchell & Ryan 1997, 220). *Fulachta fiadh* have been discovered in increasing numbers in wet and marginal land in south Sligo (Egan, Byrne & Sleeman 2005, xi). For example a cluster of six burnt mounds was identified in wet ground just south of Castlebaldwin in 1998 during archaeological monitoring of the widening and realignment works on the N4[102]. During the excavations carried out in advance of the N4 SIRR revealed the remains of sixteen sites with evidence of burnt stone technology (Danaher, 2007, 39).

Prehistoric settlements tend to be difficult to identify as they survive as subsurface features and are generally only revealed during excavations. The excavations carried out in advance of the N4 SIRR revealed the remains of a middle Bronze Age settlement consisting of three circular huts in Caltragh townland and a small Iron Age structure in Magheraboy (Danaher, 2007).

[102] See Appendix 15.3 of volume 4 for Excavation Summaries.

Evidence of prehistoric occupation in the south of the county Sligo is recorded atop many of the glacial drumlins and ridges in the area, especially around Ballymote. Here upstanding barrows and cairns as well as the cist, urn and pit burials with no surface evidence, testify to the rich tradition of funerary practices extending from the Neolithic, through the Bronze Age and into the Iron Age (c. 600 BC –AD 400) (Egan, Byrne & Sleeman 2005, xi). During the N4 SIRR excavations several Bronze Age cremations were discovered and excavated in Caltragh townland (Danaher, 2007, 71).

In areas of bog and peatland evidence of past human activity takes the form of toghers and trackways, which may date from the Neolithic, Bronze and Iron Ages, as well as into the Medieval period (Mitchell & Ryan 1997, 232).

15.3.1.3 Early Medieval Period

The early medieval period (c. AD 400 – 1100) witnessed the introduction of a new type of settlement enclosure known as the ringfort. Ringforts consist of a circular area enclosed by a bank and an external ditch. Where the defensive elements consist of earthen banks the sites are generally referred to as raths, while those with stone defenses are termed cashels and are to be found especially in the western counties of Ireland. In some cases there can be up to three sets of defenses. The relatively small number of multivallate, raised and platform raths, in comparison to the vast numbers of univallate enclosures, has resulted in their identification as high status settlements (Graham 1993; Mallory & McNeill 1991). In general, ringforts functioned as defensive farmsteads and also corrals for animals. The chronology of ringforts seems to indicate that they were occupied from the beginning of the 7th until the end of the 9th centuries (Stout 1997, 24) and excavation evidence indicates that they were probably occupied for one or two centuries (Monk 1995). An enclosure is a generic monument type that includes many sites, that mainly for reasons of poor preservation, cannot be positively identified as ringforts. A feature often found near or within ringforts is an underground passage or souterrain. These souterrains are usually stone built and were probably used as places of refuge or storage. Ringforts are the most common type of archaeological monument in Ireland and are the most numerous monument type recorded in County Sligo. In south Sligo alone, the Archaeological Inventory records 1,200 examples (Egan, Byrne & Sleeman 2005, xi). Excavations carried out in advance of the N4 SIRR revealed the remains of a ringfort in Magheraboy townland (Danaher, 2007, 136).

In the 5th century Christianity was introduced to Ireland and monastic sites began to be founded throughout the country. Between the 6th and 8th centuries the influence of the church continued to grow and secular and ecclesiastical legislation document the gradual assimilation of the Church into early Irish society (Edwards 1996, 99). In many instances the monasteries began to compete with each other for power and patronage and in some case this led to inter-monastery battles. Ecclesiastical sites were generally enclosed by an oval or circular banked enclosure that was typically larger in diameter than a ringfort. Holy wells are natural springs that are generally associated with a particular saint and are often located near ecclesiastical sites. The practice of visiting holy wells is one of the oldest traditions of Irish Christianity but undoubtedly has its origin in pre-Christian times. As many as 69 holy wells are recorded in south Sligo (Egan, Byrne & Sleeman 2005, 433).

15.3.1.4 Medieval Period

The dominant families in medieval Sligo can trace their origins back to the early medieval period, when the region was at the junction of several territories and kingdoms. The O'Dowd family descended from the Úi Fiachrach Muaide in west Sligo; the O'Conor family descended from the Úi Briúin Ái of north Roscommon; the O'Hara and O'Gara families descended from Úi Briúin Bréifne of northern and eastern Sligo and the Luigne of south Sligo (Egan, Byrne & Sleeman 2005, xi). By the 11th and 12th centuries the O'Conor family came to dominate Connacht as provincial kings. In 1124 Turlough O'Conor, king of Connacht, built a fortress or *caisdeoil* at Collooney.

During the 13th century the Anglo-Normans consolidated their conquest of much of County Sligo. The region came under the control of various Anglo-Norman families, in particular the Fitz-Geralds and the de-Burghs. During this time castles, settlements, boroughs and routes were set up across Sligo. In the early 14th century Richard de Burgh created a track known as 'B*óthar an Íarla Rua*' over the Curlew Mountains running from Boyle, past Ballaghboy towards a point south of Castlebaldwin, turning west at the north end of the Bricklieve Mountains to arrive at Ballymote. One area of the modern county that did not come under direct control of the Anglo-Normans during the 13th century was the cantred of Tirerrill. This comprised a large part of southeast Sligo and was included in a grant of lands made by the Crown to the O'Conor-Sligo dynasty as part

compensation for the loss of their province of Connacht. As a result there was no Anglo-Norman settlement of Tirerrill during the 13th and 14th centuries (Egan, Byrne & Sleeman 2005, x).

By the 14th century a decline in Anglo-Norman power meant that the Gaelic lords, under the dominance of the O'Conor-Sligo family, had started to regain possession of many parts of Sligo. During the 15th and 16th centuries the towerhouse was the typical form of residence of the lords in Ireland. A late 16th century map of the 'Norweste partes of Irelande' by Baxter and Boazio shows a route running south from Collooney passing Behy castle, Tawnagh church, Bricklieve and Ballinafad castle (Johnston 2005, 139). The dominance of the Gaelic lords continued until the early 17th century at which point the Dublin government re-established control in the area. However, there were still several skirmishes between the Gaelic lords and the English troops. One such skirmish between Donal Cam O'Sullivan and the troops of Elizabeth I resulted in an epic mid-winter march of almost 1,000 people to unite with forces in Ulster. Their route brought them through Castlebaldwin and the tourist trail, the Beara Breifne Way, which runs through Castlebaldwin follows their track.

15.3.1.5 Post-medieval Period

The 16th century route between Collooney and Ballinafad was used throughout the Confederate and Williamite wars and is shown on Molls map of 1714, passing through Tawnagh (Johnston 2005, 140). The preacher John Wesley, on travelling this route between Boyle and Sligo in 1758, referred to 'eight villages... counted in seven miles' (Simms 1961, 157). In 1776 Arthur Young noted, during his tour of Ireland, that the county was going over from pasture to tillage, with most tillage farms being small, consisting of partnerships of poor people (Simms 1961, 158).

In 1798 General Humbert with his French/Irish forces reached Collooney on their march from Killalla towards Donegal. The Sligo garrison came out to confront them at Carricknagat, a townland beside Collooney. Despite winning the day at Carricknagat, Humbert abandoned his intention of marching northwards and instead headed for the midlands where he ultimately was forced to surrender at Ballinamuck, Co. Longford. A statue of Lieutenant Bartholomew Teeling, a young Irish aide to General Humbert, was erected at Carricknagat in 1898, the centenary year of the battle.

In 1802 the Boyle to Sligo route was realigned and upgraded and by 1808 it had become part of a main Mail Coach route from Dublin, improved to new post road requirements '36 feet in the clear, 24 feet with gravel' (Johnston 2005, 140). County Sligo was surveyed by the Ordnance Survey in 1837 and for the first time the boundaries of all townlands, civil parishes and baronies within the county, as well as details of field outlines, roads, estate houses and demesnes, churches, barracks, schools, cabins and antiquities such as castles, raths and abbeys were depicted on a map.

At the beginning of the 19th century Sligo was one of the most overcrowded and poverty stricken counties in Ireland. The population is estimated to have reached a density of at least 350 people per townland, with small farms and potato plots being extended onto mountainsides (Johnston 2005, 30). During the Famine years, 1845-50, Ireland's population declined in the millions due to deaths from starvation and disease and from mass emigration to North America and England. County Sligo had one of the highest mortality rates in the country during the Famine.

In 1891 the Congested Districts Board (CDB) was set up in order to improve the standard of living of the rural population. The area of south Sligo through which the proposed route passes was considered to be amongst the most severely disadvantaged and congested in the country. One of the principle aims of the CDB was to consolidate the fragmented farm holdings so as to produce more profitable and sustainable farming. The activities of the CDB included agricultural development, forestry, breeding of livestock, migration and weaving.

15.3.2 Desk Based Study

15.3.2.1 National Monuments and Recorded Archaeological Monuments (Record of Monuments and Places/RMP)

15.3.2.1.1 *National Monuments*

There are two National Monuments within the vicinity of the *Proposed Road Development*; Catlebaldwin Castle (CHC 99/ Nat. Mon. No. 373 NIAH 32403404) and Carrowkeel Neolithic Passage tomb cemetery (Nat.

Mon. No. 518/ No CHC number assigned to this site due to its considerable distance from the *Proposed Road Development*).

15.3.2.1.1.1 *17th Century Fortified House 'Castle Baldwin'*

The 17th century fortified house at Castlebaldwin (CHC 99) is currently some 230m distant from the existing N4 and the *Proposed Road Development* shall move the N4 to within 128m of the fortified house. The building is a National Monument by virtue of being in the guardianship of the Office of Public Works. While there is an information panel on the local road to the East of the house, the site is not signposted off the existing N4 and there is no clearly designated access across the fields to it. Accordingly it does generally not attract visitors, though it is a fine example of its site type, rated in the National Inventory of Architectural Heritage as being of a Regional significance (Table 15-2, Fig. 15.2.8 contained within volume 3).

15.3.2.1.1.2 *Carrowkeel Neolithic Passage Tomb cemetery*

The Neolithic passage grave cemetery at Carrowkeel is a National Monument (No. 518) under the ownership of the Office of Public Works (OPW) and lies on the Bricklieve Mountains high above the south end of the *Proposed Road Development*, approximately 2.5km from the southernmost point of the proposed road.

Carrowkeel is one of the big four passage tomb cemeteries in Ireland (the other three are Brú na Bóinne, Lough Crew, and Carrowmore). Carrowkeel is set on high ground above Lough Arrow. There are fourteen passage tombs in Carrowkeel. Six more passage tombs are located close by in the Keshcorran complex. A particular type of crude pottery found in passage tombs has been titled Carrowkeel Ware, having first been recorded in the Carrowkeel Monuments. Cairn K is at the highest point of the Carrowkeel complex. The view from the top of Cairn K to the northeast looks past Cairns H and G and out over the drumlin landscape of south county Sligo (Plates 90 & 91). The village of Castlebaldwin is visible below as a cluster of buildings at the base of the drumlin in Drumderry Townland. The existing N4 road running through Castlebaldwin can be seen as a line of trees and buildings. Further north, the line of the existing N4 road becomes unclear as it winds through the lowlands between drumlins.

Table 15-2: National Monuments in proximity to the Proposed Road Development

CHC No/ National Monument No.	RMP No.	Townlands	Classification	Distance from *Proposed Road Development*
CHC 99 Nat. Mon. 373	SL 034-185 (NIAH 32403404)	Castlebaldwin	17th century Fortified House	128m
(No CHC number) Nat. Mon 518	SL040-101 SL040-102 SL040-087 SL040-086 SL040-095 SL040-096 SL040-089 SL040-090 SL040-093 SL040-094 SL040-092 SL040-099 SL040-100 SL040-097 SL040-103	Carricknahorna East, Carrowkeel, Doonaveeragh, Treanscrabbagh, Tully	Neolithic Passage tomb cemetery	c. 2.5km

15.3.2.1.2 *Recorded Monuments (RMPs)*

There are nine recorded archaeological monuments (RMP) located within 100m of the *Proposed Road Development*. The closest RMPs to the *Proposed Road Development* are the possible enclosure in Toberbride (CHC 4/SL026-164), the site of an enclosure in Cloonamahan (CHC 21/ SL026-076) the ringfort in Cloghoge Upper (CHC 100/ SL034-191) and a ringfort in Castlebaldwin (CHC 98/ SL034-184). There are a number of additional RMP sites within 2km of the *Proposed Road Development*. These are listed in Appendix 15.1 contained within volume 4.

Table 15-3: RMPs in the vicinity of the Proposed Road Development (<100m)

CHC No.	RMP	Townland	Classification	Approx distance from permanent works
CHC 2	SL026-026	Toberbride	Ecclesiastical remains (possible)	36m
CHC 4	SL026-164	Toberbride	Possible enclosure	0m
CHC 21	SL026-076	Cloonamahan	Enclosure (site of)	0m
CHC 23	SL026-077	Cloonamahan	Ringfort	32m
CHC 75	Sl034-112	Tawnagh	Enclosure	35m
CHC 93	SL034-181	Castlebaldwin	Ringfort	25m
CHC 96	SL034-186-001 - 003	Cloghoge upper	Holy wells (3)	27m
CHC 98	SL034-184	Castlebaldwin	Ringfort	11m
CHC 100	SL034-191	Cloghoge Upper	Enclosure	9m

15.3.2.2 The Topographical Files, National Museum of Ireland

The Topographic files at the Irish Antiquities Department, National Museum of Ireland were inspected with regard to the following townlands within 1km of the *Proposed Road Development*; Collooney, Knockbeg East, Rathrippin, Toberbride, Mullaghnabreena, Knockmullin, Markree Demesne, Ardcurley, Cooperhill or Gobbadagh, Cloonamahan, Doorly, Lisconny, Knocknagroagh, Coolteen, Lackagh, Spotfield, Coolbock, Murillyroe, Drumfin, Clooneen, Behy, Newpark, Cloonlurg, Carrowkeel (ED Riverstown), Ogham, Carrownagark, Kingsbrook, Springfield, Aghalenane, Tawnagh, Whitehill, Ardloy, Cloonymeenaghan, Lissycoyne, Cloongad, Lecarrow, Sheerevagh, Drumderry, Annaghcor, Cleavry, Ballinagarrigeeney/Castlebaldwin, Cloghoge Lower, and Cloghoge Upper.

Records in the topographic files that relate to these townlands include several prehistoric artefacts.

The earliest dateable finds from the study area are Neolithic in date. Several of these items have been recovered from Carrowkeel passage tomb complex where a number of finds have been recorded over the years. Such finds include a stone pendant (NMI Register No. 1969:838), cremated human bones (1987:139, 1969:839; 1988:145; 1961:168), bone points (1982:42), bone artefacts (1969:838A), a boar tusk (IA/114/65) and various megalithic material such as pottery, bone objects, beds etc (E624:1). A stone bead (1953:68) was also found in the Carrowkeel townland but is only recorded as been found in a field. A chert javelin-head (1964:24) is recorded from the bog in Drumfin. The lithic, which was recovered at a depth of 10 foot (3m), probably dates from the Neolithic period (see Appendix 15.2 of volume 4 for details). Two polished stone axeheads, probably from the same period, are recorded from Lisconny (1929:1406) and Whitehill (1984:118). A burial (record only) is recorded from a gravel pit in Carrownagark. This burial was accompanied by a hammer stone and flint flake.

Possible Early Bronze Age activity at the Carrowkeel passage tomb complex is testified to by the discovery of human remains (1993:27) in a cist near Cairn K. Further evidence for Bronze Age activity comes from two bronze axeheads recorded from Castlebaldwin (1887:6). A cremation and a cinerary urn (1956:220-221) were discovered in a sand pit in Cleavry townland. A second burial (record only) is recorded from a gravel pit in Carrownagark. This burial was accompanied by a hammer stone and flint flake. A further burial (1946:93a) with pottery sherds (1946:93) was found in a cist in Knockmullin. Several other stray finds may also date to this period. These include two bronze axeheads from Castlebaldwin (1887:6) and Collooney (1913:111), a bronze dagger from Collooney (1913:115) and a bronze spearhead (1992:47) from Markree Demesne. The discovery of an iron spearhead from Collooney (1975:4) indicates possible Iron Age activity in the area.

There are also some finds from the study area which are difficult to assign a precise date to. These finds include two leather shoes (1957:346 & 347) from Spotfield and a trough-like vessel (1961:164) containing animal bones (1961:165) from Carrownagark.

Table 15-4: Archaeological artefact finds from the vicinity of the Proposed Road Development

NMI Reg No.	Townland	Find	Notes
1887:6	Castlebaldwin	Axehead	Bronze flanged axehead found in bog
1993:27	Carrowkeel	Human remains	Burnt human bones found in a cist at cairn K
1988:145	Carrowkeel	Cremated bone	—
1987:139	Carrowkeel	Human bones, burnt	Three pieces of cremated human bone. Found in Cairn K.
1969:839	Carrowkeel	Cremated human bone	Found on the floor of the right recess in Cairn K. Five pieces of cremated bone, including two small fragments of skull.
1969:838A	Carrowkeel	Bone artefact	Highly polished fragment of bone artefact (or tooth) Found in Cairn K
1969:838	Carrowkeel	Stone pendant	Found on the floor of the right recess in Cairn K.
1961:168 (IA/25/61)	Carrowkeel	Cremated bones	Small quantity of cremated human bone found in Cairn G
1953:68	Carrowkeel	Stone Bead	Found in a field
IA/114/65	Carrowkeel	Boar Tusk	Carved tusk of a boar. Found in one of the passage graves in the Carrowkeel cemetery
E624:1	Carrowkeel	Megalithic material (various)	List of material held by the Duckworth Laboratory, University of Cambridge. This material includes pottery, bone objects and beads.
1982:42	Carrowkeel	Bone point (2 fragments)	Probably bone pins. Found in Cairn K.
1956:220	Cleavry	Cinerary urn	Cinerary urn containing cremated human bone found in a sand pit
1956: 221	Cleavry	Cremated human bone	Cremated bone found in a cinerary urn in a sand pit
—	Carrownagark	Burials, hammer stone and flint flake.	Record of the discovery of a burial in a gravel-pit.
1961:164	Carrownagark	Trough-like vessel	Wooden trough-like vessel found in a bog with some animal bones in association
1961:165	Carrownagark	Animal bones	Found in association with a trough-like vessel in the bog
1975:4 (IA/138/1974)	Collooney	Iron spearhead (leaf shaped blade)	Found in a field in wet soil churned up by cattle
1913:115	Collooney	Ogival Bronze Dagger	Ogival Bronze Dagger similar to Harbison Type Antrim
1913:111	Collooney	Bronze flanged axehead	Found in 1864. Bronze flanged axehead with bar-ledge stop type.
1964:24	Drumfin	Javelin-head	Barbed and tanged chert javelin-head, found in a bog
1946:93a	Knockmullin	Cremated bones	Found during ploughing beneath stone cist
1946:93	Knockmullin	Pottery sherds	Found during ploughing beneath stone cist
SA 1927:901(a-h)	Lecarrow	Some decorated potsherds, human burnt and unburnt bones, worked antler and/or bones, flat end scraper	—

NMI Reg No.	Townland	Find	Notes
		and bone pin or needle	
1929:1406	Lisconny	Polished stone axehead	Found in bed of river
1992:47	Markree Demesne	Bronze spearhead	Bronze spearhead found in the River Arrow while diving
1957:346 & 347	Spotfield	Two leather shoes	Found during turf cutting
1984:118	Whitehill	Polished stone axe	Found at an unknown depth in a bog

15.3.2.3 Previous Archaeological Work

A search was made of the excavations bulletins and the NRA excavation database for reference to past licensed archaeological investigations in the vicinity of the *Proposed Road Development*.

There were 12 entries for work carried out within the relevant townlands. Archaeological discoveries were made on several sites; none of these sites are being impacted by the *Proposed Road Development*. The 1989 assessment of a site in Lecarrow revealed a possible oval enclosure abutting a ringfort. Monitoring in the vicinity of the church in Collooney revealed a possible graveyard and ditch. An unusual bank was identified during testing and monitoring of a site in Carrowkeel. Several other investigations did not lead to the identification of any archaeological features or finds. Archaeological test excavation undertaken at Drumderry in the field adjoining the ringfort (SL034-178) revealed nothing of archaeological interest. Monitoring carried out at Shreeveragh and various other townlands (did not reveal anything of archaeological significance. The Curlew-Mountain Project revealed the remains of six *fulachta fiadh*, which were preserved *in situ*. (see Appendix 15.3 of volume 4 for details on all entries).

Table 15-5: Archaeological investigations undertaken in the study area

Licence No.	Excavation Ref	Townland	Type	Notes
03E1243	2003:1637	Cloghoge Lower	No archaeological significance	Testing revealed nothing of archaeological significance
01E0565	2001:1152	Bricklieve, Castlebaldwin	No archaeological significance	Testing revealed nothing of archaeological significance
04E1574	2004:1515	Drumderry	No archaeological significance	Testing revealed nothing of archaeological significance
02E1763	2002:1661	Sheerevagh	No archaeological significance	Monitoring revealed nothing of archaeological significance
02E0821	2002:1681	Tawnagh	No archaeological significance	Monitoring revealed nothing of archaeological significance
—	1989:086	Lecarrow	Ringfort with enclosure	Identification of a ringfort and an oval enclosure
03E1709	2003:1655	Kilmorgan	No archaeological significance	Testing revealed nothing of archaeological significance
03E1858	2003:1656	Kilmorgan	No archaeological significance	Testing revealed nothing of archaeological significance
03E0669	2003:1626	Carrowkeel	Unknown	A possible bank was identified during testing and monitoring which may relate to an area of decorative trees
05E0305	2005:1354	Various	Monitoring	Monitoring revealed nothing of archaeological significance
94E127	1994:204	Collooney	Church site	Monitoring in the vicinity of a church and mill revealed a possible graveyard and ditch
99E0652	1999:787	Collooney	Infantry barrack,	Testing in the vicinity of a possible infantry barrack did not reveal anything of

Licence No.	Excavation Ref	Townland	Type	Notes
			possible	archaeological significance
00E0383	2000:0882	Old Street, Collooney	Medieval urban	Further testing on this site confirmed the findings of previous investigations (94E0127)
02E1081	2002:1658	Rathrippin	No archaeological significance	Testing revealed nothing of archaeological significance
98E0202	1998:569	Curlew Mountains Project	Fulachta fiadh	Monitoring revealed six fulachta fiadh all of which were preserved in situ

15.3.2.4 Cartographic Analysis

15.3.2.4.1 *The Proposed Road Development on 1st edition Ordnance Survey Map, Co. Sligo Sheets 26, 27, 33 and 34 (1837-42)*

This mapping shows several features of note with regard to the built heritage (see Fig. 3 a-d of Appendix 15.8 in volume 4). In Toberbride townland the ecclesiastical site SL026-026 (CHC 2) is labeled Tober Bride; however, the rath and souterrain are not marked. Two vernacular buildings in Toberbride are also shown (CHC 3 and 6). Several vernacular building (CHC 9, 10, 11, 13) in Toberscanavan in Mullaghnabreena townland are marked. To the southeast of Toberscanavan at the location of a proposed pond at c. Ch. 1,050- 1,140m a mill is located within the Fair Green (CHC 12). The vernacular building (CHC 18) in Ardcurley townland is shown.

In Cloonamahan the recorded ringfort SL026-077 (CHC 23) is shown as a simple enclosure and a small rectangular building is shown on the site of the structure (CHC 24) indicating it is at least early 19th century in date. The townland boundary between Ardcurley and Doorly (CHC 25) has been straightened considerably since the time of the 1st edition map and a series of field boundaries shown on this map have since been removed.

In Doorly a number of small rectangular buildings are also depicted (CHC 26, 28, 31 and 33) but these don't appear on later maps so they may have been abandoned in the intervening years. The sites of structures (CHC 29 and CHC 30) have a different footprint to the buildings that currently stand there, indicating that the original structures have been altered or replaced. In the same townland the flat topped bank (CHC 34) that was noted during the field inspection (see section 15.3.3 below) is shown as a route-way to a group of buildings that no longer exists. Many of the fields shown in this area on the 1st edition map have subsequently been subdivided or their boundaries no longer survive. The ringfort (SL026-103) in Doorly is illustrated 152m to the northeast of the *Proposed Road Development*.

The townland boundary between Doorly and Knocknagroagh (CHC 37) is a stream. This stream runs in a northeast-southwest direction. Just north of the townland boundary but within Doorly townland an area of wetland or marsh is depicted and was deemed to be an Area of Archaeological Potential (CHC 36) being the location of a proposed constructed wetlands attenuation pond at c. Ch. 3450-3590m.

In Knocknagroagh two structures, presumably a dwelling house and an outhouse (CHC 39) are depicted, enclosed within a small field located to the northeast of the *Proposed Road Development* at c. Ch. 4,040m, southeast of the proposed realignment of the L-55016-0 and immediately northwest of a proposed access route to the pond at c. Ch. 4,160-4,300m. The dwelling fronts onto the existing local road L-55016-0 that links to the N4 and the outbuilding behind it is accessed by a short avenue. The northern field boundary is depicted as a tree line.

The location of the proposed constructed wetlands attenuation ponds at c. Ch. 4,160-4,300m and associated access route in Knocknagroagh townland is a large field and extends into two smaller fields to the north. The northern field has a row of trees marking its eastern boundary and a lane is shown running eastwards from the southern end of this field to provide access to the adjoining dwelling (to the east of the proposed ponds) and further east to the road. Two additional vernacular buildings (CHC 40 and 41) are depicted to the west of the *Proposed Road Development*. The boundary between the townlands of Knocknagroagh and Drumfin (CHC 44) that crosses the *Proposed Road Development* at c. Ch. 4,430-4,470m is shown as a stream.

Proposed constructed wetlands attenuation ponds at c. Ch. 4,830-5,080m and the associated access route in Drumfin are located near Lough Corran, which on the 1st edition map is shown as occupying a larger area than

it presently does. The area must have been wet ground at the time of the mapping (CHC 45) since there are also fewer drainage channels in the area than are present today though- it is shown as wetland or marsh on the mapping.

The Spoil Repository and Borrow Pit (SR-LI-01 and SR/BP Type 2 No. 01) is a long linear area located adjacent to the Proposed Road. Other than a field boundary that has since been removed there are no features of note shown within this area. Spoil Repository and Borrow Pit (SR/BP Type 02-02) and Spoil Repository (SR-LI-02) also lie within this area of uncultivated ground/bog land (CHC 45) to the southwest of Boathole Lough. These areas are located to the west of the village of Drumfin, in the townland of the same name and to the south of the road (L-5502-0). The land to the west of this area is subdivided into several fields, indicating that it is more suited to farming.

In Drumfin the early 19th century dwelling structure (CHC 47) is shown on the 1st edition map. The proposed ponds at c. Ch. 6,380-6,580m in Drumfin are located in the fields to the northwest of the local road L-1502-32. The two proposed Spoil Repositories (SR-LI-03 and SR-LI-04) in this townland are located within a large area of marshy land (CHC 49). A northwest-southeast orientated townland boundary (CHC 48) runs across the proposed pond and the two Spoil Repositories. The proposed constructed wetlands attenuation pond at c. Ch. 7,680-7,850m and associated access route in Carrownagark are located in an area to the north of a tributary of the Unshin River. The map shows an earlier arrangement of field boundaries that have since been altered. No other features of note are shown at this location. Further south in the same townland a laneway is shown running from a farmhouse, on the east side of the *Proposed Road Development*, along the line of the parallel linear banks CHC 51 identified during the field inspection (see section 15.3.3 below). The ring forts (SL034-008-001;-002 and SL034-011) which are located in the same townland to the west of the *Proposed Road Development* respectively are illustrated on this map.

In Kingsbrook the linear bank (CHC 55) identified during the field inspection is shown as a field boundary on the map. The location of the proposed pond at c. Ch. 8,760-8,870m in Kingsbrook is shown as an area of marshy ground (CHC 56) within a large field to the north of Cuilleencroobagh Lough. On the 1st edition map Cuileencroobagh Lough covers a larger area on this map than it occupies today. Two quarries are illustrated to the southeast of the area, on the eastern side of the existing N4. The early 19th century structure (CHC 57) in Kingsbrook is shown on the 1st edition map but the road L-54033-0 post-dates this map.

The land to the northwest of Aghalenane Lough, in the townland of the same name is largely undrained unenclosed marsh (CHC 59). The earthen bank in Aghalenane (CHC 61) that was identified during the field inspection is shown as a field boundary. The proposed pond at c. Ch. 9,330-9,440m is located in an area of open ground to the west of the marshy ground around the lough. The field boundaries in the area of the proposed pond at c. Ch. 10,000-10,120m in Aghalenane remain unchanged today from those shown on the 1st edition map and the proposed location of the Constructed Wetland area/constructed wetlands attenuation pond is not marked as wetland (CHC 62).A small rectangular building (CHC 64) is located to the south of this area.

The 1st edition map depicts a group of small rectangular buildings (CHC 67) that no longer exists, located c. 40m south of the townland boundary between Ardloy and Springfield (CHC 66), where this boundary makes a right-angled turn to the south. The townland boundary (CHC 66) traverses the proposed location of a Spoil Repository and Borrow Pit (SR/BP Type 01-01). Another former structure (CHC 70) is shown on this map, west of the Springfield/Tawnagh townland boundary (CHC 71). The map shows a number of field boundary kinks in Tawnagh in the area around the site of the possible enclosure (CHC 72) (noted from the aerial photography – see section 15.3.2.6 below). An early routeway, the probable Mail Coach Road (CHC 74) in Cloonymeenaghan, is shown running c. 50m west of the ringfort (SL034-112) in Tawnagh (CHC 75). A group of small buildings (CHC 76), no longer extant, are depicted at the point where the proposed route meets the probable Mail Coach Road (CHC 75).The Spoil Repository and Borrow Pit (SR/BP Type 01-03 and SR/BP Type 2 No.3) are located in large fields covering much of the centre of the townland.

The townland boundary between Cloonymeenaghan, Sheerevagh and Cloongad (CHC 79) crosses the road corridor at c. Ch 12,240-12,290m. Some of the fields in this area are depicted as wetland or marsh and may have archaeological potential (CHC 78 and 82). Greyfort Cottage is shown c.200m to the northeast of the *Proposed Road Development* and a wooded area/ orchard is illustrated to the northeast of the cottage.

The proposed ponds in Sheerevagh at c. Ch. 12,370-12,520m are located in a large field c. 120m to the west of Greyfort Cottage and north of vernacular building (CHC 51). Several ring forts are clearly shown in the

surrounding area on the 1st edition map. There are six of these sites to the northeast of the *Proposed Road Development*, the closest of which are SL034-176 and SL034-126, which lie c.200m to the northeast. Two more ringforts (SL034-177; -178) are located c. 180m further southeast and c.400m to the west is another site (SL034-117). Quarries shown on the mapping are located to the east and the southeast of the *Proposed Road Development*.

In Drumderry a building or cabin is shown on the site of the early-mid 19th century structure (CHC 84). The cross roads where the village of Castlebaldwin is now situated is shown as a group of half a dozen small buildings or cabins. The 17th century house (CHC 99) which gives the present village its name is shown and named as 'Castlebaldwin'. No features are shown at the location of the proposed roundabout at c. Ch. 13,600-13,670m, although the road linking from the roundabout to the existing N4 crosses the townland boundary between Castlebaldwin and Cloghoge Upper (CHC 92). The northeastern link road to the L-1404-0 runs along the line of the boundary (CHC 90) between the townlands of Ballanagarrigeeney or Castlebaldwin and Drumderry and the townland boundary between Drumderry, Cleavry and Cloghoge Upper (CHC 88). It then turns north-eastwards and cuts across the boundary between the townlands of Drumderry and Annaghcor (CHC 87). A proposed adjoining link running south-eastwards to the L-1403-0 runs across the location of houses (CHC 85 and 86) shown on this map. The former is a rectangular structure with its long axis fronting onto the L-1403-0. The latter comprises two structures one facing onto the L-1401-0 and the other is a smaller structure fronting onto the L-1403-0. Neither of these structures is extant but there may be below surface foundations and associated features surviving at these locations.

A northwest-southeast orientated field boundary, that has since been removed, is shown running across proposed Landscape mitigation area (LS. Mit-01). The field boundary is located at the bend in the road L-1404-0. Interestingly, part of a road that is no longer extant is illustrated running eastwards across the existing N4 and into the proposed Landscape mitigation area (LS. Mit-01). This section of road runs along the line of the townland boundary between Cloghoge Upper and Cleavry and stops at the townland boundary with Drumderry, Ballanagarrigeeney or Castlebaldwin (CHC 88) and is shown only as a dashed line to the east of that boundary. The line of that road equates roughly with the modern field boundary that extends from the existing N4 as far as the townland boundary in this area.

The Landscape Mitigation Area (LS Mit 02) occupies several fields, however, the field boundaries shown on this map vary somewhat from the present field boundaries at this location. The boundary around the second field from the north is defined by a series of large trees. That field is a smaller more regularly-shaped area than the field that presently occupies this location. The two southern fields are shown as areas of wetland/marsh.

The ringfort in Castlebaldwin SL034-184 (CHC 98), located to the east of the *Proposed Road Development*, is depicted as a hachured enclosure. In Cloghoge Upper the three named holy wells recorded monuments SL034-186-001; 002; 003 (CHC 96) are shown as 'Tober Bride', 'Tober Murry' and 'Tober Patrick'. The enclosure located in the townlands of Cloghoge Upper and Cloghogue Lower recorded monument SL034-191 (CHC 100) is not shown on the 1st edition map. The proposed ponds in Castlebaldwin at c. Ch. 13,940-14,080m are located within an area shown as boggy ground (CHC 89) that is 'liable to floods'. The northern field boundaries have been altered from those shown on this map. The 19th century structures (CHC 94) are depicted on this map and are located west of the N4.

15.3.2.4.2 *The Proposed Road Development on the 2nd edition Ordnance Survey Map, Co. Sligo Sheets 26, 27, 33 and 34 (1885)*

Some changes to the area of the *Proposed Road Development* are indicated on the 2nd edition map. In Toberbride townland the complex of buildings (CHC 06) is still evident. The mill (CHC 12) to the southeast of Toberscanavan village is also depicted. In the townland of Cloonamahan a small rectangular building is shown on the site of the early 19th century structure (CHC 24) In Doorly the small rectangular structures depicted on the 1st edition on the sites of (CHC 31), and (CHC 32) are no longer shown. The routeway along the flat topped bank (CHC 34) is shown.

In Drumfin a field boundary is shown along the linear banks (CHC 51), identified from the field inspection.

The structure in Kingsbrook (CHC 57) is shown on the 2nd edition map. The vernacular building (CHC 64) is also depicted on this map; however, the two buildings (CHC 67 and 70) are no longer evident. This map also shows a number of field boundary kinks in the area about the site of the possible enclosure CHC 72 (noted from the aerial photography) in Tawnagh.

The group of small buildings (CHC 76) depicted on the 1st edition map at the point where the proposed route meets the early routeway (CHC 74) in Cloonymeenaghan have been removed by the publication of the 2nd edition map. Many of the fields shown in this area on the 2nd edition map have been enlarged and changed from those shown on the 1st edition.

The early-mid 19th century structure in Drumderry (CHC 81) and the stone wall field boundary (CHC 83) in the same townland are shown on the 2nd edition map.

The village of Castlebaldwin is not named on the 2nd edition map; however the map shows a 'Constabulary Barracks' on the northwest corner of the crossroads. The 17th century house (CHC 99) which gives the present village its name is shown and named as 'Castlebaldwin'. The ringfort recorded monument SL034-184 (CHC 98) is depicted as a hachured enclosure on this map.

The three holy wells Recorded Monument SL034-186 (CHC 96) are named 'Tober Bride', 'Tober Murry' and 'Tober Patrick'. The Recorded Monument enclosure SL034-191 (CHC 100) is not shown on the 2nd edition map.

15.3.2.4.3 *The Proposed Road Development on 25" map (1899-1913 www.osi.ie) and the 3rd edition Ordnance Survey Map, Co. Sligo Sheets 26, 27, 33 and 34 (1911).*

A study of the revised edition maps shows several notable changes to the areas within the *Proposed Road Development* (see Fig. 4 a-d of Appendix 15.8 in volume 4).

In Toberbride townland the ecclesiastical site SL026-026 (CHC 2) is labeled Toberbride (site of). The southern and westen part of the enclosure is also hachured and the souterrain is labeled 'Caves'. The vernacular buildings (CHC 3, 5 and 6) in Toberbride are also shown. The mill and Fair Green to the southeast of Toberscanavan village in Mullaghnabreena Townland are no longer evident- the buildings (CHC 11) are no longer marked. A series of field drainage channels extant on the site of the proposed pond at c. Ch. 2,060-2,230m in Ardcurley are shown on this map. This indicates that the land improvement works were undertaken in the intervening years. The vernacular buildings (CHC 26, 28, 31 and 33) in Doorly townland are no longer indicated. The dwelling (CHC 32) has been built in the intervening years and there is a second dwelling to the southeast.

The field boundaries in the area of the proposed ponds at c. Ch. 3,450-3,590m in Doorly/ Knocknagroagh have been altered from those depicted on the 1st edition. An additional field has been created and some land improvement works have also been undertaken since the area is no longer shown as marsh. The mill and eel weir located on the river to the east of this site that were labelled on the earlier map are not shown on this edition.

There have been alterations to the 19th century structure in Knocknagroagh (CHC 39) is the site of this former structure), and its enclosing field boundary. The structure is now set further back from the road and it would appear either that it was rebuilt or that the northern structure was extended. The field boundary has been reduced in size and the trees along the former northern boundary have been felled. The field boundary to the west of this structure has been extended and the small structure that formerly stood at the end of the shorter laneway is no longer extant.

The townland boundary to the north of the ponds at c. Ch. 4,160-4,300m in Knocknagroagh has been altered since the 1st edition map. It follows the line of the stream that runs along the eastern side of the proposed ponds – the alignment has remained unchanged since that time. The location of the ponds has been sub-divided into a number of fields and those field boundaries remain largely unaltered from this time, although a boundary along the northern field shown on this map has since been removed.

The dwelling shown to the east of the *Proposed Road Development* at c. Ch. 4,950m and the associated access route in Drumfin on the 1st edition map is not illustrated on this edition and it must have been removed in the interim period. A series of drainage channels have also been created in this time.

Proposed Spoil Repositories and Borrow Pits (SR-LI-01, SR-LI-02 and SR/BP Type 02-No. 2) are now divided by the recently constructed road leading west from Drumfin. The culvert (CHC 46) was probably built at this time.

The proposed ponds at c. Ch. 6,380-6,580m are located in the second field to the northwest of the L-1502-32 and their location spans three field boundaries on the northeastern side of the townland boundary between Cloonlurg and Drumfin (CHC 48).

An area of marshy ground (CHC 49) c. 400m to the southeast of the proposed pond occupies the proposed Spoil Repositories (SR-LI-03 and SR-LI-04). A series of new field boundaries and drainage channels are shown in this area on this map. The field boundaries in the area of the proposed pond at c. Ch. 7,680-7,850m and associated access route in Carrownagark have been altered since the draughting of the earlier map but remain unchanged today from those illustrated on the map.

There is little change from the 1st edition map at the location of the proposed pond at c. Ch. 8,760-8,870m in Kingsbrook. This is shown as an area of marshy ground (CHC 56) within a large field to the north of Cuilleencroobagh Lough and the lough covers a much bigger area than that of the modern lake.

The road L-54033-0 is illustrated on this map and a system of drainage channels have been created in the area to the north of Aghalenane Lough. One such channel /field boundary runs northeast-southwest across the location of the proposed pond at c. Ch. 9,330-9,440m. A new field boundary has been created at the location of the proposed access route to the north of the existing road.

The field boundaries in this area remain unchanged and the proposed location of the Constructed Wetland area/constructed wetlands attenuation pond at c. Ch. 10,000-10,120m is shown as marshy ground (CHC 62) on this map. The dwellings (CHC 64, 67, 70 and 76) are no longer evident. Dwelling (CHC 65) has been built in the intervening years.

The layout of Greyfort Cottage in Sheerevagh townland and its associated field boundaries to the north of the proposed ponds at c. Ch. 12,370-12,520m have been noticeably altered since the 1st edition map. A new field boundary has been created to the southwest of the cottage and the area to the west of this boundary is shown as marsh. This field boundary is still intact and is within the proposed area. The proposed access road also cuts across the townland boundary between Sheerevagh and Drumderry (CHC 80). Greyfort cottage is no longer standing and the associated woodland/orchard has been felled. A new structure is shown to the southeast of where the cottage had stood. This rectangular structure is accessed from the same driveway that led to the cottage and is built to the southeast of an existing structure depicted on the earlier map. The land to the south of the stream forming the townland boundary has been further subdivided and the small square structure that had been shown in the field to the south of the area has been removed.

The footprint of the house (CHC 86) at c. Ch. 200m (of access road) at the location of the proposed adjoining link running south-eastwards to the L-1403-0 has been altered from that shown on the earlier map. Drainage channels have been cut along the field boundaries at the location of the proposed ponds at c. Ch. 13,940-14,080m since the 1st edition map and this ground is no longer shown as marsh or 'liable to flood'.

The road shown in the Landscape Mitigation Area (LS. Mit-01) on the 1st edition map is no longer extant, but the townland boundary (CHC 88) is still shown at this location. One structure (CHC 95) is shown within the proposed Landscape Mitigation Area (LS. Mit-02) on this map that was not present on the 1st edition and are no longer extant. The 19th century structures (CHC 94) are depicted on this map and one is labelled a post office.

15.3.2.5 Toponyms

Some of the townland names give an indication of the type of topography of the area, with many of the placenames referring to hills or ridges (Table 15-6). These include place names beginning with *Ard-*, meaning a height, *Drum-*, meaning a ridge, or *Cnoc,* meaning hill, such as Drumderry (Ridge of the derry or oak wood) and Drumfin (White ridge) and Knocknagroagh (hillock of the sheep, ricks or stacks). Placenames such as Annaghcor (marsh of the herons or cranes) and Ballanagarrigeeney (Mouth of the ford of the small rocks) give an indication of the wetlands and rivers that are common features in the study area.

The placenames also give an indication of the type of land and land-uses in the region. There are several placenames which begin with *Cloon-*, meaning meadow, suggesting that at the time when these placename originated much of this area was already open land.

The placenames may also refer to potential archaeological sites. Townlands beginning with *Lis-* meaning fort are plentiful. Such names include Lisconny (Fort of firewood) and Lissycoyne (O'Coan's fort). The placename Knockadoo (Hill of the mound) probably refers to the large cairn on the summit of the hill. The placename Kilmorgan (Kilmorgan) indicates that there may once have been a church in this area.

Table 15-6: Topoynms within the study area

Townland	Origin	Derivation	Meaning
Aghalenane	Irish	*Achadh Leanáin*	Field of the lemanor concubine
Annaghcor	Irish	*Eanach Corr*	Marsh of the herons or cranes
Ardcurley	Irish	—	Hill of 'curley'
Ardlee	Irish	Árd laogh	Hill of the calves
Ardloy	Irish	*Ard Laigh*	Hill of the loy or spade
Behy	Irish	Beithe	Birch, birchland
Bellanagarrigeeny	Irish	*Beul Atha na g-Carraiginigh*	Mouth of the ford of the small rocks
Carrowkeel	Irish	*An Cheathrú Chaol*	Narrow quarter
Carrownagark	Irish	*Ceathramh na g-cearc*	Quarter of the hens (grouse)
Castlebaldwin	English	—	Relates to the 17th century house reputed to have been owned by the Baldwin family
Cleavry	Irish	*Cliabhraigh*	Baskets
Cloghoge	Irish	*Clochóg*	Small stones- generally applied to stony land
Cloonamahan	Irish	*Cluain-na meathan*	Meadow of the oak slits for sieves'
Clooneen	Irish	Clúinín	Small lawn or meadow
Cloongad	Irish	*Clún gad*	Lawn of the gads or withers
Cloonlurg	Irish	*Cluain Lorg*	Plain or lawn of the tracks
Cloonymeenaghan	Irish	*Clun Ui Mhaoinneachan*	O'Minaghan's lawn or meadow or lawn
Collooney	Irish	*Cúil Mhuine*	Recess of the bald/hornless cow
Coolbock	Irish	*Cúlbhaic*	Back of the bend
Coolteen	Irish	*Cúiltín*	Little corner
Cooperhill or Gobbadagh	—	—	—
Doorly	Irish	*Duirle*	Hard ground
Drumderry	Irish	*Drom Doire*	Ridge of the derry or oak wood
Drumfin	Irish	*Drum Fionn*	White ridge
Kilmorgan		Cill Murchain	Morgans church
Kingsbrook	English	—	—
Knockadoo		Cnoc A' Dumha	Hill of the mound
Knockbeg	Irish	*Cnoc beag*	Small hill
Knockmullin		Cnoc a mhuillinn	Hill of the mill
Knocknagroagh	Irish	*Cnuicín na gcaerach or Cnoc-na-gcruach*	hillock of the sheep or hillock of the ricks or stacks
Lackagh	Irish	Leacac	hill side or land of flag stones

Townland	Origin	Derivation	Meaning
Lecarrow		Leath Cheathramh	Half quarter
Lisconny	Irish	*Lios-conaidh*	Fort of firewood
Lissycoyne		*Lios Ui Choáin*	O'Coan's fort
Markree Demesne	—	—	—
Mullaghnabreena	Irish	*Mullach-na-bruidhne*	Summit of the *breen* or fairy palace
Murillyroe		*Muirchille-ruadh*	Red Sleeve
Newpark	English	—	—
Ogham		Ocham	Crooked yew
Rathrippin	Irish	—	Rippin's ? Fort
Sheerevagh	Irish	*Sídh/Sidh riabhach*	Grey hill or fort
Springfield	English	—	—
Spotfield	English	—	—
Tawnagh	Irish	*Tamhnach*	A mountain field
Toberbride	Irish	*Tobar Bríghde*	St. Bridget's church or well
Whitehill	English	—	—

15.3.2.6 Aerial Photographs

The line of the proposed route corridor was inspected using colour aerial photographs provided by Sligo County Council Roads Design Office (Scale 1:5000) as well as high altitude black-and-white aerial photographs from the Geological Survey of Ireland and aerial photographs on the OSI website (http://maps.osi.ie). The photographs were consulted in order to identify any anomalies that may indicate previously unknown cultural heritage sites.

No features of archaeological potential were noted on the aerial photographs for Spoil Repository areas, nor within the location of the proposed ponds. Three possible archaeological features were noted along the line of the proposed route.

In Doorly townland the site of a possible sub-circular enclosure (CHC 35) (approx. diameter 48m) was identified from the aerial photographs in the middle of a small pasture field due east of a ringfort - rath/cashel Recorded Monument (SL026-103) that lies over 150m from the *Proposed Road Development*. The proposed route passes through the location of this possible enclosure (CHC 35) at Ch. 3,000m. The field inspection revealed no visible trace of this possible enclosure. The historic cartographic analysis also failed to identify any relevant evidence for this possible enclosure.

In Tawnagh townland the site of a possible sub-circular enclosure (CHC 72) (approx. diameter 25m) was identified situated directly in the line of the proposed route at Ch. 11,040m. It was identified in the southeast corner of a large pasture field beside a kink in a field boundary. This overgrown hedge and bank field boundary is situated at the shoulder of a west facing drumlin hill. The site of the possible enclosure was visited during the field inspection up slope from the field boundary (Plate 61 & 62). Whilst the field inspection noted the kink in the field boundary no trace of an enclosure was visible on the ground. Apart from the field boundary kink the historic cartographic analysis revealed no evidence for this possible enclosure.

Another possible enclosure was identified from aerial photography examination in Cloonymeenaghan Townland (CHC 77, Plate 68). There are no above ground traces of this site which lies partly within the line of the *Proposed Road Development*.

15.3.2.7 Architectural Heritage

The Record of Protected Structures (RPS) in the County Sligo Development Plan 2011-2017 and the National Inventory of Architectural Heritage (NIAH) were consulted to establish the presence or absence of any protected structures on or adjacent to the *Proposed Road Development*.

There are no RPS protected structures or NIAH listed structures directly impacted on by the *Proposed Road Development*. The closest RPS Protected Structure is the Former Castlebaldwin National School (RPS 138; CHC 91), which is situated c. 20m to the west of the proposed Landscape Mitigation Areas (LS-Mit-01 and LS. Mit-02). For details of RPS in the broader study area see Appendix 15.4 of volume 4. The 17th century fortified house at Castlebaldwin (CHC 99) is listed on the NIAH (NIAH 32403404) and shall be c. 130m distant from the *Proposed Road Development*. Situated within 1km of the *Proposed Road Development* are a further 11 RPS protected structures and 7 NIAH listed structure (see Appendix 15.4 of volume 4).

The northernmost part of the proposed road is located c. 250m to the southwest of the historic boundary of Markree Demesne (CHC 08, see Fig. 15.2.1 of volume 3). There are several protected structures associated with the Demesne (RPS 294-304) including Markree Castle, gates and gate lodges, a gardener house, a stable, an ice house, a bridge, an observatory and a group of estate cottages. The *Proposed Road Development* does not encroach into the demesne grounds, nor does it impact on any part of the demesne boundary or the associated features and it will not be visible from the main house, Markree Castle.

All upstanding pre-1950 buildings within 50m from the edge of the proposed road take were given a cultural heritage constraint (CHC) number. The majority of the structures visited along the line of the proposed route are (or were) associated with the small farms that are a feature of the landscape. Many of the structures visited are former dwellings that are now either derelict or used as storage.

A three bay, two storey early 19th century dwelling (CHC 3) is located just west of the proposed road at c. chainage 150m in Toberbride. To the south of this is a former early 20th century dwelling (CHC 5) which is currently being used as a barn. A number of buildings were identified in the clustered settlement of Toberscanavan in Mullaghnabreena Townland. A series of early 19th century buildings (CHC 9) are situated on the western side of the current N4. Just south of these is the protected structure (CHC 10, RPS 202) known as Toberscanavan House. On the opposite side of the current N4 and on the site of the proposed pond at c. Ch 1,050-1,140m is a derelict early 19th century dwelling (CHC 13).

In Ardcurley townland there is a dwelling and farm building which appear on the 1st and 3rd edition maps (CHC 18). South of this there are two identical iron gates with dressed stone piers (CHC 20 and 22). These are probably 19th century in date and may be related to entrance routes leading to Markree (CHC 08) Demesne though they are outside the boundaries of the demesne itself. A five bay one storey derelict early 19th century dwelling, (CHC 24; Plate 19) is located about 35m from the western edge of the road in Cloonamahan.

In Doorly near the northern end of the *Proposed Road Development* where the proposed route leaves the existing road and cuts across green field, there are a number of CHC architectural heritage structures. On the western edge of the road are the remains of possible gateway or structure consisting of two parallel walls of several courses of stone (CHC 27; Plate 21). On the east side of the current N4 road is an early 19th century bungalow that has been modernised (CHC 29; Plate 22). On the west side of the proposed route is an unoccupied early 19th century one-storey farm dwelling (CHC 30; Plate 23) which is set back off the main road via a tree-lined drive. Lying to the east of the road take is an unoccupied early 20th century one-storey dwelling (CHC 32; Plate 25). The proposed road then cuts through the line of an old routeway and the former site of a dwelling (CHC 34 & 33) to the west of a mid-late 19th century one-storey stone built structure formerly a dwelling, (that lies just over 50m east of the proposed road).

Several dwellings were identified in Knocknagroagh townland. An old school house (CHC 38) is located at the junction of the existing N4 and the L-55016-0 at the proposed pond site. Further southwest along the L-55016-0 there are two other early 19th century structures. CHC 40 has been modernised while CHC 41 is being used as farm buildings.

The proposed route passes to the east of an early 19th century unoccupied dwelling in Drumfin (CHC 47; Plate 38). This structure is a one-storey cottage and later extension, roofed in corrugated iron, currently being used as storage and shelter for livestock. Further south in Kingsbrook there is a double gate with a stone wall extending partially into the field (CHC 54) and west of this is an early 20th century dwelling which has been modernised (CHC 53). The route passes to the west of an unoccupied row of early 19th century one-storey farm

buildings (CHC 57; Plate 51). Further south in Aghalenane townland there is an early 20th century dwelling which is still occupied (CHC 65). A little to the southwest of the proposed route in Springfield is a late 19th century farm dwelling (CHC 69; Plate 60).

In Tawnagh the proposed route passes through the probable line of an early road (CHC 74; Plate 64 & 65), identified from cartographic and documentary sources as a section of the early 19th century Mail Coach Road that ran between Boyle and Sligo towns. A section of this old road CHC 74 is identifiable in the metalled laneway (Plate 64 & 65) that runs west past a modern farm yard with a derelict 19th century cottage. In Drumderry, to the west of the proposed route, is an unoccupied early-mid 19th century four-bay two storey farm house (CHC 81; Plate 70). Also in Drumderry the proposed route passes to the west of a derelict early 19th century two storey three-bay farm house (CHC 84, Plate 75).

The proposed route passes to the east of Castlebaldwin village. In Castlebaldwin, c. 40m to the south of the proposed link road to the proposed roundabout is the former National School (CHC 91; Plate 82), included on the Record of Protected Structures (RPS No. 081). Approximately 130m east of the proposed route is the NIAH listed 17th century fortified house ruin of 'Castlebaldwin' (CHC 99/ NIAH 32403404/RMP SL034-185/ National Monument 373- Plate 86). On the west side of the existing N4 road is a derelict and overgrown early 20th century creamery building (CHC 97) behind which is a group of three holy wells that are recorded monuments (CHC 96; Plate 87).

15.3.3 Field Inspection

Several field inspections were conducted on the *Proposed Road Development* over the years as alterations and amendment were made to the road alignment and associated permanent work areas. The initial field inspection was carried out over three days, 7th-9th November 2005. The weather was very wet on the first day which necessitated the abandonment of the inspection for that afternoon. The following two days were bright, cold and dry. On the third day of the field inspection a visit was made to the northern end of the Bricklieve Mountains in order to assess the likely visual impact, if any, the proposed route will have on the passage tomb cemetery at Carrowkeel. A second field inspection was carried out on the 12th November 2009. The weather was wet but bright. The aim of the second field inspection was to visit any areas where the proposed route was modified, enlarged or added to, since the initial field inspection.

A further field inspection specific to the assessment undertaken in relation to the 'Spoil Management Report' on 8th December 2011, when the weather was dull and showery. The Spoil Repository Area (SR-LI-01) was inspected. A third field inspection covering the areas of proposed design changes, including the road alignment, link roads and roundabouts as well as soil infilling areas and constructed wetland areas was carried out in cold, overcast mainly dry conditions on 29th November 2012. Carrowkeel Passage Tomb cemetery and the Landscape Mitigation Areas (LS. Mit -01 and LS. Mit-02) were re-visited on May 21st 2013. A further field inspection was carried out on the 24th of June 2013 and included visits to several proposed ponds and Spoil Repositories.

The aim of these field inspections was to visit each area in order to assess it for archaeological, architectural and cultural heritage potential and establish whether the proposed works will impact any built heritage features. All features or sites of potential built heritage merit within 50m of the area were assigned a Cultural Heritage Constraint number (CHC) and Recorded monuments within 100m were assigned CHC numbers. In addition, the following were given CHC numbers: areas of wetland archaeological potential, townland boundaries, stream and river crossings, upstanding buildings pre-1950 in date and any other features that were considered to be of cultural heritage merit.

15.3.3.1 Field Inspection of the *Proposed Road Development*

The mature conifer plantation from c. Ch. 6,900-7,450m was too dense to walk through and some of the wetland areas were too wet and overgrown to traverse in full, but access to the other areas was possible.

The northern end of the *Proposed Road Development* follows the line of the existing N4 road with new access roads in Toberbride townland. At c. Ch. 2600m the proposed route leaves the existing N4 and continues to the west of it.

The field inspection commenced in the townland of Toberbride at the northern end of the proposed route south of Collooney at c. Ch. -100m. In Toberbride at c. Ch. -40m the proposed road is adjacent to a townland boundary of hedgerow type (CHC 01; Plate 1). A little further along the proposed route at c. Ch.-30 to 50m is

an adjacent recorded monument SL026-026 (CHC 02; Plate 2) consisting of a ringfort and souterrain and a holy well site that gives the townland its name '*Tober Bride*'. The site has been designated as a possible ecclesiastical site on the basis of the placename and the extant archaeological features. At c. Ch. 150m the proposed route passes east of an early 19th century dwelling (CHC 03) and at c. Ch. 290m the access road crosses a recorded monument SL026-164 (CHC 04; Plate 3), the site of a possible enclosure in pasture land, which has been levelled, and of which there is now no above ground visible trace. To the east of this is a former early 20th century dwelling (CHC 5) which is currently being used as a barn. At c. Ch. 450-490m there is a townland boundary that the existing road has already truncated (CHC 07; Plate 4). The townland boundary CHC 07 is of earthen bank type with an adjacent drainage ditch, topped in parts by dry stone walling.

At Toberscanavan in Mullaghnabreena Td. in the area of c. Ch. 950-1100m there are several CHC sites. On the eastern side of the proposed route is a small parcel of wetland which is the proposed location of a constructed wetlands attenuation pond. The area for the proposed pond covers three fields. Immediately west of this area and within the land-take of the proposed road is a modern well which was probably built during the upgrading of the current N4 and replaced the well that appears on the 3rd edition OS map from which the placename- Toberscanavan- may derive. This area is generally low lying and quite waterlogged. A stream runs along the west and north of the area forming the townland boundary between Ardcurley and Mullaghnabreena (CHC 14). A vernacular house (CHC 13, Plate 8) with modern extensions is situated in the most western field. This house is visible on the 1st and 3rd edition OS maps. On the 1st edition OS map there are two additional buildings located to the south and southeast; however no traces of these were identified during the site visit. The second field was very waterlogged and had been covered with an infill of large construction stones with piles of these stones visible along the entrance to the third field. This field appears to have been the location of a mill site and fair green (CHC 12) in use in the 19th century and possible earlier, which were marked on the 1st edition OS map. No traces of the mill were evident. The mill is not marked on the 3rd edition map and thus it can be assumed was no longer in use by that time. The third and final field in this area was covered with similar construction material along the southern part of the field and was quite waterlogged to the north in the vicinity of the stream with bullrushes growing. There was evidence of modern dumping of hard material along the southern part of the field. Nothing of archaeological interest was identified. On the west side of the road are two early 19th century two-storey houses, one of which appears to be unoccupied (CHC 09; Plate 5). In proximity to these buildings is 'Toberscanavan House' (CHC 10; Plate 6) which is included as a protected structure (RPS No. 202) in the Record of Protected Structures is a stone built six bay two-storey structure. The property seems to be unoccupied and the roof appears to be intact.

The existing N4 road passes Toberscanavan Lough (CHC 15) on its west side at c. CH. 1,320-1,380m and bisects a townland boundary (CHC 16; Plate 11) at c. Ch. 1,510m. This townland boundary is obscured by a young deciduous plantation. At c. Ch. 1,610-1,670m at the junction of the N4 with a local road L-3606-9, leading past Cloonamahan Gate Lodge, the ground is wetland (CHC 17; Plate 12). The tie in of a local road at this point will involve ground reduction in part of this field. On the east side of the proposed route there is an early 19th century dwelling (CHC 18; Plate 13) at c. Ch. 1,710m, lying within the road take. A little further along the road at c. Ch. 1,830m there is a 20th century roadside memorial (CHC 19; Plate 14) opposite which is a simple wrought iron gate with dressed stone piers (CHC 20; Plate 15). A second and almost identical gate (CHC 22, Plate 16 & 17) is located c. 350m south at c. Ch. 2,180m. This gate way appears to have marked the entrance to a routeway crossing the field in a north-south direction towards the southern lodge of Markree Demesne. This route is visible on the 3rd edition OS map and the outline of this route is still visible. This gate way leads into the proposed site of a constructed wetlands attenuation pond. The field, currently used for grazing, is low-lying with rushes growing throughout. Iris flowers were growing along the edge of a drain running northwest-southeast across the field.

On the western side of the N4 at c. Ch. 2,100-2,240m there are two recorded monuments. The enclosure (CHC 21, SL026-076) at c. Ch. 2,090-2,140m was removed during the construction of the L-14019-0 road. The ringfort SL026-077 (CHC 23; Plate 18) is located in pasture land about 40m from the western edge of the road take at c. Ch. 2,190-2,240m. An early 19th century dwelling, which is derelict, (CHC 24 Plate 19) is located to the western edge of the road at c. Ch. 2,290m. There is a townland boundary (CHC 25) between Ardcurley/Cloonamahan / Doorly at c. Ch. 2,300m. The boundary is formed by mature deciduous trees and hedgerow (Plate 20). A coniferous forest lies to the northeast.

Also in the townland of Doorly located within the proposed road corridor at about Ch. 2,420 there are the remains of a possible gateway or structure consisting of two parallel walls of several courses of stone (CHC 27;

Plate 21). Between c. Ch. 2,600m and 2,900 there are three dwellings and a structure from the 19th/20th century. An early 19th century bungalow which has been modernised (CHC 29; Plate 22) is located on the east side of the current N4 road and an unoccupied early 19th century dwelling on the west side of the road (CHC 30; Plate 23). CHC 30 is set back off the road and has an overgrown tree-lined drive connecting to the main road. Within the field to southeast of CHC 30 beside the existing road is an overgrown gravel extraction pit (Plate 24).

At about Ch. 2,600 the proposed route leaves the existing N4 and continues to the west of it. The land type at this point is rough pasture. The *Proposed Road Development* passes to the west of the early 20th century one-storey dwelling (CHC 32; Plate 25). The proposed route then cuts through a flat topped bank (CHC 34; Plate 26) which has been identified from the 19th century OS maps as an old route way which led to a dwelling which is now destroyed. At c. Ch. 3,000m a possible enclosure (CHC 35; Plate 27) that was identified from aerial photographs is located within the *Proposed Road Development* area in Doorly townland. There are no traces visible above ground of this potential site.

The proposed route then passes through some rough pasture land up to c. Ch. 3,390m at which point the ground becomes wetland which is deemed to be an Area of Archaeological Potential (CHC 36; Plate 28-29). It is proposed to locate a constructed wetlands attenuation pond in the vicinity of this wetland between c. Ch. 3,450- 3,590m. To the south of this wetland area (CHC 36) there is a townland boundary at c. Ch. 3,690m which is a small stream (CHC 37; Plate28). The proposed pond at Doorly/ Knocknagroagh at c. Ch. 3,450-3,590m occupies part of four fields. The townland boundary (CHC 37) runs in a northwest-southeast direction and is marked by a stream/drain. The three southern fields slope to the north and are marshy wetland with some archaeological potential (CHC 36, Plate 28-29). There is a clear hump/raised area (c. 10m by 5m) in the eastern end of the southern field, but there was nothing to indicate that this was an archaeological feature and it is probably topographical in nature. The northern field is better drained and is noticeably greener with grass cover that could be grazed. It is uneven ground.

An overbridge in Drumfin is proposed at c. Ch. 4,020m on the northern side of the existing local road L-55016-0. The proposed realignment joins the existing N4 to the north of the L-55016-0 and the 19th century structure CHC 38 (Plate 30). A pond is proposed at the location of this structure (CHC 38) c. 150m east of c. Ch. 4040m. The location of former 19th century buildings (CHC 39) shown on the OS maps, to the west of structure (CHC 38) was visited and an area of uneven ground was noted at the western end (Plate 31). This uneven ground indicates that it is likely the foundations of these structures remain *in situ*. The vernacular building (CHC 40) has been modernised and the building (CHC 41) is currently used as farm buildings.

The ground south of the local road at c. Ch. 4,070m is rough pastureland which slopes down towards the outflow stream from Lough Corran where the ground becomes steadily wetter. From c. Ch. 4,070-4,790 the ground is wetland and deemed to be an Area of Archaeological Potential (CHC 43; Plate 32). The proposed ponds at Knocknagroagh Ch. 4,160-4,300m are bounded to the east by the townland boundary with Lackagh, which is defined by a canalised stream. The location occupies part of three fields that are currently being grazed by sheep. The southern field is a flat land and is delimited from the adjoining flat field by an east-west orientated drain. The northern field slopes towards the southeast and there are traces of what appears to be an old field boundary running east-west across the centre of this field. This boundary (CHC 42) corresponds with one shown on the 1st edition and 25" OS maps and lies within the road take to the north of the proposed ponds). There are good views of Maeve's cairn megalithic tomb on the summit of Knocknarea far to the north

The outflow stream from Lough Corran forms part of the townland boundary between Knocknagroagh and Drumfin (CHC 44). The proposed route then passes through rough pastureland until it again becomes wetland at about Ch. 5,065m (CHC 45; Plate 33-36). The wetland area of archaeological potential CHC 45 extends for about 500m up to a local road at c. Ch. 5,560m. The proposed pond adjacent to Lough Corran, in Drumfin townland c. Ch. 4,830-5,080m occupies part of three fields that slope westwards toward the lake (Plate 34). These fields are all bounded by deep drainage channels and can be described as wetland (CHC 45). The southern field could not be accessed because it was very overgrown and the drainage ditch between it and the northern field was not readily crossed. Part of the soil in the central field had been exposed revealing black, peaty ground. Nothing of archaeological or architectural interest was noted in these areas but the peaty wetland nature of the land may have archaeological potential. The Spoil Repository Area SR/BP Type 02-No.1 Ch. c. 5,350-5550m is located on this wet, marshy ground (CHC 45), the adjoining Spoil Repositories SR/BP Type 02-No.02 and SR-LI-02 at c. Ch. 5,600 – 5,750m are located in flat, low-lying boggy ground (CHC 45) (Plate 35). At the time of the visit a geotechnical test trench was being excavated and this revealed that there was a

depth of approximately 1m of peaty soil covering the field. A stone lined culvert (CHC 46, Plate 37) was identified at the north of the field which lined up with the northeast-southwest running drain. The culvert ran beneath and extended across the entire width of the existing road (L-5502-0). No archaeological features were identified in these areas, but the boggy ground (CHC 45) may have archaeological potential.

At c. Ch. 5,880m the proposed route passes close to an early 19th century unoccupied dwelling in Drumfin (CHC 47; Plate 38). This structure is a one storey cottage with an extension at one end. It is roofed in corrugated iron and currently being used as a storage shed. The land type along the proposed route from CHC 47 up to the local road L1502-32 at Ch. 6,630m is rough pasture. The proposed ponds at c. Ch. 6,380-6,580m occupy parts of three fields which are in pasture. These fields all slope steeply to the west where there is an area of wetland. As wetland this area has archaeological potential (CHC 49) (Plate 40-41).

Spoil Repository Areas SR-LI-03 and SR-LI-04 occupies the fields at c. Ch. 6,600-6,890m and extending across the existing road L-1502-32, where a realignment is planned. The fields to the south of the existing road are marginal land (CHC 49, Plate 40-41). The land at the eastern side is drier and there is a raised area at the southeastern end of the central field. The townland boundary (CHC 48) (Plate 39) runs across the proposed Spoil Repository Areas and pond. The proposed road realignment will be at a higher elevation than the present road and in the pasture field to the north of the L -1502-32.

The proposed route crosses at c. Ch. 6,730m into a mature conifer plantation which extends for about 450m through the proposed landtake. At c. Ch. 7,350m the proposed route passes through the junction of townland boundaries between Cloonlurg, Carrowkeel and Carrownagark townlands (CHC 50).

The ponds and associated access route proposed at c Ch. 7,680-7,850m occupy parts of four pasture fields that slope down to the southwest, where there is an area of wetland adjacent to a tributary of the river Unshin, but outside the boundary of the proposed ponds. Nothing of archaeological or architectural interest was noted in these fields.

The proposed route runs along the western edge of a drumlin hill, beginning to climb the side of the sloping ground at about Ch. 7,800m onwards. A short distance to the south at about Ch. 7,930m the proposed route passes through a linear feature consisting of parallel low earthen banks (CHC 51; Plate 42) which has been identified from the 19th century OS maps as old laneway and later as a field boundary. The existing field boundaries in this area are of mature coppiced hawthorn and whitethorn bushes with low earthen banks and the fields are in pasture. A double gate with large stone pillars (CHC 54, Plate 46) with a rubble wall extending for approximately 4m into the field where the boundary continued in hedgerow was identified. To the west of the proposed route there is an early 20th century dwelling which has been modernised (CHC 53). At Ch. 8,630-8,680m the proposed route cuts the townland boundary between Carrownagark and Kingsbrook (CHC 52; Plate 43-44) and passes at c. Ch. 8,730m a section of linear earthen bank containing large stones (CHC 55; Plate 47) which has been identified from the 19th century OS maps as an old field boundary.

Between c. Ch. 8,750-8,970m the proposed road-take passes through some wetland (CHC 56; Plate 48-50) which is at the western edge of Cuilleencroobagh Lough. The proposed ponds at c. Ch. 8,760-8,870m occupy this wetland area. The access route associated with these ponds runs across two fields and the townland boundary between Carrownagark and Kingsbrook (CHC 52). The northern field of the link road is marshy ground that slopes to the south and is delimited by the townland boundary). The field to the south of this boundary is drier land that is in pasture. A significant hill rises to the west and there is an area of wetland on the lower ground to the east. The next field to the south is marshy ground. Although the adjoining southern field is also wetland it is not quite as wet and there is a dryland margin around the western edge of this field. The ground is wetter again in the next field to the south and is very overgrown.The proposed route continues through pasture land, along the eastern edge of a steep drumlin hill, where at about Ch. 9,250m the *Proposed Road Development* runs to the west of an early 19th century dwelling (CHC 57; Plate 51).

A proposed link road extending northwards from the L-54033-0 around Ch. 9,310m will occupy a level ridge in the pasture field to the north of that road and the ground in the rest of that field rises significantly to the north of the proposed road alignment (Plate 52). The proposed ponds at c. Ch. 9,330-9,440m occupy the corner of a pasture field. An area of level ground leading into the field from the gate indicates the presence of a farm track (Plate 53). This track (CHC 58) is illustrated on the 25" OS map (1899-1913) but is not shown on the 1st edition and presumably dates to the late 19th/early 20th century.

The *Proposed Road Development* passes over an area of wetland at about Ch. 9,500 for about 240m (CHC 59, Plate 54). The townland boundary between Kingsbrook and Aghalenane (CHC 60; Plate 55) lies at the southern

end of the wetland area CHC 59. The proposed route along this stretch also cuts an earthen bank field boundary (CHC 61).

A proposed pond at c. Ch. 10,000-10,120m will occupy an area of wet marshy ground (CHC 62) to the south of Ardloy Lough and bounded to the north by the townland boundary between Ardloy and Aghalenane (CHC 63). This wetland area is recognised as one of archaeological potential.

The proposed route then curves to the east travelling through an area of pastureland, cutting through a small section of wetland (CHC 62, Plate 56) at c. Ch. 10,000m before crossing the existing N4 road at c. Ch. 10,220m. To the south of this there is an early 20th century dwelling which is still occupied (CHC 65). The proposed route then travels over rising ground to the summit of a small hill where at about Ch. 10,550m the road cuts the townland boundary (bank and hedgerow) between Ardloy and Springfield (CHC 66; Plate 57).The proposed Spoil Repository SR/BP Type 01-No.1 is located on the top of this small ridge and the townland boundary (CHC 66) bisects the area. The proposed route then continues on down the side of the hill into low lying and wetland area (CHC 68; Plate 59-60) between c. Ch. 10,550 - 10,690m. At Ch. 10,740-10,830m the proposed route passes through another townland boundary, which is a stream, (CHC 71). A little to the southwest of the proposed route is a late 19th century dwelling (CHC 69; Plate 60). The Spoil Repository Area SR/BP Type 01-No.2 is located just east of the townland boundary (CHC 71) at c. Ch 10,830-10,980m. This area is situated on a small ridge currently used for grazing. Nothing of archaeological interest was identified in this area. However, to the east of the Spoil Repository Area at c. Ch. 11,040m on the shoulder of this hill a potential enclosure site (CHC 72; Plate 61-62) was identified from the field inspection and aerial photographic analysis as a kink in an overgrown hedge and bank field boundary. The proposed route runs along the southern edge of a drumlin hill and at c. Ch. 11,290-11,320m it cuts through the townland boundary between Tawnagh and Cloonymeenaghan (CHC 73; Plate 63). At about Ch. 11,290-11,570m the proposed route passes through the probable line of an early road (CHC 74; Plate 64-65), identified from cartographic and documentary sources as a section of a Mail Coach Road that ran between Boyle and Sligo towns. A section of this old road CHC 74 is identifiable in the metalled laneway (Plate 65) that runs west of the ringfort (SL034-112; CHC 75). The proposed route passes at a distance of about 40m from that monument (Plate 64). Just south of the line of the coach road (CHC 74) proposed Spoil Repository Areas (SR/BP Type 01-No.3 and SR/BP Type 02-No.3) are situated between c. Ch. 11,420-11,760m. This area is located on the top of a ridge which slopes down to the west (Plate 67). Nothing of archaeological interest was identified in this area.

At c. Ch. 11,890m the proposed route passes west of the site of a possible enclosure (CHC 77; Plate 68) that was identified from field inspection and aerial photographs. Between c. Ch. 11,940 -12,500m the proposed route passes through wetland (CHC 78) and through the townland boundary between Cloonymeenaghan, Sheerevagh and Cloongad (CHC 79), which is a stream at c. Ch. 12,240-12,290m. The proposed route then crosses a Local road L54041-0 at c. Ch. 12,320m and passes through further wetland (CHC 82; Plate 71) between c. Ch. 12,500-12,680m. A proposed pond is located within this wetland area between c. CH 12,370-12,520m. The proposed route crosses the townland boundary (CHC 80; Plate 69) between Sheerevagh and Drumderry. To the southwest of this is an unoccupied early-mid 19th century four-bay two storey farm house (CHC 81; Plate 70).The route then continues through sloping pastureland with several of the fields containing the remains of gravel extraction pits (Plate 73). The Spoil Repository Area SR/BP Type 01-No.4 spans four of these low lying fields. Nothing of archaeological interest was noted in this area (Plate 72).

At about Ch. 13,100-13,180m the access track linking to the local road L-1404-0 clips part of a length of stone wall (CHC 83; Plate 74). The proposed route slopes down along the south side of a drumlin hill towards the local road at c. Ch. 13,510m. It passes at a distance of about 40m a derelict early 19th century two storey dwelling (CHC 84, Plate 75).

Passing to the east of Castlebaldwin village and the existing N4, at about Ch. 13,600m, the *Proposed Road Development* crosses the townland boundary between Drumderry and Castlebaldwin (CHC 90; Plate 78-81). The proposed roundabout at c. Ch. 13,600-13,660m runs across the townland boundary (CHC 90) and another field boundary. The proposed realignment of the L-1404-0 road on the east side of the proposed route and roundabout comes in relatively close proximity (40m) to a recorded monument SL034-181 (CHC 93 Plate 83), a ringfort. At about 100m east of Ch. 13,600m the proposed western realignment of this local road runs along the townland boundary (CHC 90) and across the townland boundary between Cloghoge Upper and Castlebaldwin or Ballanagarrigeeney (CHC 92, (Plate 81 & 88). The link terminates at a distance of about 25m from the former National School at Castlebaldwin (CHC 91; Plate 82). The school is included as a protected structure (RPS No. 81) in the Record of Protected Structures for County Sligo.

The line of the proposed link road between the Proposed N4 and L-1404-0/L-1403-0 at c. Ch. 13,600 curves northwest-southeast and traverses through five fields, climbing to higher ground in the north. The northern end of this link road runs diagonally across a grass covered field in which a 19th century structure (CHC 86) stood. There are no visible traces of that structure. A stone wall revetment runs along the southeastern boundary of that field along the edge of the existing local road L-1404-0. The road here is at a level c.1m below that of the field. The proposed link road then crosses the existing road and traverses the south-western corner of another pasture field, crosses the southern boundary of the field which is also the townland boundary between Drumderry and Annaghcor (CHC 87). The road travels diagonally across the next two pasture fields that slope down to the south. The southern extent of this road travels along the line of the townland boundary between Ballanagarrigeeney or Castlebaldwin and Drumderry (CHC 90). This boundary is defined by a mature hedgerow that runs along a raised area comprising an earthen bank in places and a stone wall in other parts (Plate 78-81).

The proposed Landscape Mitigation Area LS. Mit-01 is to the west of the roundabout at c. Ch. 13,580-13,690m on an area of ground that slopes down to the south, where rushes indicate the presence of wetland (CHC 89). It is bounded to the east by the townland boundary CHC 90. The townland boundary between Cloghoge Upper and Ballanagarrigeeney or Castlebaldwin (CHC 92) runs in a northeast-southwest direction through this area and the adjoining Landscape Mitigation Area LS Mit.-02 (Plate 81). This townland boundary is a deep water-filled drainage ditch. The northwestern extent of this feature marks the boundary between the townland of Castlebaldwin and Drumderry (CHC 88, Plate 77). Landscape Mitigation Area LS Mit. 02 is a large area that occupies parts of six fields. As already noted the townland boundary CHC 92 runs across this area (Plate 81). The northern edge of this proposed soil infill area follows the break of slope in that field, where a wetland area occupies the lower level. The existing N4 is at a noticeably higher level than this location but further south there is less of a difference between the level of the road and that of the fields.

At about Ch. 13,590m the proposed route of the N4 passes through some wetland (CHC 89; Plates 77) for a distance of about 200m. The route also passes about 20m from recorded monument SL 034-184 (CHC 98; Plate 85), a ringfort. About 130m from the east side of the proposed route is the 17th century fortified house called 'Castlebaldwin' (CHC 99; Plate 86) which is a Recorded Monument (SL034-185), as well as a National Monument under the guardianship of the Office of Public Works (No. 373) and is also listed on the National Inventory of Architectural Heritage (NIAH 32403404). On the west side of the existing N4 road and over 50m from the proposed route is a derelict early 20th century creamery building (CHC 97; Plate 84) . A recorded monument SL034-186 (CHC 96; Plate 87), consisting of a group of three holy wells named for Saints Bride, Murry and Patrick, is situated behind the creamery. At c. Ch. 13,650-13,910m the proposed route cuts a townland boundary which is a stream (CHC 92; Plate 81 & 88). The same boundary is cut further north by the proposed realignment of the Local road L-1404-0.

The proposed location of ponds at c. Ch. 13,940-14,080m is marginal ground that is very overgrown and there is tree cover at the northern end of the field. The presence of rushes indicates wet ground (CHC 89; Plate 77). The field boundaries defining this large field are all deep drainage channels. The townland boundary (CHC 92) runs along the northern edge of the proposed pond (Plates 81 & 88). Another townland boundary (CHC 101; Plate 89) crosses the *Proposed Road Development* at Ch. 14,200m. The proposed new road ties back in to the existing N4 at about Ch. 14,200m. At about Ch. 14,240m a small link road proposed along the western side of the route passes about 10m from a recorded monument SL034-191 (CHC 100; Plate 89), an enclosure. The proposed route terminates at Ch. 14,522 in the townland of Cloghoge Lower.

15.3.3.2 Field Inspection – Carrowkeel Passage Tomb Cemetery, Bricklieve Mountains

On 9th November 2005 a visit was made to the northern end of the Bricklieve Mountains and in particular the Neolithic passage grave cemetery at Carrowkeel, which is a National Monument (No. 518) under the ownership of the Office of Public Works (OPW). The purpose of this visit was to assess the potential visual impact, if any, the proposed route may have on Carrowkeel Cemetery which lies on the Bricklieve Mountains high above the south end of the *Proposed Road Development*, approximately 2.5km from the southernmost point of the proposed road. The weather at the time of the visit was dry and cloudy, allowing moderate visibility of the landscape around Carrowkeel. This site was revisited on May 21st 2013 on a bright clear day with the Landscape and Visual Consultants.

Carrowkeel is one of the big four passage tomb cemeteries in Ireland (the other three are Brú na Bóinne, Lough Crew, and Carrowmore). Carrowkeel is set on high ground above Lough Arrow. There are fourteen

passage tombs in Carrowkeel. Six more passage tombs are located close by in the Keshcorran complex. A particular type of crude pottery found in passage tombs has been titled Carrowkeel Ware, having first been recorded in the Carrowkeel Monuments. Cairn K is at the highest point of the Carrowkeel complex. The view from the top of Cairn K to the northeast looks past Cairns H and G and out over the drumlin landscape of south county Sligo (Plates 90-91). The village of Castlebaldwin is visible below as a cluster of buildings at the base of the drumlin in Drumderry Townland. The existing N4 road running through Castlebaldwin can be seen as a line of trees and buildings. The line of the existing N4 road becomes gradually less visible as it winds northwards through the lowland drumlin landscape.

15.3.3.3 Field Inspection – 17th century house, 'Castle Baldwin' (SL034-185)

On 8th November 2005 a visit was made to the ruins of 'Castle Baldwin' (CHC 99), a 17th century house situated about 420m southeast of the modern village of Castlebaldwin (See Appendix 15.1 of volume 4 for details). The purpose of this visit was to assess the impact that the proposed route will have on this 17th century structure, which is both a Recorded Monument (SL034-185) and a National Monument (No. 373) in the care of the Office of Public Works and is also listed on the NIAH (32403404). Views to and from the 17th century house were assessed from north-to-west-to-south (Plate 86). The weather at the time of the visit was dry and bright. The site was revisited on May 21st 2013 in the company of the landscape and visual consultant.

The 17th century house is currently about 215m from the existing N4 which runs southeast of the village of Castlebaldwin. At present the rear of the structure is visible through the tree-line/hedgerow along the eastern edge of the existing N4. The house faces NE away from the existing N4 and the *Proposed Road Development*. An overgrown ringfort (RMP SL034-184; CHC 98) lies about 98m to the west of the 17th century house. No ancillary structures are present nor any features relating to the 17th century house apparent in the hinterland of the building.

15.3.4 Inventory of Constraints

All recorded archaeological monuments within the immediate vicinity of the proposed road take were given a cultural heritage constraint number (CHC). In addition the following were given CHC numbers: areas of archaeological potential; townland boundaries; stream and river crossings; upstanding buildings pre-1950 in date; and any other features that were considered to be of cultural heritage merit.

There are a total of 101 built heritage constraints in proximity to the *Proposed Road Development*. The CHCs consist of the following heritage types: Townland boundaries (22 no.); Protected structures (no. 2); 19th /early 20th century structures (21 no.); sites of 19th century structures (16 no.); wetland Areas of Archaeological Potential (13 no.); early routeways (3 no.); possible enclosure sites (3 no.); old field boundaries (4 no.); a demesne (no. 1); 19th century gates (no. 4); a culvert (no. 1) and a roadside memorial (no. 1). One National Monument and nine other RMP sites located in proximity to the Proposed Route Design and the Spoil Repository Areas are also included as CHCs including a potential ecclesiastical site (no. 1); a complex of holy wells (1 no.) and a number of ringforts (7 no.). See Appendix 15.5 of volume 4 for a detailed list of all sites within the Archaeological, Architectural and Cultural Heritage Site Inventory.

15.4 Predicted Impacts of the *Proposed Road Development*

15.4.1 Introduction

The National Roads Authority (NRA) guidelines for the assessment of archaeological and architectural heritage (2005) were used in the writing of this report. The types of impact are generally categorised as direct impact, indirect impact or no predicted impact. A direct impact is where a feature or site of archaeological heritage merit is physically located in whole or in part within the footprint of the proposed route alignment. An indirect impact is where a feature or site of archaeological heritage merit or its setting is located in close proximity to the footprint of the proposed route alignment. No predicted impact is where the potential route alignment does not adversely or positively affect an archaeological heritage site.

Where sites are deemed to be of potential merit only, in that it is not known in advance of further surveys whether there are any archaeological remains present or not at these locations/sites then, these impacts have been deemed to be 'potential'.

Please refer to Section 15.2 for further details of Impact assessment methodology used.

15.4.2 Impact Assessment Table

There are a total of 101 Cultural Heritage Constraints in proximity to the *Proposed Road Development*. The CHCs consist of the following site types: Townland boundaries (22 no.); Protected Structures (2 no.); 19th /early 20th century structures (21 no.); sites of 19th century structures (16 no.); wetland (13 no.); early routeways (3); possible enclosure sites (3 no.); old field boundaries (4 no.); a demesne (no. 1); 19th century gates (no. 4); a culvert (no. 1) and a roadside memorial (no. 1). A National Monument and nine other RMP sites are located in proximity to the *Proposed Road Development*. The National Monument is a 17th-century fortified house at Castlebaldwin that is also listed on the RMP and NIAH. A second National Monument that has being included in the assessment, but has not being assigned as Cultural Heritage Constraint number, is Carrowkeel Passage tomb cemetery which is located high up on the Bricklieve Mountains 2.5 kilometres distant from the *Proposed Road Development*. The RMP sites include a potential ecclesiastical site (no. 1), a complex of holy wells (1 no.); and several ring forts (7 no.).

See Appendix 15.5 of volume 4 for a detailed list of all sites within the Archaeological, Architectural and Cultural Heritage Site Inventory.

Included within the CHC list in Table 15-7 below and the Inventory are several CHCs that are in close proximity to the edge of the road but will not be affected by the *Proposed Road Development*. The reason for this is that for certain sections of the *Proposed Road Development* (at the Cloonamahan and the Castlebaldwin end) the existing road will not be altered significantly but only improved. The effect, therefore, of the *Proposed Road Development* on the various CHCs along those parts of the proposed route which already are beside or near the existing N4 road, is that they are considered to be not impacted upon.

Table 15-7: Impact Assessment Table

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 1	Collooney/ Toberbride	Townland boundary	Direct	0m	Imperceptible
CHC 2	Toberbride	Recorded monument: Ecclesiastical remains possible; Ringfort; Souterrain; Holy well site (SL026-026)	Indirect	36m	Slight
CHC 3	Toberbride	Early 19th century structure	Direct	0m	Moderate
CHC 4	Toberbride	Recorded monument – possible enclosure (SL026-164)	Direct	0m	Potentially Significant
CHC 5	Toberbride	Early 20th century structure	Direct	0m	Moderate
CHC 6	Toberbride	Site of early 19th century structures	Direct	0m	Potentially moderate
CHC 7	Toberbride/ Mullaghnabreena	Townland Boundary as stream	Direct	0m	Potentially significant
CHC 8	Markree Demesne	Demesne	No predicted impact	15m	None
CHC 9	Mullaghnabreena	Early 19th century structure	Direct	0m	Moderate
CHC 10	Mullaghnabreena	Protected structure (RPS 202)	No predicted impact	3m	None
CHC 11	Mullaghnabreena	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 12	Ardcurley	Site of mill and Fair Green	Direct	0m	Potentially significant
CHC 13	Ardcurley	Early 19th century structure	Direct	0m	Moderate

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 14	Mullaghnabreena / Ardcurley	Townland Boundary as stream	Direct	0m	Potentially significant
CHC 15	Ardcurley	Lake shore	Direct	0m	Potentially significant
CHC 16	Ardcurley/Cloonamahan	Townland Boundary	Direct	0m	Imperceptible
CHC 17	Cloonamahan	Bog/ wetland area of archaeological potential (AAP)	Direct	0m	Potentially significant
CHC 18	Ardcurley	Site of early 19th and 20th century structures	Direct	0m	Potentially moderate
CHC 19	Cloonamahan	20th century road side memorial	Direct	0m	Imperceptible
CHC 20	Cloonamahan	Iron gate with stone piers – possibly 19th century	Direct	0m	Moderate
CHC 21	Cloonamahan	Recorded monument: Enclosure (SL026-076)	Direct	0m	Imperceptible
CHC 22	Ardcurley	Iron gate with stone piers – possibly 19th century	Direct	0m	Moderate
CHC 23	Cloonamahan	Recorded monument: Ringfort (Rath/Cashel) (SL026-077)	Indirect	32m	Imperceptible
CHC 24	Cloonamahan	Early 19th century structure	No predicted impact	11m	None
CHC 25	Ardcurley/ Cloonamahan/ Doorly	Townland boundary	Direct	0m	Potentially moderate
CHC 26	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 27	Doorly	Stone structure, in ruins	Direct	0m	Moderate
CHC 28	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 29	Doorly	Early 19th century structure	Direct	0m	Moderate
CHC 30	Doorly	Early 19th century structure	Direct	0m	Moderate
CHC 31	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 32	Doorly	Early 19th century structure	No predicted impact	19m	None
CHC 33	Doorly	Early 19th century structure (site of)	Direct	0m	Potentially moderate
CHC 34	Doorly	Flat topped bank (early routeway)	Direct	0m	Potentially significant
CHC 35	Doorly	Possible enclosure, from aerial photograph	Direct	0m	Potentially significant
CHC 36	Doorly	Wetland AAP	Direct	0m	Potentially significant

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 37	Doorly/ Knocknagroagh	Townland boundary as stream	Direct	0m	Potentially significant
CHC 38	Knocknagroagh	19th C structures	Direct	0m	Moderate
CHC 39	Knocknagroagh	19th C structure (site of)	Direct	0m	Potentially moderate
CHC 40	Knocknagroagh	Early 19th century dwelling	No predicted impact	5m	None
CHC 41	Knocknagroagh	Early 19th century dwelling	No predicted impact	8m	None
CHC 42	Knocknagroagh	Former field boundary	Direct	0m	Potentially significant
CHC 43	Knocknagroagh	Wetland AAP	Direct	0m	Potentially significant
CHC 44	Knocknagroagh/ Drumfin	Townland boundary as stream	Direct	0m	Potentially significant
CHC 45	Drumfin	Wetland AAP	Direct	0m	Potentially significant
CHC 46	Drumfin	Stone-lined culvert	Direct	0m	Moderate
CHC 47	Drumfin	Early 19th century structure	No predicted impact	20m	None
CHC 48	Drumfin/ Cloonlurg	Townland boundary as stream	Direct	0m	Potentially significant
CHC 49	Carrownagark	Wetland AAP	Direct	0m	Potentially significant
CHC 50	Cloonlurg / Carrowkeel (ed Riverstown) / Carrownagark	Townland boundary as river	Direct	0m	Potentially Significant
CHC 51	Carrownagark	Linear bank (early routeway)	Direct	0m	Potentially significant
CHC 52	Carrownagark / Kingsbrook	Townland boundary	Direct	0m	Potentially moderate
CHC 53	Kingsbrook	Early 20th century structure	Direct	0m	Moderate
CHC 54	Carrownagark	Gate	Direct	0m	Moderate
CHC 55	Kingsbrook	Linear bank (old field boundary)	Direct	0m	Potentially significant
CHC 56	Kingsbrook	Wetland AAP	Direct	0m	Potentially significant
CHC 57	Kingsbrook	Early 19th century structure	Indirect	0m	Imperceptible
CHC 58	Kingsbrook	Old laneway (possibly 19th century)	Direct	0m	Significant
CHC 59	Kingsbrook	Wetland AAP	Direct	0m	Potentially significant
CHC 60	Kingsbrook/ Aghalenane	Townland boundary	Direct	0m	Potentially moderate
CHC 61	Aghalenane	Old field boundary	Direct	0m	Potentially significant
CHC 62	Aghalenane	Wetland AAP	Direct	0m	Potentially significant
CHC 63	Aghalane/Ardloy	Townland boundary	Direct	0m	Potentially moderate

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 64	Aghalenane	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 65	Aghalenane	Early 19th century dwelling	No predicted impact	23m	None
CHC 66	Ardloy/ Springfield	Townland boundary	Direct	0m	Potentially moderate
CHC 67	Ardloy	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 68	Springfield	Wetland AAP	Direct	0m	Potentially significant
CHC 69	Springfield	Late 19th century structure	No predicted impact	3m	None
CHC 70	Springfield	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 71	Springfield/ Tawnagh	Townland boundary as stream	Direct	0m	Potentially significant
CHC 72	Tawnagh	Possible enclosure, from aerial photograph	Direct	0m	Potentially significant
CHC 73	Tawnagh/ Cloonymeenaghan	Townland boundary as stream	Direct	0m	Potentially significant
CHC 74	Cloonymeenaghan	Early road (Mail coach road)	Direct	0m	Potentially significant
CHC 75	Tawnagh	Recorded monument: Ringfort (Rath/Cashel) (SL034-112)	Indirect	35m	Imperceptible
CHC 76	Cloonymeenaghan	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 77	Cloonymeenaghan	Possible enclosure site (from field inspection)	Direct	0m	Potentially significant
CHC 78	Cloonymeenaghan	Wetland AAP	Direct	0m	Potentially significant
CHC 79	Cloonymeenaghan/ Sheerevagh/Cloongad	Townland boundary as stream	Direct	0m	Potentially significant
CHC 80	Sheerevagh/ Drumderry	Townland boundary	Direct	0m	Potentially moderate
CHC 81	Drumderry	Early-mid 19th century structure	No predicted impact	27m	None
CHC 82	Sheerevagh	Wetland AAP	Direct	0m	Potentially significant
CHC 83	Drumderry	Stone wall field boundary	Direct	0m	Moderate
CHC 84	Drumderry	Early 19th century dwelling	No predicted impact	39m	None
CHC 85	Annaghcor	Site of early 19th century structure	Direct	0m	Potentially moderate
CHC 86	Annaghcor	19th C houses (Site of)	Direct	0m	Potentially moderate
CHC 87	Annaghcor/ Drumderry	Townland boundary	Direct	0m	Potentially moderate
CHC 88	Drumderry/ Cleavry/Cloghoge Upper	Townland boundary	Direct	0m	Potentially moderate

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 89	Castlebaldwin/ Cloghoge Upper/ Cloghoge Lower	Wetland AAP	Direct	0m	Potentially significant
CHC 90	Drumderry/ Castlebaldwin	Townland boundary	Direct	0m	Potentially moderate
CHC 91	Cloghoge Upper	Protected structure: '*Former Castlebaldwin National School*' (RPS 138)	No predicted impact	3m	None
CHC 92	Castlebaldwin/ Cloghoge Upper	Townland boundary as stream	Direct	0m	Potentially significant
CHC 93	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) (SL034-181)	Indirect	25m	Slight
CHC 94	Cloghoge Upper	19th C structure	No predicted impact	3m	None
CHC 95	Cloghoge Upper	19th C structure (site of)	Direct	0m	Potentially moderate
CHC 96	Cloghoge Upper	Recorded monument: Holy wells (3) (SL034-186)	No predicted impact	27m	None
CHC 97	Cloghoge Upper	20th century creamery building	No predicted impact	3m	None
CHC 98	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) (SL034-184)	Indirect	11m	Moderate
CHC 99	Castlebaldwin	National Monument 17th century Fortified House (No. 373/ SL 034-185/NIAH 32403404)	Indirect	128m	Slight
CHC 100	Cloghoge Upper/ Cloghoge Lower	Recorded monument: Enclosure (SL034-191)	Indirect	9m	Moderate
CHC 101	Cloghoge Upper/ Cloghoge Lower	Townland boundary as stream	Direct	0m	Potentially significant
N/A	Carrowkeel	National Monument Passage tomb cemetery (SL040-101 SL040-102 SL040-087 SL040-086 SL040-095 SL040-096 SL040-089 SL040-090 SL040-093 SL040-094 SL040-092 SL040-099 SL040-100 SL040-097 SL040-103	Indirect	c. 2.5km	Slight

15.4.3 Impacts on known Archaeological Sites (National Monuments and RMP sites)

There are nine recorded monuments within 100m of the *Proposed Road Development*.

The *Proposed Road Development* will have a **direct impact** on one known archaeological monument, a potential enclosure site in Toberbride Townland (CHC 4/SL026-164). There are no above ground visible traces of this site which had been originally identified from an aerial photograph. This impact is deemed to be potentially significant, in the event that there are sub-surface archaeological remains present at the site.

There shall be a moderate indirect impact on the ringfort in Cloghoge Upper (SL034-191/CHC 100). This enclosure, a probable medieval settlement lies immediately adjacent to the existing N4 and a proposed access road shall encroach a few metres closer to the site which sits atop a small hillock, causing an indirect impact of moderate significance.

There shall be an indirect visual impact on the recorded monument ring forts in Castlebaldwin (SL034-181/CHC 93), (SL034-184/CHC 98), in that the *Proposed Road Development* encroaches on their immediate environs. While there are no direct impacts on either site the impact is deemed to be moderate in relation to CHC 98 and slight in terms of CHC 93 (Figure 15.2.8 of volume 3).

The significance of the impact on the possible ecclesiastical site in Toberbride (SL026-026/CHC 2), the ringfort in Cloonamahan (SL026-77/CHC 23) and the ringfort (SL034-112/CHC 75) in Tawnagh at the northern end of the *Proposed Road Development* are considered imperceptible to slight. There shall be no direct impact on the three adjacent holy wells in Cloghoge Upper at the southern end of the *Proposed Road Development* just south of Castlebaldwin (SL034-186-001; -002;-003/CHC 96)

Table 15-8: Impacts on known archaeological sites

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
CHC 2	Toberbride	Recorded monument: Ecclesiastical remains possible; Ringfort; Souterrain; Holy well site (SL026-026)	Indirect	36m	Slight
CHC 4	Toberbride	Recorded monument – possible enclosure (site of) (RMP: SL026-164)	Direct	0m	Potentially significant
CHC 21	Cloonamahan	Recorded monument: Enclosure SL026-076	Direct	0m	Imperceptible
CHC 23	Cloonamahan	Recorded monument: Ringfort (Rath/Cashel) SL026-077	Indirect	32m	Imperceptible
CHC 75	Tawnagh	Recorded monument: Ringfort (Rath/Cashel) SL034-112	Indirect	35m	Imperceptible
CHC 93	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) SL034-181	Indirect	25m	Slight
CHC 96	Cloghoge Upper	Recorded monument: Holy wells (3) SL034-186	No predicted impact	27m	None
CHC 98	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) SL034-184	Indirect	11m	Moderate
CHC 99	Castlebaldwin	National Monument 17th century Fortified House (No. 373/ SL 034-185/ NIAH 32403404)	Indirect	128m	Slight
CHC 100	Cloghoge Upper/ Cloghoge Lower	Recorded monument: Enclosure SL034-191	Indirect	9m	Moderate

CHC No	Townland	Site Type/Reference	Type of Impact	Approx. distance from permanent works	Impact Significance
N/A	Carrowkeel	National Monument Passage tomb cemetery	Indirect	c. 2.5km	Slight

15.4.3.1 17th century Fortified House 'Castlebaldwin' CHC 68

The National Monument and NIAH listed 17th century fortified house 'Castlebaldwin Castle' (Nat. Mon. No. 373/NIAH 32403404) (SL034-185/CHC 99) currently lies some 230m east of the existing N4. The house faces W and the existing N4 and the *Proposed Road Development* both run to the rear of the house. The rear of the house is visible to passing traffic intermittently through the existing N4 roadside hedgerow. It is a fine structure of its type, albeit in ruins, and has a Regional rating assigned to it in the NIAH. There is an information panel regarding the structure on the local road which runs to the E of the house, parallel with the existing N4, though access across the fields to the structure is not clearly marked and evidently not promoted.

The proposed N4 route will shift the road east, and the landtake for the road will be about 128m from the 17th century house, passing through the rough pasture and wetland area of archaeological potential (CHC 89) that lies between the existing N4 and the structure. At present a local road runs from the northeast down slope towards the village of Castlebaldwin at a minimum distance of about 320m from the 17th century house. It is proposed to create a new roundabout junction and slip road onto the proposed N4 to the east of the village of Castlebaldwin. The 17th century house will be about 190m from the proposed roundabout and the proposed road that will link with the local road L-1403-0.

The construction of the proposed new junction at Castlebaldwin and route realignment works will involve ground disturbance to within 128m of the 17th century house. Whilst no upstanding archaeological features or remains relating to the 17th century house were identified during the field inspection it is possible that subsurface archaeological material may exist. The recommended archaeological testing to be carried out along the proposed route to the east of the 17th century house will identify the presence or absence of any archaeological features, deposits or artefacts that may be associated with this monument.

The existing N4 is visible from the 17th century house and *vice versa*. As the proposed route alignment will necessitate moving the road closer to the monument, it is considered that the proposed route and junction at Castlebaldwin and the proposed link road leading north-eastward from this would have a slightly greater visual impact than exists already. This potential visual impact would be lessened by the proposed provision of hedgerow and feature planting alongside the junction and road edges at Castlebaldwin, which shall also assist in softening the edges of the *Proposed Road Development* from the perspective from Carrowkeel passage tomb cemetery high up on the mountains to the south (see below).

The visual impact and landscape mitigation regarding this site is dealt with in the Landscape and Visual Impact Chapter of this EIS.

15.4.3.2 Carrowkeel Neolithic Passage Tomb Cemetery (no CHC number)

The Neolithic Passage tomb cemetery at Carrowkeel is also a National Monument (Nat. Mon. No. 518). This important prehistoric cemetery is located 2.5km south of the *Proposed Road Development* high up on the Bricklieve mountains.

The nearest section of the proposed N4 realignment to Carrowkeel Cemetery is the junction just south of Castlebaldwin village a distance of approximately 2.5km. The proposed route passes on the southeast side of the Drumderry Drumlin, and continues north beyond the drumlin, away from Castlebaldwin. The site was visited on the 21st May 2013 with the Landscape and Visual consultants. The portion of the proposed route that curves up from the existing N4 towards the Drumderry drumlin will be visible from Carrowkeel, though such an impact is not seen as significant due to the fact that the existing road and Castlebaldwin village is already visible from the site; that said proposed roadside landscaping of the *Proposed Road Development* aimed at softening the edge of the realignment shall help reduce any visual impact. It should be noted that the existing N4 is visible from the site and at no point does the proposed new development come closer to the site

than the existing road. The impact of the *Proposed Road Development* on Carrowkeel cemetery is deemed indirect and slight, being a minor visual impact only.

The visual impact and landscape mitigation regarding this site is dealt with in the Landscape and Visual Impact Chapter of this EIS.

15.4.3.3 Impacts on Areas of Archaeological Potential (AAP)

The proposed route passes through a number of areas which are considered to be of archaeological potential. Areas of archaeological potential have been identified in the NRA guidelines[103] as those which are:

- In close proximity to known archaeological monuments (discussed above);
- Have an association with either topographic features or wetland terrain;
- Placename evidence;
- Find spots or stray finds (None)

For the purposes of this impact assessment report, 3 types of Areas of Archaeological Potential are identified:

- Wetland;
- Townland boundaries that are streams/rivers, and
- Morphological anomalies (being potential archaeological sites, some of which were initially identified from aerial photographs, historic mapping and field inspection);

It may be the case that no archaeological features are present in these areas of archaeological potential. In the event that archaeological features or sites are found through the proposed mitigation (see below) then such archaeology is likely to require full excavation. For that reason the impact of the *Proposed Road Development* is classed as 'potentially significant'.

15.4.3.3.1 *Wetland*

The proposed route traverses 13 areas identified as bog and wetland which are deemed to be Areas of Archaeological Potential for their potential to contain archaeological remains, notably organic preserved remains.

Table 15-9: Impact assessment on wetland areas of archaeological potential

CHC No	Townland	Description	Approx. Ch. (m)	Approx. distance from road take (metres)/ Type of Impact	Impact significance
15	Ardcurley	Lake shore	1,320-1,380	0m/ Direct	Potentially significant
17	Cloonamahan	Bog/ wetland area of archaeological potential (AAP)	1,610 – 1,670	0m/ Direct	Potentially significant
36	Doorly	Wetland	3,390-3,700	0m/ Direct	Potentially significant
43	Knocknagroagh	Wetland	4,070-4,790	0m/ Direct	Potentially significant
45	Drumfin	Wetland	4,790-5,800	0m/ Direct	Potentially significant
49	Drumfin/Clonlurg/Carrownagark	Wetland	6,350-7,400	0m/ Direct	Potentially significant
56	Carrownagark/Kingsbrook	Wetland	8,750 - 8,970	0m/ Direct	Potentially significant

[103] *Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes*, NRA 2005. Section 5.7.1-Areas of Archaeological Potential.

CHC No	Townland	Description	Approx. Ch. (m)	Approx. distance from road take (metres)/ Type of Impact	Impact significance
59	Kingsbrook	Wetland	9,500-9,760	0m/ Direct	Potentially significant
62	Aghalenane	Wetland	10,000-10,200	0m/ Direct	Potentially significant
68	Springfield	Wetland	10,550 - 10,690	0m/ Direct	Potentially significant
78	Cloonymeenaghan/Sheerevagh	Wetland	11,940 - 12,500	0m/ Direct	Potentially significant
82	Drumderry/Sheeravagh	Wetland	12,500 - 12,680	0m/ Direct	Potentially significant
89	Castlebaldwin/ Cloghoge Upper/ Cloghoge Lower	Wetland	13,590-14,100	0m/ Direct	Potentially significant

15.4.3.3.2 *Townland Boundaries as Watercourses*

The proposed route also passes through a number of townland boundaries which are streams and rivers and which are deemed to have archaeological potential.

Table 15-10: Impact assessment on townland boundaries as watercourses

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from road take (metres)/ Type of Impact	Impact Significance
7	Toberbride/ Mullaghnabreena	Townland Boundary as stream	450-490	0m/ Direct	Potentially significant
14	Mullaghnabreena / Ardcurley	Townland Boundary as stream	1,050-1,120	0m/ Direct	Potentially significant
37	Doorly /Knocknagroagh	Townland boundary as stream	3,690	0m/ Direct	Potentially significant
44	Knocknagroagh /Drumfin	Townland boundary as stream	4,430- 4,470	0m/ Direct	Potentially significant
48	Drumfin /Cloonlurg	Townland boundary as stream	6,400-6,990	0m/ Direct	Potentially significant
50	Cloonlurg / Carrowkeel (ed Riverstown) / Carrownagark	Townland boundary as river	7,350	0m/ Direct	Potentially Significant
71	Springfield /Tawnagh	Townland boundary as stream	10,740-10,830	0m/ Direct	Potentially significant
73	Tawnagh/ Cloonymeenaghan	Townland boundary as stream	11,290-11,320	0m/ Direct	Potentially Significant
79	Cloonymeenaghan/ Sheerevagh/Cloongad	Townland boundary as stream	12,240-12,290	0m/ Direct	Potentially Significant
92	Castlebaldwin /Cloghoge Upper	Townland boundary as stream	13,650-13,910	0m/ Direct	Potentially Significant
101	Cloghoge Upper/ Cloghoge Lower	Townland boundary as stream	14,200	0m/ Direct	Potentially Significant

15.4.3.3.3 *Townland Boundaries, Morphological Anomalies/ Potential archaeological sites*

Eleven townland boundaries which fall under the category of sites of archaeological potential as many townland boundaries are of some antiquity. There are several instances where the road cuts townland boundaries composed of hedgerows with earthen banks and/or ditches. As the *Proposed Road Development* necessitates only part removal of certain sections of these boundaries which are extensive features in the landscape the impact is deemed to be moderate only

Table 15-11: Impact assessment on townland boundaries as hedgerow and banks

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*	Impact Significance
1	Collooney/ Toberbride	Townland boundary	-40	0m	Imperceptible
16	Ardcurley/Cloonamahan	Townland Boundary	1,510	0m	Imperceptible
CHC 25	Ardcurley/ Cloonamahan/ Doorly	Townland boundary	2,300	0m	Potentially moderate
52	Carrownagark/ Kingsbrook	Townland boundary as hedgerow	8,630-8,660	0m	Potentially moderate
60	Kingsbrook /Aghalenane	Townland boundary as hedgerow	9,640- 9,690	0m	Potentially moderate
63	Aghalenane/ Ardloy	Townland boundary as hedgerow	10,140-10,260	0m	Potentially moderate
66	Ardloy /Springfield	Townland boundary as earthen bank and stone wall	10,300-10,550	0m	Potentially moderate
80	Sheerevagh/ Drumderry	Townland boundary as Bank and drain	12,440-12,580	0m	Potentially moderate
87	Annaghcor/ Drumderry	Townland boundary	240 (access road)	0m	Potentially moderate
88	Drumderry/Cleavry/Cloghoge Lower	Townland boundary	13,600-13,640	0m	Potentially moderate
90	Drumderry /Castlebaldwin	Townland boundary as earthen bank and hedgerow	13,600	0m	Potentially moderate

The proposed route passes through four possible early routeways and three potential archaeological sites which were identified through analysis of aerial photographs and field inspections.

Table 15-12: Impact assessment on morphological anomalies/potential archaeological sites

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Type of Impact	Impact Significance
34	Doorly	Flat topped bank (early routeway)	2,900	0m/ Direct	Potentially significant
35	Doorly	Possible enclosure	3,000	0m/ Direct	Potentially significant
51	Carrownagark	Linear bank (early routeway)	7,930	0m / Direct	Potentially significant
58	Kingsbrook	Old laneway	9,360	0m / Direct	Potentially significant

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Type of Impact	Impact Significance
72	Tawnagh	Possible enclosure	11,040	0m/ Direct	Potentially Significant
74	Cloonymeenaghan	Early road (Mail coach road)	11,290 and 11,570	0m/ Direct	Potentially Significant
77	Cloonymeenaghan	Possible enclosure	11,890	0m/Direct	Potentially Significant

15.4.4 Impacts on Architectural Heritage

The proposed route will **not** directly impact on any Protected Structures (RPS) or structures listed on the NIAH. However, there are three protected structures in proximity to the Proposed Road Development.

The RPS structure in Mullaghnabreena is an early 19th century dwelling known as 'Toberscanavan House' (RPS 202, CHC 10). It lies beside the current N4 and adjacent to the *Proposed Road Development*; however, no impact is predicted.

There is one RPS Structure, the former National School in Castlebaldwin, that is adjacent to the *Proposed Road Development* and Landscape Mitigation Areas LS. Mit. 01 and LS. Mit. 02 (RPS: 138; CHC 91) (Figure 15.2.8 of volume 3) but this structure will not be directly impacted upon.

There shall be an indirect visual impact on one structure listed on the NIAH, the 17th century fortified house at Castlebaldwin (CHC 99), also a National Monument, which lies c. 128m from the *Proposed Road Development*. The impact on this site has been addressed above under national monuments (Archaeology) as it is such a monument, but has a dual status as it is also protected under Architectural heritage statute.

The proposed N4 route will shift the road east, to about 128m from the 17th century house, passing through the rough pasture and wetland area of archaeological potential (CHC 89) that lies between the existing N4 and the structure. At present a local road runs from the northeast down slope towards the village of Castlebaldwin at a minimum distance of about 320m from the 17th century house. It is proposed to create a new roundabout junction and slip road onto the Proposed N4 to the east of the village of Castlebaldwin. The 17th century house will be about 195m from the proposed roundabout and the proposed road that will link with the local road L-1403-0.

The construction of the proposed new junction at Castlebaldwin and route realignment works will involve ground disturbance to within 128m of the 17th century house. Whilst no upstanding archaeological features or remains relating to the 17th century house were identified during the field inspection it is possible that subsurface archaeological material may exist. The recommended archaeological testing to be carried out along the proposed route to the east of the 17th century house will identify the presence or absence of any archaeological features, deposits or artefacts that may be associated with this monument.

The existing N4 is visible from the 17th century house and *vice versa*. As the proposed route alignment will necessitate moving the road closer to the monument, it is considered that the proposed route and junction at Castlebaldwin and the proposed link road leading north-eastward from this would have a slightly greater visual impact than exists already. This potential visual impact would be lessened by the proposed provision of hedgerow and feature planting alongside the junction and road edges at Castlebaldwin, which shall also assist in softening the edges of the *Proposed Road Development* from the perspective from Carrowkeel passage tomb cemetery high up on the mountains to the south.

Regarding the impact of the *Proposed Road Development* on the other protected structures, Toberscanavan House and the National School building within the village of Castlebaldwin, the impact is deemed to be negligible/none, as these buildings are adjacent to the existing N4 and the *Proposed Road Development* poses no additional impact on them.

Table 15-13: Impact assessment on RPS/NIAH sites

RPS No. / NIAH	CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Type of Impact	Impact Significance
202	10	Mullaghnabreena	Protected structure: 'Toberscanavan House'	1,050	3m/No predicted impact	None
373/3240 3404	99	Castlebaldwin	17th century Fortified House 'Castlebaldwin'	13,820	128m/Indirect	Slight
138	91	Cloghoge Upper	Protected structure: 'Former Castlebaldwin National School'	13,650	11m/No predicted impact	None

15.4.4.1 Other Architectural Heritage features

There are several structures located adjacent to the *Proposed Road Development* where the road is intended to be widened or realigned. These structures have been assigned CHC numbers but are not of any significant architectural merit.

Nine of these structures will be **directly impacted** upon by the *Proposed Road Development* necessitating their removal. These include the early 19th century dwellings (CHC 3, 9, 13, 29, 30 and 38), the early 20th century dwellings (CHC 5 and 53) and the ruined stone structure (CHC 27) The other CHC structures will **not** be directly impacted upon by the *Proposed Road Development*. There are several other structures that lie in proximity to the proposed route but will have **no predicted impacts**.

The sites of sixteen 19th century structures that will be directly impacted upon by the construction of the proposed road have been identified. There are no visible remains of these structures and it is recommended that the locations of the former structures are investigated by means of archaeological test excavation prior to the commencement of road construction in order to establish whether any subsurface remains or associated features are present. Of particular interest is the former site of a mill and fair green just southeast of Toberscanavan in Mullaghnabreena townland (CHC 12) where it is proposed to construct a constructed wetlands attenuation pond. Features relating to the mill may be uncovered during testing.

Table 15-14: Impact assessment on other site of architectural heritage

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Impact	Impact Significance
3	Toberbride	Early 19th century structure	150	0m /Direct	Moderate
5	Toberbride	Early 20th century structure	110 (access road)	0m /Direct	Moderate
9	Mullaghnabreena	Early 19th century structure	980-1,000	0m/Direct	Moderate
13	Ardcurley	Early 19th century structure	1,080	0m/Direct	Moderate
24	Cloonamahan	Early 19th century structure	2,290	11m	None
27	Doorly	Stone structure, in ruins	2,440	0m/Direct	Moderate
29	Doorly	Early 20th century structure	2,600-2640	0m/Direct	Moderate
30	Doorly	Early 19th century structure	2,600-2,650	0m/Direct	Moderate
32	Doorly	Early 19th century structure	2,800	19m/None	None
38	Knocknagroagh	19th C structures	390 (access road)	0m/Direct	Moderate

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Impact	Impact Significance
40	Knocknagroagh	Early 19th century dwelling	4,040	5m /None	None
41	Knocknagroagh	Early 19th century dwelling	90 (access road)	8m /None	None
47	Drumfin	Early 19th century structure	5,880	20m/None	None
53	Kingsbrook	Early 20th century structure	8,640	0m/Direct	Moderate
57	Kingsbrook	Early 19th century structure	9,250	0m/Indirect	Imperceptible
65	Aghalenane	Early 19th century dwelling	10,270	23m/None	None
69	Springfield	Late 19th century structure	10,650	3m/None	None
81	Drumderry	Early-mid 19th century structure	12,520	27m/None	None
84	Drumderry	Early 19th century dwelling	13,420	39m/None	None
94	Cloghoge Upper	19th century structure	13,750	7m/None	None
97	Cloghoge Upper	20th century creamery building	13,840	10m/None	None
6	Toberbride	Site of early 19th century structures	300	0m/Direct	Potentially moderate
11	Mullaghnabreena	Site of early 19th century structure	1,000	0m/Direct	Potentially moderate
12	Ardcurley	Site of mill and Fair Green	1,070	0m/Direct	Potentially significant
18	Ardcurley	Site of early 19th and 20th century structures	1,710	0m/Direct	Potentially moderate
26	Doorly	Site of early 19th century structure	2,330	0m/Direct	Potentially moderate
28	Doorly	Site of early 19th century structure	2,500	0m/Direct	Potentially moderate
31	Doorly	Site of early 19th century structure	2,800 (access road)	0m/Direct	Potentially moderate
33	Doorly	Site of early 19th century structure	2,900	0m/Direct	Potentially moderate
39	Knocknagroagh	19th C structure (site of)	4,040	0m/Direct	Potentially moderate
64	Aghalenane	Site of early 19th century structure	10,200	0m/Direct	Potentially moderate
67	Ardloy	Site of early 19th century structure	10,530	0m/Direct	Potentially moderate
70	Springfield	Site of early 19th century structure	10,690	0m/Direct	Potentially moderate
76	Cloonymeenaghan	Site of early 19th century structure	11,350	0m/Direct	Potentially moderate
85	Annaghcor	Site of early 19th century structure	50 (access road)	0m/Direct	Potentially moderate

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. distance from *Proposed Road Development*/Impact	Impact Significance
86	Annaghcor	19th century structure (site of)	200 (access road)	0m/Direct	Potentially moderate
95	Cloghoge Upper	19th century structure (site of)	13,800	0m/Direct	Potentially moderate

15.4.5 Impacts on Cultural Heritage features

The proposed route passes through or is adjacent to a number of features of cultural heritage interest.

Table 15-15: Impact assessment on other sites/ features of cultural heritage merit

CHC No	Townland	Site Type	Approx. Ch. (m)	Approx. Distance from road take (metres)	Impact Significance
19	Cloonamahan	20th century road side memorial	1,830	0m	Imperceptible
20	Cloonamahan	Iron gate with stone piers – possibly 19th century	1,830	0m	Moderate
22	Ardcurley	Iron gate with stone piers – possibly 19th century	2,180	0m	Moderate
34	Doorly	Flat topped bank (early routeway) and site of early 19th century	2,900	0m	Potentially significant
42	Knocknagroagh	Old field boundary	4,110	0m	Potentially significant
46	Drumfin	Stone-lined culvert	250 (access road)	0m	Moderate
51	Carrownagark	Linear bank (early routeway)	7,930	0m	Potentially significant
54	Carrownagark	Gate	8,650	0m	Moderate
55	Kingsbrook	Linear bank (old field boundary)	8,730	0m	Potentially significant
58	Kingsbrook	Old laneway (19th C?)	9,360	0m	Significant
61	Aghalenane	Old field boundary	9,670-9,750	0m	Potentially significant
74	Cloonymeenaghan	Early road (Mail coach road)	11,290-11,570	0m	Potentially significant
83	Drumderry	Stone wall field boundary	13,100-13,180	0m	Moderate

15.5 Proposed Mitigation Measures

15.5.1 Introduction

In accordance with the Code of Practice (2000) between the National Roads Authority and the Minister of the Department of Arts, Heritage and the Gaeltacht, every effort has been made to avoid direct impacts on archaeological or architectural heritage features. One recorded archaeological monument which is the site of a levelled possible enclosure will be directly impacted upon by the *Proposed Road Development*. No National

Monuments nor protected buildings will be directly impacted by the proposed route. One possible enclosure was identified on aerial photographs in Doorly townland. If the presence of an enclosure is confirmed during archaeological test trenching it is proposed that this site be preserved by record in agreement with the Department of Arts, Heritage and the Gaeltacht.

All necessary licences, procedures and consents as specified in the National Monuments Act 1930-2004 will be complied with as part of this mitigation strategy. All mitigations shall be carried out under Ministerial Directions. The detailed methodology for all of proposed built heritage mitigation will be set out in method statements agreed with the National Monuments Service, in consultation with the National Museum of Ireland, and these method statements will form the basis for applications for the relevant statutory consents for the work, in accordance with the *National Monuments Acts 1930–2004.*

Several different sorts of mitigation have been mentioned above in relation to specific impacts. The mitigations include further archaeological investigations, surveys, and screen-planting, all as set out with respect to individual affected features in Table 15-16 below.

15.5.2 Specific mitigations

Targeted archaeological test excavations shall be carried out at all those locations, detailed above and in Table 15-16 below, which are deemed to have archaeological potential.

Building surveys shall be carried out on those structures, as detailed above and in Table 15-16 below, that are being directly impacted on by the *Proposed Road Development*.

Townland Boundary Surveys shall be carried out on those sections of townland boundaries, as detailed above and in Table 15-16 below, that are being traversed by the *Proposed Road Development*.

Wade surveys shall be carried out of those sections of watercourses, as detailed above and in Table 15-16 below, that are being directly impacted on by the *Proposed Road Development*.

Screen planting. It is proposed, as detailed in Table 15-16 below, that the carefully designed hedgerow and feature planting alongside the junction and embankments in Castlebaldwin as outlined in the Landscape and Visual Impact Assessment Chapter (10) of this EIS, should substantially lessen any visual impact of the *Proposed Road Development* from the Carrowkeel Passage Tomb cemetery and from the 17th century fortified house at Castlebaldwin. It is noted that the existing N4 is visible from both monuments already.

Geophysical survey shall be employed, as detailed in Table 15-16 below, at number of potential archaeological sites, in advance of test excavations and also where possible in other areas along the proposed route so as to inform the test trenching strategy.

15.5.3 General mitigation measures

15.5.3.1 Archaeological Investigations (Test Excavations and Archaeological Excavation)

- In addition to the targeted site specific test trenching proposed (see above), a general testing strategy will be applied to all lands required for the *Proposed Road Development*. All archaeological features or finds and architectural and cultural heritage revealed will be mitigated prior to or during the construction of the *Proposed Road Development* in agreement with the National Monuments Section and the NRA Project Archaeologist.
- The archaeological test trenching shall entail mechanical excavation of a 2m-wide trench along the centre-line of the proposed route with regular offset trenches to the edge of the land to comprise a testing sample of a minimum of 10% of the landtake. This is to be organised by and carried out in the presence of suitably qualified archaeologists and carried out under Ministerial Directions. During test excavations, upon discovery of any archaeological features or horizons the topsoil will be removed to the level of any archaeological features, if present; otherwise the trenches shall be excavated to the depth of subsoil.
- Subsequent mitigation will involve either preservation *in situ* or preservation by record through full archaeological excavation. All mitigation practices will be carried out in accordance with current best practice and under Ministerial Directions.

15.5.3.1.1 *Reporting and dissemination*

- Illustrated technical and interpretive reports on all archaeological investigations on the *Proposed Road Development* will a) be filed with the regulatory authorities (National Museum of Ireland, National Monuments Service) and b) offered also to Sligo Library Service within 12 months of the completion of all archaeological fieldwork on the *Proposed Road Development*.
- An illustrated summary of any significant archaeological discoveries will be offered for publication in an appropriate periodical (e.g. *Sligo Field Club publications*) or in the NRA's archaeological monograph series within 24 months of the completion of fieldwork.

Table 15-16: Mitigation Measures:- List of affected built heritage features with summary of proposed mitigations and also general mitigations (end section of table). Features with a 'nil' are omitted here.

CHC No	Townland	Site Type	Type of Impact	Approx. Distance from permanent works	Impact Significance	Mitigation Measure
CHC 1	Collooney/ Toberbride	Townland boundary	Direct	0m	Potentially moderate	Test trenching[104] and Townland Boundary Survey
CHC 2	Toberbride	Recorded monument: Ecclesiastical remains possible; Ringfort; Souterrain; Holy well site (SL026-026)	Indirect	36m	Slight	Test trenching
CHC 3	Toberbride	Early 19th century structure	Direct	0m	Moderate	Basic Documentation Building Survey[105]
CHC 4	Toberbride	Recorded monument – possible enclosure (RMP: SL026-164)	Direct	0m	Potentially significant	Test trenching and excavation if necessary.
CHC 5	Toberbride	Early 20th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 6	Toberbride	Site of early 19th century structures	Direct	0m	Potentially moderate	Test trenching
CHC 7	Toberbride/ Mullaghnabreena	Townland Boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 9	Mullaghnabreena	Early 19th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 11	Mullaghnabreena	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 12	Ardcurley	Site of mill and Fair Green	Direct	0m	Potentially significant	Test trenching
CHC 13	Ardcurley	Early 19th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 14	Mullaghnabreena / Ardcurley	Townland Boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 15	Ardcurley	Lake shore	Direct	0m	Potentially significant	Test trenching

[104] All test-trenching will be undertaken within the limits of the CPO.

[105] Cf. Appendix D. 'Basic Documentation' refers to the minimum level of information to be recorded for structures as set out in the NRA Guidelines for architectural assessment.

CHC No	Townland	Site Type	Type of Impact	Approx. Distance from permanent works	Impact Significance	Mitigation Measure
CHC 16	Ardcurley/Cloona mahan	Townland Boundary	Direct	0m	Imperceptible	Test trenching and Townland Boundary Survey
CHC 17	Cloonamahan	Bog/ wetland area of archaeological potential (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 18	Ardcurley	Site of early 19th and 20th century structures	Direct	0m	Potentially moderate	Test trenching
CHC 19	Cloonamahan	20th century road side memorial	Direct	0m	Imperceptible	Re-location
CHC 20	Cloonamahan	Iron gate with stone piers – possibly 19th century	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 21	Cloonamahan	Recorded monument: Enclosure SL026-076	Direct	0m	Imperceptible	Test trenching
CHC 22	Ardcurley	Iron gate with stone piers – possibly 19th century	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 23	Cloonamahan	Recorded monument: Ringfort (Rath/Cashel) SL026-077	Indirect	32m	Imperceptible	Test trenching
CHC 25	Ardcurley/ Doorly	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 26	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 27	Doorly	Stone structure, in ruins	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 28	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 29	Doorly	Early 19th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 30	Doorly	19th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 31	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 33	Doorly	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 34	Doorly	Flat topped bank (early routeway)	Direct	0m	Potentially significant	Test trenching
CHC 35	Doorly	Possible enclosure, from aerial photograph	Direct	0m	Potentially significant	Geophysical Survey and Test trenching. If a site is identified it will be preserved by record
CHC 36	Doorly	Wetland AAP	Direct	0m	Potentially significant	Test trenching
CHC 37	Doorly/ Knocknagroagh	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary

CHC No	Townland	Site Type	Type of Impact	Approx. Distance from permanent works	Impact Significance	Mitigation Measure
						Survey
CHC 38	Knocknagroagh	19th C structures	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 39	Knocknagroagh	19th C structure (site of)	Indirect	0m	Potentially moderate	Test trenching
CHC 42	Knocknagroagh	Former field boundary	Direct	0m	Potentially significant	Test trenching and Townland Boundary Survey
CHC 43	Knocknagroagh	Wetland	Direct	0m	Potentially significant	Test trenching
CHC 44	Knocknagroagh/ Drumfin	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 45	Drumfin	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 46	Drumfin	Stone-lined culvert	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 48	Drumfin/ Cloonlurg	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 49	Carrownagark	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 50	Cloonlurg / Carrowkeel (ED Riverstown) / Carrownagark	Townland boundary as river	Direct	0m	Potentially Significant	Wade survey and Townland Boundary Survey
CHC 51	Carrownagark	Linear bank (early routeway)	Direct	0m	Potentially significant	Test trenching
CHC 52	Carrownagark / Kingsbrook	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 53	Kingsbrook	Early 20th century structure	Direct	0m	Moderate	Basic Documentation Building Survey
CHC 54	Carrownagark	Gate	Direct		Moderate	Basic Documentation Building Survey
CHC 55	Kingsbrook	Linear bank (old field boundary)	Direct	0m	Potentially significant	Test trenching
CHC 56	Kingsbrook	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 57	Kingsbrook	Early 19th century structure	Indirect	5m	Imperceptible	Basic Documentation Building Survey
CHC 58	Kingsbrook	Old laneway (19th C?)	Direct	0m	Significant	Test trenching
CHC 59	Kingsbrook	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching

CHC No	Townland	Site Type	Type of Impact	Approx. Distance from permanent works	Impact Significance	Mitigation Measure
CHC 60	Kingsbrook/ Aghalenane	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 61	Aghalenane	Old field boundary	Direct	0m	Potentially significant	Test trenching
CHC 62	Aghalenane	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 63	Aghalenane/Ardloy	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 64	Aghalenane	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 66	Ardloy/ Springfield	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 67	Ardloy	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 68	Springfield	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 70	Springfield	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 71	Springfield/ Tawnagh	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 72	Tawnagh	Possible enclosure, from aerial photograph	Direct	0m	Potentially significant	Geophysical Survey and Test trenching
CHC 73	Tawnagh/ Cloonymeenaghan	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 74	Cloonymeenaghan	Early road (19th century Mail coach road)	Direct	0m	Potentially significant	Topographical Survey and Test trenching
CHC 75	Tawnagh	Recorded monument: Ringfort (Rath/Cashel) SL034-112	Indirect	35m	Imperceptible	Test trenching
CHC 76	Cloonymeenaghan	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 77	Cloonymeenaghan	Possible enclosure site, from field inspection	Direct	0m	Potentially significant	Geophysical Survey and Test trenching
CHC 78	Cloonymeenaghan	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 79	Cloonymeenaghan/ Sheerevagh/Cloongad	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 80	Sheerevagh/ Drumderry	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey

CHC No	Townland	Site Type	Type of Impact	Approx. Distance from permanent works	Impact Significance	Mitigation Measure
CHC 82	Sheerevagh	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 83	Drumderry	Stone wall field boundary	Direct	0m	Moderate	Basic record
CHC 85	Annaghcor	Site of early 19th century structure	Direct	0m	Potentially moderate	Test trenching
CHC 86	Annaghcor	19th C house (Site of)	Direct	0m	Potentially moderate	Test trenching
CHC 87	Annaghcor/ Drumderry	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 88	Drumderry/ Castlebaldwin	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 89	Castlebaldwin/ Cloghoge Upper/ Cloghoge Lower	Wetland (AAP)	Direct	0m	Potentially significant	Test trenching
CHC 90	Drumderry/ Castlebaldwin	Townland boundary	Direct	0m	Potentially moderate	Test trenching and Townland Boundary Survey
CHC 92	Castlebaldwin/ Cloghoge Upper	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
CHC 93	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) SL034-181	Indirect	25m	Slight	Test trenching
CHC 95	Cloghoge Upper	19th C structure (site of)	Direct	0m from	Potentially moderate	Test trenching
CHC 98	Castlebaldwin	Recorded monument: Ringfort (Rath/Cashel) SL034-184	Indirect	11m	Moderate	Test trenching
CHC 99	Castlebaldwin	National Monument 17th century Fortified House (No. 373/ SL 034-185)	Indirect	128m	Slight	Hedge and feature planting at junction and embankments
CHC 100	Cloghoge Upper/ Cloghoge Lower	Recorded monument: Enclosure SL034-191	Indirect	9m	Moderate	Test trenching
CHC 101	Cloghoge Upper/ Cloghoge Lower	Townland boundary as stream	Direct	0m	Potentially significant	Wade survey and Townland Boundary Survey
N/A	Carrowkeel	Neolithic Passage tomb cemetery	Indirect	2.5km	Slight	Hedge and feature screen planting at junction and embankments

15.5.4 Conclusion

All proposed heritage mitigation will be carried out at the earliest opportunity, in advance of road construction, so as to ensure an adequate amount of time for the excavation or preservation *in situ* of any

archaeological features that may be identified by the testing. All mitigation shall be carried out under Ministerial Directions.

The location of additional haul roads/access roads and site compounds during construction will require testing and archaeological monitoring.

Where archaeological test excavations in advance of construction cannot be carried out, for whatever reason, such untested Greenfield areas will be monitored by a suitably qualified archaeologist during construction/removal of topsoil.

15.6 Residual Impacts on the *Proposed Road Development*

If all recommended mitigation measures are followed then there will be no residual impact on the archaeological, architectural and cultural heritage resource in and within the immediate vicinity of the *Proposed Road Development*.

15.7 Cumulative & Indirect Impacts

15.7.1 Cumulative Impacts

15.7.1.1 Potential Waste Soils activity outside the CPO as a result of the *Proposed Road Development*

A potential cumulative impact of the *Proposed Road Development* is the potential waste soils activity which may be required offsite (outside the CPO of the *Proposed Road Development*) as outlined in Chapter 4 of this EIS. An assessment has been undertaken in accordance with the Spoil Management Report (appendix 4.3 in volume 4), which outlines a Range of Options in the vicinity of the *Proposed Road Development* which may be considered suitable in principle to accept land spreading/deposition operations, insofar as, placement of subsoil and peat materials on those sites would not pose a threat to human health or the environment. It will be a matter for the contractor to source such sites (if it is deemed required), however, the established potential sites (outside the CPO) described below and in section 10 of the aforementioned *Spoil Managment Report* allows for the cumulative impacts (in the context of this Chapter) of such an activity to be assessed. The potential sites include those options which are described as Options 2 (Conifer Plantations) and 4 (Agricultural Lands) in the aforementioned report.

15.7.1.1.1 *Option 2 Sites (Conifer Plantations)*

There are no known built heritage sites within the identified *Option 2* areas. The potential Option 2 areas are all potentially located in wetland areas and are thus considered to have archaeological potential. These areas and any sub-surface archaeological sites, features or artefacts that may be within them would be directly impacted upon. In order to mitigate for this direct and potentially significant impact archaeological testing will be required. This will ensure that archaeological sites are identified and where such sites cannot be preserved *in situ* then they will be preserved by record by means of archaeological excavation. Any artefacts removed from their wetland context during excavation will probably require conservation prior to being curated in a museum. The site of a possible structure is located in area LD CP 02 and area LD CP 03 is located just south of a barrow (SL027-173). Testing in these areas will identify any features that may be associated with these sites.

The macro effect of developing *Option 2* is that the number and size of wetland areas in the environs of the proposed road will be reduced. Works may impact directly on previously unknown archaeological sites and may necessitate preservation by record of such sites.

Table 15-17: Option 2 sites; Potential Impacts and Potential Mitigation.

Townland	Site Type	Type of Impact	Relevant area/s	Distance from individual LP CD area (metres)	Impact Significance	Possible Mitigation
Spotfield	Wetland AAP	Direct	LD CP 01	0m	Potentially moderate	Test trenching
Turnalaydan	Wetland AAP	Direct	LD CP 02	0m	Potentially moderate	Test trenching
Turnalaydan	Site of possible outhouse or structure	Direct	LD CP 02	0m	Potentially moderate	Test trenching
Murillyroe/ Cooperhill	Stream as townland boundary	Direct	LD CP 03	0m	Potentially moderate	Wade survey and Townland Boundary Survey
Coolbock	Possible Barrow SL027-173	Indirect	LD CP 03	20m	Slight	Test trenching and excavation if necessary.
Murillyroe	Wetland AAP	Direct	LD CP 03	0m	Potentially moderate	Test trenching
Clooneen/ Branchfield	Wetland AAP	Direct	LD CP 04	0m	Potentially moderate	Test trenching
Cloneen	Wetland AAP	Direct	LD CP 05	0m	Potentially moderate	Test trenching
Cloonlurg and Cloneen	Stream as townland boundary	Direct	LD CP 06	0m	Potentially moderate	Wade survey and Townland Boundary Survey
Cloonlurg and Cloneen	Wetland AAP	Direct	LD CP 06	0m	Potentially moderate	Test trenching
Cloonlurg and Carrownagark	Wetland AAP	Direct	LD CP 07	0m	Potentially moderate	Test trenching

15.7.1.1.2 *Option 4 sites (Agricultural Lands)*

There are no known built heritage sites within the identified *Option 4* areas. These two areas are located in wetland and are thus considered to have archaeological potential. These areas and any sub-surface archaeological sites, features or artefacts that may be within them would be directly impacted upon. In order to mitigate for this direct and potentially significant impact archaeological testing will be required. This will ensure that archaeological sites are identified and where such sites cannot be preserved *in situ* then they will be preserved by record by means of archaeological excavation. Any artefacts removed from their wetland context during excavation will probably require conservation prior to being curated in a museum.

The macro effect of developing *Option 4* is that the number and size of wetland areas in the environs of the proposed road will be reduced. Works may impact directly on previously unknown archaeological sites and may necessitate preservation by record of such sites

Table 15-18: Option 4 sites; Potential Impacts and Potential Mitigation.

Townland	Site Type	Type of Impact	Relevant area/s	Distance from individual LP CD area (metres)	Impact Significance	Possible Mitigation
Cloonymeenaghan	Wetland AAP	Direct	LD AG 01 LD AG 02	0m	Potentially moderate	Test trenching
Cloonymeenaghan/Cloongad	Townland boundary as stream	Direct	LD AG 02	0m	Potentially significant	Wade survey and Townland Boundary Survey

15.7.2 Macro impact post mitigation

Mitigation in the form of targeted test trenching would allow for the identification of any archaeological features within the possible waste areas. The test trenching would also assess the impact of the waste area on such sites/features and the based on the results of test excavations the Heritage Authorities will advise on the appropriate mitigation; either preservation *in situ* or preservation by record by means of archaeological excavation. Once this mitigation has been completed the overall impact is that where archaeological sites or features or parts thereof have been removed these will be preserved by record. In a wider context the setting of such features or sites will be permanently altered.

15.8 Relevant Figures and Appendices

15.8.1 Figures contained in Volume 3

The following figures have been produced specifically for the purposes of this Chapter and are contained in Volume 3 of the EIS:

Fig. 15.1: National Monuments in the Vicinity of the *Proposed Road Development*;

Fig. 15.2.1 to 15.2.8: Location of Recorded Monuments, Protected Structures and Cultural Heritage Constraint Sites.

15.8.2 Appendices contained in Volume 4

The following additional documents relevant to the text in this Chapter are contained in Volume 4 of the EIS and include:

Appendix 15.1.: Recorded Monuments and Places;

Appendix 15.2.: Topographic Files (NMI);

Appendix 15.3: Excavation Summaries;

Appendix 15.4: Architectural Heritage Sites;

Appendix 15.5: Inventory of Cultural Heritage Sites;

Appendix 15.6: Documentation of a 'Record from the Past'

Appendix 15.7: Cultural Heritage Plates

Appendix 15.8: Additional Figures;

Schedule of Commitments and Summary of Cumulative Impacts

This section of the Environmental impact Statement provides a:

- Summary of the Schedule of Commitments and Ameliorative Measures; and a
- Summary of the Cumulative Impacts.

16 Schedule of Commitments and Summary of the Proposed Ameliorative Measures

16.1 Introduction

The Schedule outlined on the following pages lists the commitments and amelioration measures for the N4 Collooney to Castlebaldwin *Proposed Road Development*; which will be specified in the contract documents/client specification.

The environmental measures detailed within the EIS will be implemented as an integral part of the *Proposed Road Development*. An Environmental Operating Plan will be prepared in accordance with NRA Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan. This plan will outline procedures for the delivery of environmental mitigation measures and for addressing general day-to-day environmental issues that can arise during the construction phase of a national road development.

Table 16-1: Schedule of Commitments and Summary of Ameliorative Measures

No.	Stage	Description	Main Report (Volume 2) Reference
		GENERAL	
4.1	C	Normal hours of work will be Monday to Saturday 07:00 to 19:00 hours unless specific restrictions are placed on certain activities within certain chapters of the EIS. Certain operations may however be carried out outside of these hours with the permission of the contracting authority.	4.10.1
4.2	C&O	The site development works for the various spoil repositories/borrow pits shall be carried out in a manner which is demonstrable to achieve the performance objectives of the various sites (as described in section 4.10.2.2.2).	4.10.2.2.2
4.3	C	Compliance with and development of the Outline Construction and Demolition Waste Management Plan (as described in section 4.10.3) into a Construction Stage Plan.	4.10.3
4.4	C	The locations where local roads require temporary diversions during construction of the realignment are listed in Table 4-15 of Chapter 4. These diversions will in most cases be accommodated within the land-take required for construction of the *Proposed Road Development.* However, there are localised instances where the diversion may be via alternative routes on the local road network. All diversion routes will be properly sign posted. In all additional cases to those described below, local road access shall be maintained throughout the construction process via localised treatment measures within the landtake required for the *Proposed Road Development.*	4.10.6
4.5	C	Compliance with and development of the Outline Erosion and Sediment Control Plan (described in section 4.10.9) into a Construction Stage Plan.	4.10.9
4.6	C	The environmental commitments outlined in this EIS will as already discussed (section 4.10.8.3 of this Chapter) be included within the EOP to be developed by the Contractor. The Local Authority will appoint an Environmental Assurance Officer who shall be responsible for *inter-alia*: (1) Ensuring that the measures included in the EOP consider the full gamut of environmental commitments contained within this EIS; (2) Ensuring that the method statements and environmental measures detailed in the EOP are implemented on site via regular auditing procedures; (3) Ensuring that the controls described in the Erosion and Sediment Control Plan are adequately adhered to;	4.10.10

No.	Stage	Description	Main Report (Volume 2) Reference
		(4) Ensuring that the approach and objectives of the Spoil Management Plan are adequately adhered to; (5) The auditing of Waste Management practices carried out under the Construction and Demolition Waste Management Plan. In addition, the Environmental Assurance Officer shall audit any design changes made during the detailed design phase to ensure that the effects of such changes do not have any additional significant effects. The Environmental Assurance Officer will be delegated powers under the contract sufficient for any appropriate instructions to be issued.	
CHAPTER 6 SOCIO ECONOMIC			
6.1	C&O	Encourage construction traffic to use new alignment where possible;	6.5
6.2	C&O	Provide footpath (slightly elevated above road surface) and cyclepath (on the southern side of the link between Castlebaldwin village and the roundabout) at Castlebaldwin Junction (roundabout) with the realigned L1404-0;	6.5
6.3	C	Use signage to direct walkers to crossing at Castlebaldwin Junction where the *Proposed Road Development* severs the L1404-0 and Historical Trail;	6.5
6.4	C	Provide signage at Castlebaldwin and Toberbride junctions to encourage cyclists to use the existing road as an alternative to the new alignment in accordance with the provisions of the NRA DMRB;	6.5
6.5	C	Provide tourism signage in line with NRA guidelines at Castlebaldwin Junction including for Carrowkeel Megalithic Complex;	6.5
6.6	C	Provide services signage to encourage use of petrol, retail and food facilities in Castlebaldwin;	6.5
6.7	C	Provide limited car parking for vehicles together with tourism information (for Carrowkeel, Castlebaldwin Fortified House, the Historical Trail and other local facilities) at the proposed landscaped mitigation area in Castlebaldwin as described in the Landscape and Visual Impact Assessment Chapter (See Fig. 10.1.8);	6.5
6.8	C	Allow for access to the landscaped area. See also mitigation proposed in the Landscape and Visual Impact Assessment Chapter.	6.5

No.	Stage	Description	Main Report (Volume 2) Reference
CHAPTER 7 NON AGRICULTURAL PROPERTY (RESIDENTIAL)			
7.1	C	Where existing access is affected, this will be reinstated as described in Appendix 7.1 (Volume 4 of this EIS). In some cases it may not be feasible to reinstate the original access however an alternative access will be provided.	7.5
7.2	*C*	Where a boundary wall of a non-agricultural property is impacted upon by the *Proposed Road Development,* mitigation will involve the replacement of the boundary on a like for like basis, subject to issues of road safety. If necessary, these works will be carried out as part of the contract or the landowner may be compensated to replace the boundary wall.	7.5
7.3	*C*	The Contractor will be obliged to maintain reasonable access to all properties at all times during the construction of the *Proposed Road Development*. This may require temporary alternative access arrangements at some locations. Information will be made available to affected landowners on the construction programme and its impact on properties.	7.5
7.4	*C*	The NRA code of practice *Guide to Process and Code of Practice for National Road Projects Planning and Acquisition of Property for National Roads* will be adhered to with respect to all land potentially impacted by the construction of the *Proposed Road Development*. These measures include the following: - The local authority will appoint a Project Liaison Officer who will liaise and engage with the affected parties or their representatives on matters relating to the *Proposed Road Development*. The Project Liaison Officer will act as first point of contact should individual encounter difficulties; - Where excavations interfere with water supplies, sewers, or septic tanks, these services will be restored as a matter of urgency by the local authority or those acting on its behalf, provided the property owner facilitates all necessary access to enable this to be done; - Steps will be undertaken to minimise dust and mud from construction activities. Measures will include, as appropriate, the watering of the road and containment of material with dust or mud potential and are further outlined in the Air Quality chapter of this EIS; - Noise mitigation for construction activities will be incorporated into the development and mitigation measures will be further outlined in the Noise and Vibration chapter of this EIS.	7.51

No.	Stage	Description	Main Report (Volume 2) Reference
CHAPTER 8 NOISE & VIBRATION			
8.1	*O*	Provision of noise barriers as follows: Location R010 The proposed mitigation measure for Location R010 consists of a 3.5 metre high 45 metre long barrier on the east side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.1 contained within volume 3. Location R016 The proposed mitigation measure for Location R016 consists of a 1.5 metre high 95 metre long barrier on the west side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.2 contained within volume 3. Location R119 The proposed mitigation measure for Location R119 consists of a 4.0 metre high 145 metre long barrier on the east side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.3 contained within volume 3. Location R227 The proposed mitigation measure for Location R227 consists of a 2.0 metre high 190 metre long barrier on the south side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.6 contained within volume 3. Location R254 The proposed mitigation measure for Location R254 consists of a 4 metre high 200 metre long barrier on the north side of the *Proposed Road Development*. The location of this barrier is shown in Fig. 8.1.7 contained within volume 3.	8.5.1
8.2	*C*	The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1* and the *European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001*. These measures will ensure that: - No plant used on site will be permitted to cause an on-going public nuisance due to noise; - The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations; - All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract;	8.5.2.1

No.	Stage	Description	Main Report (Volume 2) Reference
		- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers; - Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use; - Any plant, such as generators or pumps, which are required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen; - During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 8-9 (of Chapter 8) using methods outlined in BS 5228 "*Noise and Vibration Control on Construction and open sites*".	
8.3	*C*	Normal working times will be 07:00 to 19:00hrs Monday to Saturday. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached. Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority. When overtime and shift work is permitted, the hauling of spoil and delivery of materials outside normal working hours is prohibited and the noise limits outlined in Table 8-9 (of Chapter 8) will apply.	8.5.2.2
8.4	*C*	The emergency work referred to above may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.	8.5.2.3
8.5	*C*	The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities will be limited to the values set out in Table 8-14 (of Chapter 8). Measures shall be taken to minimise vibration due to plant and machinery on the site and no machine which uses the dropping of heavy weights for the purpose of demolition shall be permitted. Ground vibration from additional traffic due to the development under consideration would be expected to be orders of magnitude less than that required to cause cosmetic or structural damage to buildings or lead to disturbance of occupiers, hence mitigation measures are not required in respect of the operational phase. It may be concluded that the *Proposed Road Development* is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.	8.5.3

No.	Stage	Description	Main Report (Volume 2) Reference
		CHAPTER 9 AIR QUALITY AND CLIMATE	
9.1	*C*	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 activities. In order to minimise dust emissions during construction, a series of mitigation measures have been prepared for implementation during the construction phase of the project. These measures are as follows: - Site roads will be regularly cleaned and maintained as appropriate. Hard surface roads will be swept to remove mud and aggregate materials from their surface while any unsurfaced roads will be restricted to essential site traffic only. Any road that has the potential to give rise to fugitive dust will be regularly watered during dry and/or windy conditions; - Vehicles using site roads will have their speeds restricted where there is a potential for dust nuisance at nearby properties; - Where practicable, vehicles exiting the site shall make use of a wheel wash facility prior to entering onto public roads. This will ensure that mud and other wastes are not tracked onto public roads. Public roads outside the site will 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 will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods; - The dust minimisation procedures put in place will be monitored and assessed. In the event of dust nuisance occurring outside the site boundary, the effectiveness of existing measures will be reviewed and further mitigation will be implemented to rectify the problem. Provided the dust minimisation measures outlined above are adhered to, the air quality impacts during the construction phase will not be significant.	9.51
		CHAPTER 10 LANDSCAPE & VISUAL	
10.1	*C&O*	Landscape and visual mitigation measures for this *Proposed Road Development* are predominantly in the form of roadside screen planting, the assimilation of embankments within the land take boundary of the proposed road, and the incorporation of measures for wildlife as informed by the Flora, Fauna & Fisheries Impact Assessment. These mitigation measures are shown on Figures 10.1.1 to 10.1.8 contained within Volume 3 of this EIS. Given the linear constraints of the planting zone, the structure of	10.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		the landscape planting is generally intended to reflect the existing hedgerows and woodlands. The species composition of the screen planting will reflect the landscape context of each section of road. Throughout woodland areas proposed planting mixes include high and low canopy woodland mixes, riparian woodland mixes, hedgerow and shrub mixes as listed in the Table 10-6 to Table 10-12 contained within Chapter 10. Generally high canopy woodland is proposed within established woodland or forest areas with low canopy woodland, hedgerow or shrub mixes at woodland fringes. Riparian woodland is proposed at constructed wetlands and river crossings. In farmland areas shrub and hedgerow mixes are to be used to reinstate existing planting areas. A mature high canopy woodland and shrub mix is proposed for the landscape mitigation site at Castlebaldwin. This woodland mix contains a small proportion of standard size trees at planting stage. A suitable grassland treatment is proposed for all areas of open ground within the CPO where no screen or feature planting is proposed. The species mixes in these woodland areas are to reflect species found and in accordance with the Native Woodland Scheme Guidelines (Department of Agriculture, Fisheries and Food - Native Woodland Scheme – Establishment August 2011). In conjunction with the ecological consultant a list of tree and shrub species for the various habitats has been compiled that occur along the route and the appropriate species mix will be applied for each zone. The habitat mixes are provided in the Table 10-6 contained within Chapter 10. At individual properties, the landscape and visual mitigation proposals are primarily focused on screening and reinstatement works including the replacement of existing boundary vegetation in order to integrate the *Proposed Road Development* into the existing landscape context. Mitigation measures at individual properties in a woodland setting normally comprise high or low canopy woodland planting. All areas including embankments and road verges outside proposed planting zones are to be seeded with a suitable semi-natural dry or wet grassland seed mix, similar to the species composition found in the locality in accordance with section 6.1 of the NRA Guide to Landscape Treatments for National Road Schemes in Ireland. Where the proposed alignment cuts into drumlin hills all cut slopes outside rock faces will be seeded with a suitable grass mix. Type 1 Spoil Repository/Borrow Pits located within hill sites will be re-graded to restore existing hill slopes and subsequently turned into grassland mimicking existing pastoral fields. Hedgerow planting is proposed in areas where existing hedgerow patterns existing to reconnect disrupted hedgerow lines. At constructed wetlands outside pool areas and areas proposed for riparian woodland planting a wet grassland treatment is to be implemented in accordance to 4.5.2 of the *NRA Guide to Landscape Treatments for National Road Schemes in Ireland*. At pool areas a marsh habitat containing sedges, grasses, Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be planted. Surrounding banks in wetland areas will be graded to gentle slopes and shallow edges to allow	

No.	Stage	Description	Main Report (Volume 2) Reference
		further colonisation with marsh plant communities. Type 2 Spoil repository sites are to be re-graded with reclaimed peat material from the road works and be reseeded with a verge mix similar to the species *composition of the existing verge, with a high concentration of seed* mix to encourage rapid re-colonisation to control the spread of invasive species. The *measures outlin*ed for this *type of repository* are proposed t*o mimic bog wet*land conditions and to encourage re-colonization. An extensive infill area which is required to re-grade existing lands is proposed as Landscape Mitigation at Castlebaldwin south of Drumderry Hill. Details of this area are included in Figure 10.1.8 contained within Volume 3 of this EIS.	
10.2	*O*	A number of planting mixes, including a short and medium version of high canopy woodland, are proposed for different sections of the proposed road. The objective behind each planting mix is outlined below with specific plant mixes listed thereafter: - High canopy woodland mix– a collection of trees and shrubs which will eventually establish mature broadleaf woodland containing dominant species such as oak. Areas proposed for high canopy woodland mix are confined to established mature woodland clusters along the route. A mature woodland mix containing a small proportion of standard size trees is proposed at the landscape mitigation site at Castlebaldwin. - Low canopy woodland mix – a collection of sub-dominant canopy woodland species with a reduced or no presence of dominant species such as oak. Areas proposed for low canopy woodland mix comprise woodland edges and small woodland clusters where dominant tree species are largely absent. - Riparian woodland mix – a collection of riparian dominant and sub-dominant canopy woodland species. Areas proposed for wet woodland mix comprise river and lake edges where established wet woodland species occur. - Shrub mix – a collection of high and low shrub species with a reduced presence or omission of low canopy tree species. Areas proposed for shrub planting comprise the proposed landscape mitigation area at Castlebaldwin. Shrub species are also contained within woodland areas. - Hedgerow and Mature Hedgerow mix – a collection of traditional hedgerow species proposed for locations where existing hedgerow lines are in existence and have been interrupted or disjointed by the proposed development. A mature hedgerow mix contains a small proportion of standard size trees. - Grass seeding – in all areas within the CPO where no woodland, shrub, hedgerow or feature planting is proposed a suitable grassland mix with species similar to the locality is to be applied. In general a dry meadows and grassy verges grass mix is to be applied to all road verges, embankments and areas within the constructed wetlands not subject to periodic flooding. A wet grassland mix is to be applied to poorly drained lowland areas, river banks and areas at constructed wetlands which are subject to periodic flooding. At pool areas a marsh habitat containing sedges, grasses, Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be planted. - Grass mixes	10.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		The selection of suitable grass mixes at detailed design stage will take into account the characteristics of specific locations. Reference is to be made to the Flora, Fauna and Fisheries Impact Assessment in devising an appropriate species list for each location. - Feature planting – consisting of specimen trees in linear or clustered arrangement to highlight landscape features or gateways The proposed plant mixes have been selected in consultation with the Flora, Fauna and Fisheries consultant having regard to 'A Guide to Habitats in Ireland' (Fossitt, 2000) and the NRA publication 'A guide to landscape treatments for National Road Schemes in Ireland' and consists of those described in Table 10-6 of Chapter 10.	
10.3	*C*	Irish provenance plant material will be utilised on the *Proposed Road Development*. The Contract Documents will require the Contractor to consult with a nursery early in the construction implementation stage to ensure such plant material is available at the end of the construction period. Note that Ash planting on national road schemes is not permitted (refer to NRA circular 05/2013) and ash trees are therefore excluded from the plant lists until further notice. The proposed minimum planting size for all woodland mixes are 2-3 year old tree seedlings (whips) of a height between 60-150cm – 60cm for shrubs and 120cm-150cm for trees. The minimum planting size for marshland plants such as Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) is to be 70 to 90cm. Mature hedgerows to include standard (8-10cm girth) Oak and Rowan trees. Scots pine to be planted at 40cm height. Feature planting to consist of Extra Heavy Standard trees (14-16cm girth). Where mature plant material for reinstatement works such as standard trees are required then the Contractor must acquire whips in a nursery, at the commencement of the construction implementation stage, and ensure that these will have reached standard size by the end of construction such that Irish provenance standard trees will be available. Reinstatement works at individual properties will not include invasive species or potential invasive species (also refer to Invasive Species Ireland website invasivespeciesireland.com). Plant spacing shall be staggered at 1-2m centres. Planting density of the marshland pollution control species should be 4 per square metre. For hedgerows a staggered double row at 0.5m spacing should be planted. Plant material is described in Tables 10-6, 10-7, 10-8, 10-9, 10-10, 10-11 and 10-12 of Chapter 10.	10.5.2.1
10.4	*C*	A walkover survey during construction will be undertaken to identify available soil types and soil pH in order to verify the appropriate native woodland mix from the lists provided under section 10.5.2 of Chapter 2. The survey will be under taken in accordance to the native woodland scheme manual (*Department of Agriculture Fisheries and Food publication – Native Woodland Scheme Manual 2008*) and the establishment report (*Department of Agriculture Fisheries and Food publication -Native Woodland Scheme – Establishment August 2011*).	10.5.2.2

No.	Stage	Description	Main Report (Volume 2) Reference
10.5	*O*	Proposed mitigation measures in relation to Landscape Features contributing to Character Distinctiveness This section sets out planting mitigation measures in relation to woodland, hedgerow and shrub planting. In addition all areas within the CPO where no screen and feature planting is proposed are to be seeded with a suitable grass mix as detailed above. *Collooney to Toberscanavan Loughs (Chainage -190m - 1,600m)* - Clusters of roadside low canopy woodland and hedgerow planting are recommended to both sides of the *Proposed Road Development* and at the eastern parallel link throughout Toberbride, at Toberscanavan and east of the Toberscanavan Loughs; - Riparian woodland planting is proposed throughout the Toberscanavan Loughs woodlands. *Lackagh Fen basin between Doorly Hill and Lackagh (Chainage 1,600m-4,000m)* - Clusters of roadside low canopy woodland and sections of hedgerow planting will be planted to both sides of the *Proposed Road Development* and at the western parallel link throughout the Cloonamahan and Ardcurley townlands. - Riparian woodland clusters are proposed at the constructed wetlands south in Ardcurley. - Hedgerow planting and pockets of low canopy woodland planting is recommended along the eastern slopes of Doorly Hill to the south of the proposed alignment. - Riparian woodland planting clusters are proposed at the constructed wetlands to the south of Doorly Hill. - At the overbridge at local road L-55016-0 west of Lackagh low canopy woodland planting, hedgerow planting and riparian woodland planting is proposed. *Lowland basin surrounding Lough Corran (Chainage 4,000m-5,700m)* - Along the alignment east of Lough Corran pockets of riparian woodland planting, hedgerow planting and shrub land planting are recommended. - Low canopy woodland planting and hedgerow planting will be carried out at proposed L-5502-0 local road overbridge south of the Lough Corran area. Shrub land planting is proposed at the local access track to the constructed wetlands further north. - Feature planting is proposed to mark the River crossing at Lough Corran and at Drumfin overbridge. *Local drumlin hills at Drumfin and Cloonlurg (Chainage 5,700m-6,900m)* - At the western foothills of Drumfin Hill mitigation measure include planting of hedgerow sections to reconnect disrupted hedgerow lines. - South-west of Drumfin riparian woodland planting is recommended surrounding the proposed constructed wetland area.	10.5.3

No.	Stage	Description	Main Report (Volume 2) Reference
		- Further hedgerow planting to reconnect disjointed hedgerows will be carried out along the proposed overbridge at local road L1502-32 south of Drumfin and associated access tracks and link road. - Feature planting is recommended at the L1502-32 overbridge south of Drumfin. *Drumfin River Basin and local hill at Carrownagark (Chainage 6,900m- 8,400m)* - High canopy woodland planting is proposed along the existing forest area north of Drumfin River on either side of the proposed alignment. - Riparian woodland and feature planting is proposed at the Drumfin River crossing and further south at the proposed constructed wetlands. - Hedgerow planting is recommended throughout the western slopes of Carrownagark Hill to reconnect disrupted hedgerow lines. - Further hedgerow, low canopy woodland and feature planting clusters are proposed at the L-5402-0 underpass south of Carrownagark hill. - Hedgerow planting is suggested where existing hedgerow lines are disrupted to both sides of the proposed constructed wetland access track west of Carrownagark hill. *Local drumlin hills at Kingsbrook and peatland basin surrounding Aghalenane Lough (Chainage 8,400m- 10,250m)* - Riparian woodland planting is proposed at the constructed wetlands north east of Kingsbrook Hill. - Hedgerow planting will be carried out throughout the eastern slopes of Kingsbrook Hill to reconnect disrupted hedgerow lines. - Further hedgerow, low canopy woodland and feature planting clusters are proposed at a mainline bridge over a local road south of Kingsbrook Hill. - Linear mature hedgerow planting is proposed at the western road embankments throughout the *Proposed Road Development* west of Aghalenane and Ardloy Lough. - Further Riparian woodland planting is recommended at the constructed wetlands south of Ardloy Lough. *Local drumlin hills at Ardloy/ Springfield, Tawnagh & Cloonymeenaghan (Chainage 10,250m- 11,900m)* - Ground conditions permitting clusters of low canopy woodland and reconnection of hedgerow planting will be provided at the cut slopes and the spoil repository/ borrow pit site at Ardloy/ Springfield hill. - Low canopy woodland planting, riparian woodland planting and hedgerow planting clusters are proposed at the alignment between Ardloy/ Springfield Hill and Tawnagh Hill. - Low canopy woodland planting and hedgerow planting is recommended at the cut slopes and the spoil repository/ borrow pit site at Tawnagh Hill (ground conditions permitting).	

No.	Stage	Description	Main Report (Volume 2) Reference
		- Feature planting is proposed to the west of Ardloy/Springfield hill and east of Tawnagh Hill. - Hedgerow planting to reconnect disrupted hedgerow lines will be planted at the eastern slopes and spoil repository/ borrow pit site at Cloonymeenaghan hill (ground conditions permitting). *Peatland basin between Tawnagh and Drumderry (Chainage 10,900m- 12,600m)* - Where the proposed route crosses the peatland basin between Tawnagh and Drumderry at elevated levels low canopy woodland and hedgerow planting clusters are recommended along its eastern embankments, - Riparian woodland planting is proposed at the constructed wetlands north of Drumderry Hill. *Drumderry Hill and Castlebaldwin (Chainage 12,600m- 14,522m)* - Extensive mature hedgerow planting to reconnect existing hedgerow lines is recommended along the eastern slopes of Drumderry hill on either side of the proposed mainline development as well as at the access track and spoil repository/ borrow pit site west of the alignment. - Mature hedgerow planting is also proposed along the realigned L-1404-0 towards Annaghcor to the south east of Drumderry hill, along the boundary of the proposed infill area east of Castlebaldwin and at the proposed roundabout south of Drumderry Hill. - Feature planting is recommended at the roundabout south of Drumderry Hill, at the northern and eastern infill site boundary and at the link roads to Castlebaldwin. - High canopy woodland underplanted with shrub planting is proposed at the shaped mounds within the proposed landscape mitigation site. - Riparian woodland planting is proposed at the constructed wetlands south of Castlebaldwin. - Hedgerow planting is recommended at the tie in section with the existing N4 to replace disrupted hedgerow lines. - A landscaped area with amenity grassland is proposed north of the infill site at Castlebaldwin with a viewing area towards the Castlebaldwin historic site.	
10.6	*O*	<u>Mitigation and avoidance Measures in the vicinity of individual properties</u> Mitigation proposals in addition to reinstatement measures are discussed under this section for properties anticipated to experience 'Moderate or Significant Adverse' impacts. Mitigation measures for properties with lesser anticipated impacts are listed in Appendix 10.1 contained within volume 3 of this EIS. *Chainage -190m to Chainage 2,200m (Figure 10.1.1 and 10.1.2 of Volume 3)* - A broad low canopy woodland planting strip is proposed on the roadside slopes below properties No. 03 and 05 at Toberbride. Further low canopy woodland planting is proposed on the opposite side of the alignment at the top of the	10.5.4

No.	Stage	Description	Main Report (Volume 2) Reference
		eastern cut slopes to provide screening of the eastern parallel link. - A hedgerow mix is also proposed along the local elevated access road at property 06a. - At Toberscanavan mitigation measures include clusters of low canopy planting and hedgerow planting along the main line and parallel eastern link to the west of elevated properties No. 9a and 9 and at road side property No. 10. At this property a solid noise barrier is also proposed. - Hedgerow planting and a solid noise barrier is proposed at receptor No. 16. *Chainage 2,200m to Chainage 3,420m (Figure 10.1.2 of Volume 3)* - Hedgerow and low canopy woodland planting clusters are proposed along the eastern edge of the *Proposed Road Development* at Doorly Hill to the rear of property No. 105 to provide additional screening. *Chainage 3,420m to Chainage 5,340m (Figure 10.1.3 of Volume 3)* - To the north of the three dwellings No. 117,118 and 119 mitigation measures include planting of a generous swath of low canopy woodland. In addition a solid noise barrier is proposed to the east of property No. 119. - Further stretches of hedgerow and low canopy woodland planting are recommended on the road embankments to both sides of the mainline route corridor to the east and west of properties No. 117, 118, 119 and 121. - Riparian woodland planting surrounding proposed constructed wetlands is proposed south and north of properties No. 117 and 118. *Chainage 5,340m to Chainage 7,200m (Figure 10.1.4 of Volume 3)* - Proposed mitigation measures at property 156 include low canopy woodland planting to both sides of the embankments along the proposed overbridge west of this property to ensure the privacy of this property. *Chainage 7,200m to Chainage 9,050m (Figure 10.1.5 of Volume 3)* - Mitigation measures are recommended for the proposed mainline overpass east of property No. 199, comprising low canopy woodland planting to ensure the privacy of this property. In addition hedgerow planting is recommended along the proposed accommodation track to the north of both properties. - Further hedgerow planting will be carried out at the overbridge west of property No. 197. South-west of this property riparian woodland planting is recommended to enclose the proposed constructed wetlands in this area. *Chainage 9,050m to Chainage 10,950m (Figure 10.1.6 of Volume 3)* - West of properties No. 206 and 207 at the eastern slopes of Kingsbrook hill hedgerow planting is recommended to both sides of the *Proposed Road Development* to provide screening and to reconnect existing hedgerow lines.	

No.	Stage	Description	Main Report (Volume 2) Reference
		- In addition a low canopy woodland mix is recommended at the eastern overbridge embankments adjacent to property No. 207 to ensure the privacy of this property. - North of the elevated settlement cluster at Aghalenane which includes properties No. 218, 219, 220 and 221 continuous mature hedgerow planting will be carried out along the southern road embankment extending from Kingsbrook to Ardloy/Springfield to provide screening of the *Proposed Road Development* whilst retaining filtered views of the lake areas further north. - Recommended mitigation measures for property No. 225 comprise low canopy woodland screening to protect the privacy of this dwelling. This will also provide screening to property No. 224. - At property No. 227 a noise barrier, low canopy woodland and hedgerow planting are proposed to the south of the route alignment to protect the privacy of this dwelling and to reconnect existing hedgerow lines. *Chainage 10,950m to Chainage 12,800m (Figure 10.1.7 of Volume 3)* - North of properties No. 239 and 240 generous swaths of low canopy woodland planting, hedgerow planting and feature planting along the cut slopes facing the affected properties are recommended to provide a high level of screening of the *Proposed Road Development* and accommodation track. - West of properties No. 245 and 247, where the *Proposed Road Development* runs at elevated levels clusters of low canopy woodland and mature hedgerow planting is proposed. - North-west of elevated property No. 255 riparian woodland planting is recommended within the proposed constructed wetlands and mature hedgerow planting further south along the proposed access track. *Chainage 12,800m to Chainage 14,520m (Figure 10.1.8 of Volume 3)* - At the eastern hill slopes of at Drumderry Hill facing properties No. 263, 264, 265, 268, 269, 271,271A, 272, 273and 274 extensive mature hedgerow planting is proposed to both sides of the route between circa Chainage 12,500m and circa Chainage 13,500m to provide screening and to reconnect disjointed hedgerow lines. - Further mature hedgerow and feature planting will be carried out along the L1404-0 west of the proposed alignment, the proposed roundabout at Castlebaldwin and to the east of the proposed landscape mitigation site to provide screening for properties 276,277,278 and 279.	
CHAPTER 11 AGRICULTURAL PROPERTY			
11.1	*O*	A total of twenty eight land parcels, out of the 106 assessed land parcels, have areas of lands, which have been severed. New access will be required on 39 land parcels. Access is deemed to be required where it has to be provided to a sub-divided area or to a retained area of land where the entire road frontage is removed. There are fifty land parcels on which the existing access point(s) will be affected or a new access point off an existing road may be required. The access points will have to be reinstated on	11.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		these land parcels. The extent and complexity of such access provisions vary with each farm depending on the nature of the impact and the type of enterprise being carried out. In some cases simple gateways will suffice, while in other cases new accommodation roads and bridges may have to be constructed. Timber post and rail fencing with stock proofing as appropriate will be provided along the main line, regional, local and accommodation roads. The Local Authority will maintain the fence along the National road. It will be the responsibility of the landowners to maintain the fence along regional, local and accommodation roads. Appendix 11.2 (Volume 4) summarises the level and nature of the impact the route will have on each individual farm and proposed mitigation measures relating to accommodation works.	
11.2	*C*	Construction Noise Good communication between the contractor and the landowners during the construction phase will prevent undue disturbance due to noise. Good communication with farmers will facilitate the organisation of farm enterprises, so that vulnerable livestock are kept as far away as feasible from the construction work during critical times. The contractor shall minimise impacts on agricultural lands due to construction noise by way of a programme of mitigation measures for noise and vibration control as described in the Noise and Vibration impact assessment chapter of this EIS Chapter 8.	11.5.2.1
11.3	*C*	Dust The contractor will employ measures to prevent the spread of dust onto adjoining lands. These measures are set out in the Air Quality chapter 9 of the EIS. Good communication between the contractor and the farmers in the proximity of construction activities will facilitate on-going farm enterprises so that valuable livestock are kept as far away as possible from the construction work during critical times.	11.5.2.2
11.4	*C*	Restricted Access to sub-divided Parcels As in the case of mitigating noise and dust pollution, good communication between individual farmers and the construction authorities will minimize difficulties caused by the restriction of access to severed land parcels. Such communication will produce a workable arrangement, which will allow all parties to continue their work in return for some compromise to other parties. There also should be proper termination of existing boundaries. Maintenance of open access to all landholdings and properties is required. Temporary fencing will be erected as required to delineate the site boundary and to minimize disturbance to adjacent lands. Farmers may need to move animals across the construction site while they await more permanent measures to be put in place	11.5.2.3

No.	Stage	Description	Main Report (Volume 2) Reference
		and this will be facilitated by providing gates where needed until such time as the access arrangements are in place for these farmers when these gateways will be replaced by permanent stock-proof fencing.	
11.5	*C*	Disturbance of Field Drainage Works In cases where impeded drainage during construction will cause obvious difficulty to a particular landowner, temporary measures will be taken to allow waters to drain to less critical areas and so minimise the impact.	11.5.2.4
11.6	*C*	Soil Disturbance Areas if so required on a temporary basis for road construction purposes will be returned to agricultural use following the completion of the *Proposed Road Development*.	11.5.2.5
11.7	*C*	Provision of Ducting. Where required, separate ducting will be given to take water supply and electric fencing across the proposed road to the land on the other side. The location of these will be agreed in advance of road construction on an individual farm basis and put in place during the construction phase. Again some temporary measures may be needed, such as water tanks and battery power electric fencing to ensure that disruption to farming is minimized.	11.5.2.6

No.	Stage	Description	Main Report (Volume 2) Reference
CHAPTER 12 FLORA, FAUNA & FISHERIES (Commitments set out by receptor)			
Designated Conservation Sites			
12.1	*C*	The mitigation measures highlighted for the flora and fauna sections below will be sufficient to protect those Annex I habitats and Annex II species for which the designated sites within the zone of influence have been designated. With regard to the Unshin River cSAC and the Lough Arrow cSAC and SPA complex, specific mitigation measures for the protection of water quality have been set out for works undertaken within or adjacent to watercourses connected to these designated areas. The drainage design, set out in Chapter 4 of the EIS, in addition to the Outline Erosion and Sediment Control Plan, provides the best available mitigation by avoidance to minimise impacts on watercourses and waterbodies within the study area, thus reducing the potential for downstream impacts potentially affecting water-dependant qualifying interests within designated sites during construction stage. Any plant or equipment that may have worked in environments where invasive species are present shall be suitably cleaned by high pressure hose before being employed on site to prevent the spread of invasive species. Water used for this washing process shall always be intercepted and prevented from draining back into watercourses.	12.51
Toberscanavan Lough			
12.2	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	12.51
12.3	*O*	The Drainage Design (Chapter 4) and mitigation measures specified in the Hydrological and Hydrogeological Assessment (Chapter 14) provide operational stage mitigation for the effective protection of surface water and groundwater. The proposal to allow for a possible incremental change to water levels via an adjustable weir includes the requirement that no significant change be affected on the receiving environment in the local context, and requires consultation with the NPWS (Section 4.8.5.1.4 of the EIS).	12.52
Lackagh Fen			
12.4	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access.	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat.	
12.5	*O*	Mitigation measures for the protection of Lackagh Fen require effective management of surface water and groundwater flows. Measures for the protection of groundwater flows are set out in Chapter 4 and include the provision of a drainage layer at the base of the road embankment; rock fill to allow the through-flow of groundwater; and vertical hydraulic barriers to stop groundwater from flowing along the embankment.	12.52
		Boathole Lough and Lough Corran	
12.6	*C*	Water quality mitigation measures have been set out in the Outline Erosion and Sediment Control Plan and in Chapter 14 Hydrological and Hydrogeological Assessment for the effective protection of surface water and groundwater. The road construction works area will be fenced off to avoid any further loss of peatland habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access and will not require works within raised bog or lake/lakeshore habitats identified as ecological interests of the Boathole Lough & Lough Corran Co. Sligo Biodiversity Site. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	12.51
12.7	*O*	Water quality mitigation measures have been set out in Chapter 4 (Description of *Proposed Road Development*) and in Chapter 14 Hydrological and Hydrogeological Assessment for the effective protection of surface water and groundwater.	12.52
12.8	*O*	Measures for the protection of groundwater flows are set out in Chapter 4 (Description of *Proposed Road Development*) and in the Hydrological and Hydrogeological Assessment (Chapter 14) and include the provision of vertical hydraulic barriers to stop groundwater from flowing along the embankment. During the operational phase the surface water runoff and attenuation ponds must be managed and monitored to ensure that they are working effectively and impacts to surface and ground water quality are not arising.	12.52
		Ardloy & Aghalenane Loughs	
12.9	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		the LMA will be limited to the area required for the footprint of the road and machinery access. The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	
12.10	*O*	Measures for the protection of groundwater flows are set out in Chapter 4 (Description of *Proposed Road Development*) and in the Hydrological and Hydrogeological Assessment (Chapter 14) and include the provision of a drainage layer at the base of the road embankment and vertical hydraulic barriers to stop groundwater from flowing along the embankment. During the operational phase the surface water runoff and attenuation ponds must be managed and monitored to ensure that they are working effectively and impacts to surface and ground water quality are not arising.	12.52
Cuileencroobagh Lough			
12.11	*C*	The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	12.51
12.12	*O*	Measures for the protection of surface water and groundwater flows are set out in the Hydrological and Hydrogeological Assessment (Chapter 14).	12.52
Swallow Holes Complex			
12.13	*C*	The Outline Erosion and Sediment Control Plan sets out effective measures for the protection of water quality during construction.	12.51
12.14	*O*	Measures for the protection of surface water and groundwater flows are set out in Chapter 4 (Description of *Proposed Road Development*) and in the Hydrological and Hydrogeological Assessment (Chapter 14) and include the provision of: Silt traps, sedimentation basins and / or hydrocarbon interceptors to be constructed at sensitive outfalls.	12.52
Marsh (GM1)			
12.15	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Compensatory planting of native wet grassland species will be carried out post construction in line with the prescriptions of the	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		Landscape and Visual Impact Assessment (Chapter 10).	
		Wet willow/alder/ash woodland (WN6)	
12.16	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	12.51
		Oak/ash/hazel woodland (WN2)	
12.17	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	12.51
		Scrub (WS1)	
12.18	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		Hedgerows (WL1) / Treelines (WL2)	
12.19	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access. Works within this area will be monitored by a suitably qualified ecologist to ensure that no unnecessary damage is imposed on this habitat. Compensatory planting of native species will be carried out post construction in line with the prescriptions of the Landscape and Visual Impact Assessment (Chapter 10).	12.51
		Exposed calcareous rock (ER2) at Carrownagark	
12.20	*C*	The road construction works area will be fenced off to avoid further loss of this habitat than is required. Habitat clearance within the LMA will be limited to the area required for the footprint of the road and machinery access.	12.51
		Badger	
12.21	*C*	Mitigation measures for badgers are set out in the 'Non-volant Mammal Report' (Appendix 12.3 of Volume 4) and include: a pre-construction survey, badger evacuation measures, protection of setts, provision of two underpasses in the townlands of Carrownagark and Drumderry, badger resistant fencing along the entire corridor, supervised sett destruction and creation of artificial setts. All culverts/bridges greater than 1m in diameter will be designed to be passable by mammals by incorporating a ledge. (Also an operational mitigation). Badger-proof mammal fencing will be installed along the entirety of the road corridor to provide protection for foraging and commuting animals, as detailed in the Non-volant Mammal Report (Appendix 12.3 of Volume 4). Further surveying of badgers will be undertaken immediately prior to the land clearance and construction works and mitigation measures altered according to the results of these surveys. (Also an operational mitigation) Prior to any work commencing in the vicinity of a badger sett directly affected by the road (within 30m), it must be ensured that badgers are excluded and evacuated All works affecting badger setts will require consultation with the NPWS and can only be carried out under licence and with the supervision of an approved ecologist.	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
12.22	*O*	Operational mitigations for badger are limited to ensuring that the mitigations employed during construction phase including artificial setts and wildlife fencing are operating effectively.	12.52
		Otter	
12.23	*O*	Mitigation measures for otter include the provision of mammal ledges within culverts and mammal fencing along the road corridor, as detailed in the Non-volant Mammal Report (Appendix 12.3 of Volume 4).	12.51
12.24	*O*	No operational mitigations, other than the maintenance of mammal fencing as for badger, are required for otter.	12.52
		Pine marten, Irish stoat and Irish hare	
12.25	*C*	Exclusion fencing and mammal passes for badger and otter will minimise disturbance to these species.	12.51
12.26	*O*	No operational mitigations, other than the maintenance of mammal fencing as for badger, are required for pine marten, Irish stoat and Irish hare.	12.52
		Bats	
12.27	*C*	Habitat creation and provision of linear woodland corridors as set out in the Landscape and Visual Impact Assessment mitigations (Chapter 10); provision of alternative roosts after consultation with NPWS; careful timing of the works; restriction on lighting; checking of mature trees prior to felling by an ecologist; checking of buildings/ structures prior to demolition by an ecologist	12.51
		Atlantic salmon	
12.28	*C*	No works will be carried out during the salmonid close season (unless agreed with IFI). Water quality protection measures will be adhered to following the prescriptions of the Hydrological and Hydrogeological Assessment (Chapter 14) and the Outline Erosion and Sediment Control Plan.	12.51
12.29	*O*	Operational mitigations to protect water quality within the aquatic environment will also protect salmon.	12.52
		White-clawed crayfish	
12.30	*C*	Minimisation of footprint within the aquatic environment, with further requirements for removal of this species in advance of	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		works in the aquatic environment. Water quality protection measures will be adhered to following the Outline Erosion and Sediment Control plan and the Hydrological & Hydrogeological Assessment (Chapter 14)	
12.31	*O*	Operational mitigations to protect water quality within the aquatic environment will also protect white-clawed crayfish.	12.52
		Brook lamprey	
12.32	*C*	Mitigations for water quality and the protection of salmon within the aquatic environment will serve to protect lamprey. Water quality protection measures will be adhered to following the Outline Erosion and Sediment Control plan and the Hydrological & Hydrogeological Assessment (Chapter 14). Brook lamprey will be removed prior to any works carried out within the instream habitats, particularly along the shallow water's edge. This will require an electrical fishing survey and a licence to undertake this work from the Department of Communications, Energy and Natural Resources.	12.51
12.33	*O*	Operational mitigations to protect water quality within the aquatic environment will also protect brook lamprey.	12.52
		Marsh fritillary butterfly	
12.34	*C*	Mitigation includes design and creation of new wetland habitats in the form of Constructed Wetlands as set out in the Landscape and Visual Impact Assessment (Chapter 10). These habitats will be suitable for colonisation by the food plant (Devil's bit scabious) and will form 'stepping stones' for the connectivity of suitable habitat within the *Proposed Road Development*. Additional surveys in advance of construction are required for larvae / larval webs, with potential requirement for translocation during the construction stage.	12.51
12.35	*O*	Mitigation includes replanting and management of high diversity grassland and wetland habitat within the proposed Constructed Wetlands within the CPO as detailed in the Landscape and Visual Impact Assessment (Chapter 10). This will provide suitable habitat to support the colonisation of the food plant (Devil's bit scabious). It is proposed to undertake a pre-construction baseline survey of Marsh fritillary populations at Lackagh Fen, Aghalenane/Ardloy Loughs and at any other locations this species has been recorded within the development footprint. The success of the geotechnical, hydrological and hydrogeological mitigation for road construction in each of these areas shall be measured by comparing post construction monitoring results against those pre construction ones. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These	12.52

No.	Stage	Description	Main Report (Volume 2) Reference
		results will be used to inform future design measures on road construction projects.	
		Vertigo geyeri	
12.36	*C*	Mitigation measures set out in Chapter 4 (Description of the *Proposed Road Development*) and in the Hydrological and Hydrogeological Assessment (Chapter 14) for the effective protection of surface water and groundwater flows will effectively protect the supporting habitats of this species. The protection of groundwater-dependant spring habitats at Aghalenane and Ardloy Loughs Complex will effectively protect this species.	12.51
12.37	*O*	The measures for the protection and sustainable management of the hydrological and hydrogeological regime at the supporting Annex I habitats (Aghalenane and Ardloy Loughs) are set out in Chapter 4 and in the Hydrological and Hydrogeological Assessment (Chapter 14). It is proposed to undertake a pre-construction baseline survey of Vertigo geyeri at Aghalenane/Ardloy Loughs. The success of the geotechnical, hydrological and hydrogeological mitigation for road construction at this location shall be measured by comparing post-construction monitoring results against those pre construction ones. Post Construction recording shall be carried out at both 12 months and 24 months after construction. These results will be used to inform future design measures on road construction projects.	12.52
		General comments	
12.38	*C*	During the construction phase of the project the works will be monitored by an ecologist (whose attendance shall be as determined by the Environmental Manager appointed under the EOP) to ensure that the measures to protect water quality and terrestrial ecology are fully implemented by the contractor. Impacts within the zone of impact will be monitored to ensure that these are retained within the accepted impact area and no further impacts are caused that may extend to designated sites within the vicinity of the *Proposed Road Development*. All fill material brought into the site will be screened at source at the donor site for invasive species, including Japanese knotweed, Himalayan balsam etc. to avoid spread of these species into the *Proposed Road Development* site. Invasive species found to be established within the works area will be managed and controlled to prevent their spread throughout the site or outside of the site, in advance of the construction works commencing. Should any areas that could potentially be used by frogs for spawning require disturbance between the months of February to June, the area will be inspected by an ecologist to ensure that no spawn or tadpoles are present. A derogation license from the NPWS will be required if frogs/frogspawn are to be interfered with. Any necessary modifications to the proposed mitigation measures will be made to accommodate any changes in the populations	12.51

No.	Stage	Description	Main Report (Volume 2) Reference
		of protected species within the site. These changes will be agreed in advance with the local NPWS ranger. Details of construction and operational phase monitoring will need to be agreed with NPWS at the pre-construction phase and must include for the supervision of site works by a suitably qualified ecologist (as and when required under the EOP or as determined by the EAO), with provision for an aquatic ecologist with experience in protected aquatic species and fisheries to be present during any works in the aquatic environment.	
12.39	*O*	Bat boxes, vegetative corridors, underpasses and mammal fencing will be monitored by a suitably qualified ecologist to determine the efficiency of the mitigation measures. If artificial setts are required for badgers, these will require a detailed monitoring programme to establish the success of the setts.	12.52
		CHAPTER 13 SOILS AND GEOLOGY	
13.1	*C*	Mitigation by avoidance The design is considered the best possible, in terms of minimising the impact to the geological environment. The 'cut and fill' approach has been followed as far as was reasonably practicable emphasising the requirement to utilise excavated suitable material from road cuts in road embankments; however, the earthworks balance has been largely determined by: - Poor ground conditions; - The requirement to accommodate over bridges and under bridges; - Mitigation by avoidance and reduction which was been actively applied to the design primarily as a result of hydrological and hydrogeological impacts and the influence this has on the vertical alignment; - The requirement to provide suitable cover for drainage culverts; The result of these requirements is a significant deficit of suitable material and a surplus of unsuitable material generated onsite. However, having regard to the Department of Environment, Heritage and Local Government (DoEHLG) document: *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects* and the NRA Guidelines for *the Management of Waste from National Road Projects* and through the preparation of the Spoil Management Report (Appendix 4.3 contained within volume 4 of this EIS) and the Outline Construction and Demolition Waste Management Plan (Appendix 4.4 contained within volume 4 of this EIS), the design phase included an analysis of the 'spoil' geological materials being generated and expected surplus and geological materials handling procedures. The design adheres to the fundamental principles for the effective management of raw materials and spoil for road construction by prioritising spoil prevention/minimisation, followed by spoil re-use, recycling and finally disposal for materials that cannot be subject to the other options. Any further changes at the detailed design stage (if made) must ensure that there is no increase in the level of impact to the	13.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		environment.	
13.2	*C*	Mitigation by reduction *Materials Re-Use* Referring to article 2 (1)c of the Directive on Waste and an interpretation of the legislation provided to the design team (Spoil Management Report), soil and rock material excavated from within the boundaries of the CPO and used for site engineering purposes are unlikely to fall within the definition of waste. *Suitable topsoil & subsoil material* The recovered volume of suitable topsoil & subsoil material is considered sufficient for landscaping purposes throughout the *Proposed Road Development* and there are no anticipated requirements for the import or disposal of 'topsoil' material. In addition, the recovered volume of suitable subsoil material and bedrock material, processed into general fill, is to be used in embankments, screening bunds and noise barriers. It will be the contractor's responsibility to source the deficit, some of which is likely to be from the Type 1/Type 02 Spoil Repositories/Borrow Pits included within the limits of the *Proposed Road Development,* or, from local licensed quarries, or, from further borrow pits identified by the contractor in the vicinity of the works. *Unsuitable topsoil & subsoil material* An overview of the estimated quantities of unsuitable topsoil & subsoil material generated by the *Proposed Road Development* and the methods for its treatment and handling are outlined in section 4.10.2.2 of this EIS and within the Spoil Management Report contained within appendix 4.3 to this EIS. The general conceptual approach is to identify options/sites within the vicinity of the *Proposed Road Development* which are considered suitable in principle to accept or use spoil material arising from the *Proposed Road Development*. The land spreading of excavated soil and subsoil material outside the boundaries of the road project generally requires planning permission but some forms of land reclamation may constitute exempt development under the Planning and Development Regulations. While this is ultimately the ruling of the consent authority, the contractor should satisfy themselves if such an activity is required that planning permission has been obtained or is not required for the offsite management of waste generated on the project. *Rock material* The preliminary design includes for the recovery and appropriate re-use of in the region of 27,000m^3 rock material, excavated at proposed road cuts. This material is to be re-used either in excavated form or processed as aggregates, in embankments, facings, noise barriers, culvert headwalls, gabions, channel linings, buttresses in rock slopes, rock trap bunds and road drainage systems. In	13.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		addition to this there is potential for rock material to be won on site principally from the Type 02 Spoil Repositories/Borrow Pits No. 01, 02 and 03, this material may be used by the contractor in similar instances to the above.	
13.3	*C*	Soil Disposal This volume of 'waste' (which is the material remaining) is to be stockpiled separately to any potentially contaminated 'waste' soil materials. The potential of this volume of 'waste' for reuse is to be explored in preference to offsite disposal. However, should offsite disposal prove the most suitable option, the stockpile is to be examined for non-inert materials such as wood, which are generally not acceptable at permitted waste land spreading sites, and should be removed prior to transport. On inspection, the stockpile is to be removed offsite by a licensed haulier. The main contractor shall be required to keep full records of all waste collection permits held by subcontractors involved in moving 'waste' soil and subsoil materials from the *Proposed Road Development*, all waste licences, permits and registration certificates covering the destination of the 'waste', details of any exemption from the above requirements and details of the quantities and type of 'waste'. In addition, the contract documents are to ensure that all relevant legislation is complied with and that a waste management plan is prepared in accordance with Department of Environment, Heritage and Local Government document: *Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects*.	13.5.3
13.4	*C*	Soil Handling *Topsoil* The handling of excavated 'topsoil' materials is to be managed in such a way to maintain the structure and integrity of the suitable materials for re-use. The following principles are to apply: - Avoid compaction of 'topsoil' materials by heavy machinery, which could limit vegetation establishment and encourage water-logging - Stockpile different 'topsoil' types separately - Shape stockpiles to shed water - Avoid repeated handling of 'topsoil' material, which could damage the soil structure - Avoid stockpiling the 'topsoil' material to greater than two meters in height, which could create internal anaerobic conditions and damage the soil structure - Avoid transport over long distances and movement of 'topsoil' during wet weather - If quantities of 'topsoil' are limited, mix with subsoil or PEAT	13.5.4

No.	Stage	Description	Main Report (Volume 2) Reference
		Subsoil The handling of excavated subsoil materials is also to be managed in such a way to maintain the structure and integrity of the suitable materials for re-use, in particular by minimising the ingress of water. The following principles are to apply: - Ensure that the vegetation and topsoil are in place for as long as possible - Avoid excavation and placing of subsoil during wet weather to maintain soil structure - Avoid stockpiling where feasible - Compact the subsoil material immediately after placement - Ensure that gradients on the compacted subsoil minimises the ingress of water - Remove ruts caused by heavy equipment also to minimise the ingress of water *Peat* The handling of excavated peat is more challenging in that the soil structure is less rigid and that stockpiled peat can have adverse effects on surface water bodies reaching the acidic and coloured leachate. Much of the peat excavated from the *Proposed Road Development* will be used to reinstate borrow pits along the *Proposed Road Development* corridor. The details of borrow pit locations, proposed reinstatement fill material characteristics and construction techniques are contained in the Spoil Management Report which is contained in Appendix 4.3 in the EIS. In terms of general handling of peat soils across the site, the following principles are to apply: - Avoid compaction of soft or peaty materials by heavy machinery, which could limit vegetation establishment and encourage water-logging; - Ensure that a geotechnical engineer/ engineering geologist is onsite to supervise and manage excavation works where excavation will intercept peat >1m depth; - Ensure that excavations which may undermine the upslope component of peat are sufficiently supported by buttress, frame or rampart to resist lateral slippage; - Drain the peat where excavation will intercept >1m depth in advance of excavation activity (1 month in advance where possible) to reduce pore water content and thus instability of the peat substrate; - Position such drains at an oblique angle, and never parallel, to slope contours to ensure ground stability; - Ensure that discharge volumes are attenuated prior to discharge (in accordance with the Outline Erosion and Sediment Control Plan) to watercourses by entrapping suspended sediment in gravel or aggregate material at the	

No.	Stage	Description	Main Report (Volume 2) Reference
		drain base; - Avoid stockpiling of peat in close proximity to watercourses, in particular the catotelm layer which is below the vegetated acrotelm layer (>0.3m depth) and behaves like a fluid once disturbed; - Move any excavated catotelm peat to at least 100m away from drains or streams, where feasible; - If unavoidable, establish cut-off drainage, sediment percolation through vegetation, gravel at the drain base to entrap suspended solids, stilling ponds and/ or sedimentation ponds to minimise the effects of peat runoff on watercourses; - Protect riparian zones by restricting construction disturbance within 50m of streams and drains; - Monitor the drainage and attenuation system during the construction phase (in accordance with the Outline Erosion and Sediment Control Plan), particularly at all upstream and downstream sections relative to stockpiled peat. *Erosion & Sediment Control Plan* The disturbance and exposure of soil material during road construction is inevitable; therefore the adoption of erosion and sediment control plans is essential to prevent sediment pollution and to prevent or slow runoff to allow any suspended solids to settle out in situ. The Outline Erosion and Sediment Control Plan describes the methods that will be employed in this regard and is included as Appendix 4.5 in this EIS.	
13.5	*C*	Soil Chemistry & Water Quality All fuel and other hydrocarbons stored on site during the construction phase are to be located in an impermeable bunded area designed to contain the volume of fuel stored. All refuelling of vehicles and equipment on site is to take place on an impermeable area and drainage from this area is to be contained and treated appropriately to remove contaminants prior to discharge to the surface water drainage system. All material and equipment on site is to be stored appropriately to minimise the risk of contamination of soil or groundwater. All foul drainage (from toilets, canteens etc) from construction compounds is to be collected in sealed systems and disposed of to the foul sewage network in the area or to an appropriate on-site treatment system. These measures also mitigate the impact of removing soil and subsoil material on groundwater by reducing the protection afforded to underlying groundwater aquifer.	13.5.5
13.6	*C*	Collapse of karst features The classification of karst ground conditions by typical morphological assemblages provides guidelines for the encountering of karst features during construction works. The classification suggests that epikarst-type rock head encountered within the study	13.5.6

No.	Stage	Description	Main Report (Volume 2) Reference
		area indicates a 'youthful' or reactivated 'relic' karst system, which is characterised by small 'drop-out' or 'buried' dolines or sinkholes, as identified during the karst survey, and widespread fissuring within a few meters of the surface, as indicated by the identification of an epikarst layer in the geophysical survey. The collapse of soil into pre-existing cavities or voids in the bedrock can be triggered by induced local increases of water input to the soil as a result of inadequate drainage along the *Proposed Road Development* or the lowering of the water table from above to below rock head[73, 80.] Research shows that drainage control is the key mitigation measure to minimise possible doline or sinkholes failure in a 'youthful' karst system and that the majority of highway related sinkholes identified in US study occurred along unsealed roadside trench drains[73,80]. Preventative strategies and drainage control measures in karst areas, i.e. where karst features have been identified, are to include the use; of sealed drainage, services and ditches, flexible infrastructure lines and sealed joints along the road surface, the backfilling of excavation and trenches with excavated material to ensure the same order of permeability and the discharge of road drainage to an existing stream or to a location some distance away from the highway pavement[73,80]. The collection and conveyance of road runoff in particularly sensitive areas (detailed in Chapter 14 of this EIS), should be included for in the construction methodology. Further details on drainage control are given in the Hydrological and Hydrogeological Impact Assessment Chapter and are to be applied in particular around proposed cuts. Should collapse occur during construction, the collapse is to be excavated to the bedrock drain, then refilled with inert material graded upward from coarse rocks to finer sediments to allow natural flow through the bedrock drain without the loss of sediments that cause collapse, as recommended by the American Geological Institute (AGL). The use of an additional preventative strategy such as the incorporation of geogrid reinforcement at the base of the structural road pavement in cut areas or within the embankment in fill areas, will be considered, where there is substantial soil cover over bedrock and a history of sinkhole/ doline failures[80]. While this is not the case in the karst areas of this *Proposed Road Development*, this strategy will be considered depending on the geological conditions encountered during construction. All excavation and backfilling work in karst areas is to be supervised by a karst expert whose attendance shall be as determined by the Environmental Project Manager employed by the contractor under the Environmental Operating Plan. The measures to mitigate the impact of collapse of karst features on groundwater are detailed in the Hydrology & Hydrogeology chapter.	
CHAPTER 14 HYDROLOGY & HYDROGEOLOGY			
14.1	*C*	Mitigation by avoidance The design is considered the best possible, in terms of minimising the impact to the hydrological and hydro-geological environment. Mitigation by avoidance has been actively applied to the alignment design as the Impact Assessment progressed. This includes changes made to the road design as potential impacts became apparent which are discussed in Chapter 3 of this EIS	14.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		(Consideration of Alternatives).	
14.2	*O*	Mitigation by Reduction Design Phase The current road alignment is considered the best possible design, in terms of minimising the impact to the hydrological and hydrogeological environment through mitigation by avoidance and mitigation by reduction (as described in Chapters 3 and 4 of this EIS). Any further changes at the detailed design stage (if made) must ensure that there is no increase in the level of impact to the environment. *Drainage Design* A drainage system is an integral part of the *Proposed Road Development* design and includes containment for accidental spillages at each outfall, petrol/ oil interceptors, and attenuation ponds in the form of constructed wetlands. The drainage system is designed so that surface runoff, as far as is practicable, remains in the same surface catchment area as under pre-construction conditions, that surface runoff flows through suitable attenuation infrastructure where necessary before flowing into catchments or streams and that surface runoff flows in sealed drainage for the section of the development that crosses or encounters any active karst conduits. The increased attenuation and containment of the proposed drainage system is a certain indirect impact of the *Proposed Road Development* on the existing drainage regime during the operational phase, by attenuating road runoff and by containing accidental spillages where the existing N4 road has no attenuation, containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the surface water quality is rated as high for the streams receiving runoff from the outfalls as they flow into the Unshin River and Lough Arrow which are classified by the EPA as having good status, as per above; the magnitude of this impact is rated as minor beneficial, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated minor beneficial. The increase in the volume and rate of surface runoff discharging from the catchments as a result of an increase in impervious area is a certain indirect impact of the *Proposed Road Development* on the existing drainage regime during the operational phase. The attenuation balancing ponds are designed to accommodate a 100-year return period flow and are designed to have adequate storage to allow a permissible outlet flow similar to the maximum existing flow from the catchment in accordance with UK Highways Agency publication *Vegetative Treatment Systems For Highway Runoff HA103/06* and UK Highways Agency (2009) *Surface and Sub-surface Drainage Systems for Highways HD33/06*. The importance of the surface water quality is rated as high for streams flowing into the Unshin River and Lough Arrow as per above; the magnitude of this impact is rated as negligible, resulting in a negligible change in predicted peak flood level; and therefore the significance of this impact is rated imperceptible. The design of embankments at Lackagh Fen (as described in the Geotechnical section of Chapter 4) includes sheetpiles where soft	14.5.2.1

No.	Stage	Description	Main Report (Volume 2) Reference
		ground is encountered during excavations, rockfill below the water table to allow the through flow of groundwater, and vertical hydraulic barriers to stop groundwater from flowing along the embankment. These measures will reduce the hydrogeological impacts on the fen as a result of the development. The design of embankments at Boathole and Lough Corran (as described in the Geotechnical section of Chapter 4) includes a drainage layer at the base of the embankment, sheetpiles where soft ground is encountered during excavations, rockfill below the water table to allow the through flow of groundwater, and vertical hydraulic barriers to stop groundwater from flowing along the embankment. These measures will reduce the hydrogeological impacts on the Loughs as a result of the development. The design of embankments at Ardloy and Aghalenane Loughs and adjacent to the Boathole Lough (as described in the Geotechnical section of Chapter 4) incorporates a drainage layer at the base of the embankment and vertical hydraulic barriers to prevent groundwater movement along the embankment. Also provided at Ardloy and Aghalenane Loughs is traverse embankment drainage measures. These measures will reduce the hydrogeological impacts on the site as a result of the development. The increased attenuation and containment of the proposed drainage system is a certain indirect impact of the *Proposed Road Development* on the conservation areas during the operational phase, by attenuating road runoff and by containing accidental spillages where the existing N4 road has no attenuation, containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the conservation areas is rated high, very high and extremely high; the magnitude of this impact is rated as minor beneficial, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated minor beneficial. Flow monitoring of streams DX1 to DX11 is to be undertaken prior to construction, in order to provide accurate baseline data for comparison during the construction and operation phases.	
14.3	*O*	<u>Water Quality</u> Engineering controls for calculated storm runoff volumes will be provided for the artificial road catchment and the attenuation and release of this water to the natural catchment. Attenuation of storm runoff and sediment settlement is particularly important for all drainage on the development as all parts of the road ultimately drain into either the Unshin River cSAC (c. Ch 00-190mm-13,200m) or the Lough Arrow cSAC (c. Ch13,200m-14,400m). To minimise the impact on surface water and groundwater quality, the following mitigation measures are to be adopted: - Streams DX1 to DX11 and selected groundwater monitoring boreholes are to be monitored prior to construction, in order to provide accurate baseline data for comparison during the construction and operations phases; - As outlined in the drainage design (as discussed in Chapter 4 and appendix 4.1 (volume 4) of this EIS), petrol interceptors and containment (and settlement) facilities are to be constructed at each outfall to mitigate for the risk of pollution from	14.5.2.2

No.	Stage	Description	Main Report (Volume 2) Reference
		road runoff and accidental spillages; - Verges within the design incorporate grassed surface water channels where the design standards permits to reduce soil erosion and suspended matter in runoff; - A strict procedural approach to groundwater pumping (if required) and surface runoff, which conforms to best industry practice, is to be agreed upon, prior to construction (see the Emergenecy Response section in the Outline Erosion and Sediment Control Plan).; - Grassed surface channels where used are to be sealed at locations where the bedrock aquifer is classified as extremely vulnerable, i.e. where less than 3m of subsoil is present. Current information predicts that such conditions may be encountered at c. Ch. 2,800m-3,175m, c. Ch 3,875m-4,175m and c. Ch. 10,300m-10,540m. - The Grassed surface Water Channels if used shall be sealed where possible karst features have been identified, current information predicts these locations to be from c. Ch 9,500m to c. Ch10,500m, although more locations may be identified during construction.	
14.4	*C*	<u>Material Handling</u> Of significance during the construction phase of the project is the excavated materials handling, storage and re-use. There is potential for direct and indirect negative impacts on ground stability and water quality. Control of surface water runoff from the site during the construction phase and operational phase of the *Proposed Road Development* will be required in order to manage potential runoff of contaminants into the streams. <u>Hydrology</u> To minimise the impact on drainage during construction, the following mitigation measures are to be adopted: - Flow monitoring of streams DX1 to DX10 is to be undertaken during construction on a monthly basis and for up to one year after construction, in order to ensure the impact on baseline flows is minimised. <u>Water Quality</u> To minimise the impact on surface water and groundwater quality during construction a detailed operating procedure is contained in the Outline Erosion and Sediment Control Plan (Appendix 4.5 to this EIS) and the following general mitigation measures are to be adopted: - Streams DX1 to DX10 and selected groundwater monitoring boreholes are to be monitored during construction on a	14.5.2.3

No.	Stage	Description	Main Report (Volume 2) Reference
		monthly basis and for up to one year after construction, in order to minimise the impact on baseline hydrochemistry; - Strict adherence to an agreed approach to pumping and surface runoff and the emergency spill plan is to be operated during construction; - Fuels, oils and chemicals are to be stored on impermeable bases, away from drains and watercourses; - Refuelling of plant and vehicles is to be done on impermeable surfaces, away from drains and watercourses; - Silt traps, settlement lagoons, wetlands or hydrocarbon interceptors are to be placed at sensitive outfalls. <u>Groundwater Levels</u> To monitor and minimise the impact on groundwater levels during construction, the following mitigation measures are to be adopted: - Groundwater level monitoring is to be undertaken at all available groundwater monitoring boreholes during construction on a monthly basis and for up to one year after construction and compared to the available pre-construction monitoring data. <u>Groundwater Flow</u> To minimise the impact on groundwater flow during construction, the following mitigation measures are to be adopted: - Where the proposed road cut extends to bedrock, all construction activity is to be closely monitored by a karst expert to identity any subsurface karst collapse features or active karst conduits in the unlikely event of encountering such features; - If such active karst conduits are found, additional drainage of sufficient capacity is to be incorporated into the existing drainage design for the road, in order to allow the water to flow freely during periods of high precipitation, thus preventing flooding potential; - Should active karst conduits be encountered, a system of sealed drainage is to be provided in order to intersect the proposed road alignment, consisting of a pipe of suitable dimension for floodwaters to route the water beneath the road. This closed drainage is to be independent of the road drainage, which has the potential to intercept and carry contaminated road runoff into karst bedrock features.	

No.	Stage	Description	Main Report (Volume 2) Reference
		Groundwater Supply Wells To minimise the impact on groundwater supply wells, the following mitigation measures are to be adopted: - Groundwater levels are to be monitored in the identified spring-fed well of Carrownagark group water scheme well at c. Ch. 7,900m during the construction phase. Should the well be impacted by the *Proposed Road Development*, the replacement or access to an equivalent water supply is to be dealt with as part of the accommodation works.	
14.5	*O*	Drainage The potential increase in the volume and rate of surface runoff discharging from the catchments as a direct result of increased impervious areas and the potential change in the hydraulic behaviour of local streams receiving the increased surface runoff are considered to have a slight impact on the Unshin River, its tributaries the Markree Demesne Stream, Turnalaydan Stream, Drumfin River, Springfield Stream, Lissycoyne Stream and Drumderry Stream (Lough Arrow Catchment) surface catchment areas overall. However to minimise the impact on drainage during operation, the following mitigation measures will be adopted: - Drainage outfalls are designed to be served by suitably sized constructed wetlands or interceptor ponds which will limit the runoff rate to that of existing Greenfield runoff (based on QBAR) rates for the site at all of the outfalls; - Attenuation of surface runoff is designed to be served by suitably sized holding ponds to reduce impact on stream flow. Water Quality To minimise the impact on surface water and groundwater quality during the operational phase, the following mitigation measures are to be adopted in accordance with the drainage design described in chapter 4: Spill containment measures and constructed wetlands[106] will be constructed at all outfalls. In addition hydrocarbon interceptors will be constructed at all outfalls from the mainline (national primary) carriageway. The existing N4 road has no attenuation, containment for accidental spillages and petrol interceptors, and is considered a positive one. The importance of the fisheries value is rated **medium**; the magnitude of this impact is rated as **minor beneficial**, as there is a likely reduction in pollution risk of 50% or more where existing risk is <1% annually; and therefore the significance of this impact is rated **minor beneficial.**	14.5.2.4

[106] Except in the case of outfall 01, where existing attenuation facilities will be utilised.

No.	Stage	Description	Main Report (Volume 2) Reference
CHAPTER 15 ARCHITECTURAL, ARCHAEOLOGICAL AND CULTURAL HERITAGE			
15.10	*C*	General In accordance with the Code of Practice (2000) between the National Roads Authority and the Minister of the Department of Arts, Heritage and the Gaeltacht, every effort has been made to avoid direct impacts on archaeological or architectural heritage features. One recorded archaeological monument which is the site of a levelled possible enclosure will be directly impacted upon by the *Proposed Road Development*. No National Monuments or protected buildings will be directly impacted by the proposed route. One possible enclosure was identified on aerial photographs in Doorly townland. If the presence of an enclosure is confirmed during archaeological test trenching it is proposed that this site will be preserved by record in agreement with the Department of Arts, Heritage and the Gaeltacht. All necessary licences, procedures and consents as specified in the National Monuments Act 1930-2004 will be complied with as part of this mitigation strategy. All mitigations shall be carried out under Ministerial Directions. The detailed methodology for all of proposed built heritage mitigation will be set out in method statements agreed with the National Monuments Service, in consultation with the National Museum of Ireland, and these method statements will form the basis for applications for the relevant statutory consents for the work, in accordance with the *National Monuments Acts 1930–2004.* Several different sorts of mitigation have been mentioned above in relation to specific impacts. The mitigations include further archaeological investigations, surveys, and screen-planting, all as set out with respect to individual affected features in Table 15-16 (of Chapter 15).	15.5.1
15.2		Specific mitigations **Targeted archaeological test excavations** shall be carried out at all those locations, detailed above and in Table 15-16 (of Chapter 15), which are deemed to have archaeological potential. **Building surveys** shall be carried out on those structures, as detailed above and in Table 15-16 (of Chapter 15), that are being directly impacted on by the *Proposed Road Development*. **Townland Boundary Surveys** shall be carried out of those sections of townland boundaries, as detailed above and in Table 15-16 (of Chapter 15), that are being traversed by the *Proposed Road Development*. **Wade surveys** shall be carried out of those sections of watercourses, as detailed above and in Table 15-16 (of Chapter 15), that are being directly impacted on by the *Proposed Road Development* **Screen planting**. It is proposed, as detailed in Table 15-16 (of Chapter 15), that the carefully designed hedgerow and feature	15.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		planting alongside the junction and embankments in Castlebaldwin as outlined in the Landscape and Visual Impact Assessment Chapter (10) of this EIS, will substantially lessen any visual impact of the *Proposed Road Development* from the Carrowkeel Passage Tomb cemetery and from the 17th century fortified house at Castlebaldwin. It is noted that the existing N4 is visible from both monuments already. **Geophysical survey** shall be employed, as detailed in Table 15-16 (of Chapter 15), at number of potential archaeological sites, in advance of test excavations and also where possible in other areas along the proposed route so as to inform the test trenching strategy.	
15.3		General mitigation measures *Archaeological Investigations (Test Excavations and Archaeological Excavation)* - In addition to the targeted site specific test trenching proposed (see above), a general testing strategy will be applied to all lands required for the *Proposed Road Development*. All archaeological features or finds and architectural and cultural heritage revealed will be mitigated prior to or during the construction of the *Proposed Road Development* in agreement with the National Monuments Section and the NRA Project Archaeologist. - The archaeological test trenching shall entail mechanical excavation of a 2m-wide trench along the centre-line of the proposed route with regular offset trenches to the edge of the land to comprise a testing sample of a minimum of 10% of the landtake. This is to be organised by and carried out in the presence of suitably qualified archaeologists and carried out under Ministerial Directions. During test excavations, upon discovery of any archaeological features or horizons the topsoil will be removed to the level of any archaeological features, if present; otherwise the trenches shall be excavated to the depth of subsoil. - Subsequent mitigation will involve either preservation *in situ* or preservation by record through full archaeological excavation. All mitigation practices will be carried out in accordance with current best practice and under Ministerial Directions. *Reporting and dissemination* - Illustrated technical and interpretive reports on all archaeological investigations on the *Proposed Road Development* will a) be filed with the regulatory authorities (National Museum of Ireland, National Monuments Service) and b) offered also to Sligo Library Service within 12 months of the completion of all archaeological fieldwork on the *Proposed Road Development*. - An illustrated summary of any significant archaeological discoveries will be offered for publication in an appropriate periodical (e.g. *Sligo Field Club publications*) or in the NRA's archaeological monograph series within 24 months of the	15.5.3

No.	Stage	Description	Main Report (Volume 2) Reference
		completion of fieldwork.	

17 Summary of Cumulative Impacts

17.1 Introduction

The European Commission published specific guidance with regard impacts not often directly related to the road development (*Guidance for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, May 1999*) Cumulative impacts are identified in the European Commission guidance as impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the road project.

This chapter summarises the main Cumulative Impacts described in the EIS which include:

- In relation to other road upgrade works:
  - Existing and potential upgrades to other sections of the N4 National Primary Route;
  - Upgrades to the nearby N17 including the potential N17 Collooney to Tobercurry Bypass realignment and the N17 Tobercurry Bypass realignment;
- In relation to potential offsite construction activities as a result of the *Proposed Road Development*:
  - Although considered unlikely there remains a possibility as described in section 4.10.2.2.3 of this EIS that there may be a requirement to treat a portion of the onsite generated spoil material offsite. As a measure of absoluteness, section 10 of the Spoil Management Report examines the most likely sites outside the CPO which the contractor might consider if an offsite approach was required for any particular reason. The utilisation of the sites which includes conifer plantations (4 no.) and low lying agricultural lands (2 no.) is considered in each of the relevant impact assessment chapters of the EIS in a Macro sense in terms of *Indirect* and *Cumulative* Impacts.

17.2 Socio Economic

The impact of the *Proposed Road Development* on Socio-Economic is described in Chapter 6 of this EIS.

17.2.1 Operational Phase

Cumulative impacts following the construction of the *Proposed Road Development* and implementation of mitigation measures will result in major positive cumulative impacts with other road improvements on the N4 due to journey time, reliability and economic impacts extending to the North-west through the enhanced connectivity of the region. The main impacts are described below.

17.2.1.1 Journey Patterns

Under a Medium Growth scenario in the design year the traffic model predicts increases in AADT for the mid-section of the *Proposed Road Development* of 3.8% in the Opening Year of 2017 compared with the existing N4 under a Do-Minimum scenario or 3.3% in the Design Year of 2032. Compared with the Do-Something Scenario traffic on the northern section of the existing N4 will be reduced by 80% under the Medium Growth Do-Something Scenario in the Design Year compared with the Do-Minimum scenario and on the southern section of the road below Carrownagark by over 97% compared with the Do-Minimum.

Current journey times are of the order of c. 11-12 minutes in either direction (see Chapter 4 of this EIS). The proposed re-alignment would have the effect of reducing journey times and improving journey time reliability on the N4. The impact would extend to regional journeys in that current journey times are often extended by the combination of local and through traffic and by a lack of safe overtaking opportunities. These benefits to journey patterns will increase over time once the economy recovers and should the long-term trend to increased traffic volumes resume. On the basis of current traffic volumes, the *Proposed Road Development* will result in a *slight positive* impact for regional journey times in the Opening Year. This positive impact will increase over time relative to a Do-Nothing Scenario and represents a cumulative impact in combination with road improvements elsewhere on the N4. There will be a *slight positive* impact on journey time reliability too particularly for shorter trips between, for example, Sligo and Boyle.

17.2.1.2 Economic implications

In itself, the new alignment provides only slightly improved journey times and journey time reliability although these benefits will accumulate over time in comparison with the Do-Nothing Scenario. Nevertheless, there are *major positive* economic impacts in this respect due the cumulative effect of the improved road connection given similar improvements elsewhere on the N4. An economic stimulus would result from this improved connectivity especially for businesses dependent on the N4 for communication and deliveries between the North-west and the Midlands and East of the country.

17.3 Non Agricultural Property

The impact of the *Proposed Road Development* on Non-Agricultural Property is described in Chapter 7 of this EIS.

17.3.1 Operational Phase

The cumulative impacts are considered only in terms of demolition and loss of land. Other impacts, such as air quality, noise and vibration, and visual impact are dealt with in the respective chapters of the EIS.

Although there may be some perceived cumulative impacts associated with roadwork's carried out on the existing N4 in the 1980's between Toberbride Td. and Cloonamahan Td.; these are not considered in the context of the EIS considering the passing of time from the original road improvements.

17.4 Noise and Vibration

The impact of the *Proposed Road Development* on Noise and Vibration is described in Chapter 8 of this EIS.

17.4.1 Operational Phase

Cumulative impacts following the construction of the *Proposed Road Development* are however considered limited in relation to operational noise levels considering that there are no bypasses (positive impacts on congestion is limited) directly adjoining the *Proposed Road Development* and the closest adjoining section of the N17 Collooney to Tobercurry Bypass Realignment will be online as it joins the existing N4.

17.4.2 Construction Phase

Construction impacts which may arise as a result of potential offsite spoil management activities are assessed in Appendix 8.1 contained within volume 4 of this EIS. Considering the use of each of the identified sites in section 4.10.2.2.3 of this EIS, the predicted levels at all locations assessed were in the range of 56 to 65dB $L_{Aeq,1hr,}$ less than the 70dB $L_{Aeq,1hr}$ daytime criterion recommended by NRA Guidance. In relation to vibration impacts the NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities will be limited to the values recommended in the NRA Guidance and described in the aforementioned Appendix 8.1.

17.5 Air Quality and Climate Change

The impact of the *Proposed Road Development* on Air Quality and Climate Change is described in Chapter 9 of this EIS.

17.5.1 Operational Phase

Cumulative impacts following the construction of the *Proposed Road Development* are considered limited in relation to the operational phase considering that there are no bypasses (positive impacts on congestion is limited) directly adjoining the *Proposed Road Development* and the closest adjoining section of the N17 Collooney to Tobercurry Bypass Realignment will be online as it joins the existing N4.

17.5.2 Construction Phase

Construction impacts which may arise as a result of potential offsite spoil management activities are assessed in Appendix 9.3 contained within volume 4 of this EIS. Considering the use of each of the identified sites in section 4.10.2.2.3 of this EIS the following describes cumulative impacts on Air Quality and Climate:

17.5.2.1 Air Quality

The emissions from the potential peat deposition processes leads to a dust deposition level averaged over the full year of 40.1 mg/(m^2*day) at the worst-case receptor (see Table 17-1). Based on a background deposition rate of 59 mg/(m^2*day) in the region of the subject site, the combined dust deposition level including the proposed peat deposition peaks at 99.1 mg/(m^2*day) which is only 28% of the TA Luft Limit Value of 350 mg/(m^2*day).

Predicted PM_{10} concentrations are significantly lower than the ambient air quality standards at the nearest residential receptors (see Table 17-1). The predicted 24-hour and annual concentrations (excluding background) at the worst-case receptor peak at 19.4 and 7.8µg/m^3 respectively. Based on a background PM_{10} concentration of 15 µg/m^3 the combined annual PM_{10} concentration including the proposed peat deposition peaks at 22.8µg/m^3. This predicted level equates to at most 57% of the annual limit value of 40µg/m^3. The predicted 24-hour PM_{10} concentration (including background) peaks at 34.4 µg/m^3 which is 69% of the 24-hour limit value of 50µg/m^3 (measured as a 90th%ile).

Predicted $PM_{2.5}$ concentrations at the nearest residential receptors are significantly lower than the limit value of 25 µg/m^3 which will be in place after 2015 (see Table A9.3.1). The predicted annual concentration (excluding background) at the worst-case residential receptor peaks at 0.8 µg/m^3. Based on a background $PM_{2.5}$ concentration of 9.8 µg/m^3 in the region of the facility, the annual $PM_{2.5}$ concentration including the proposed peat deposition operations peaks at 10.6 µg/m^3. This peak level equates to 42% of the annual limit value for $PM_{2.5}$.

Table 17-1: Modelled Dust Deposition Level, PM_{10} Concentration and $PM_{2.5}$ Concentration Resulting From Potential Repository Sites outside the CPO

Pollutant	Predicted Deposition and Concentration [Note 1]		Limit Value
	Excl. Bkg	Incl. Bkg [Note 2]	
Dust Deposition (Worst-case Residential Receptor)	40.1	99.1	350 [Note 3]
PM_{10} - Annual Average (Worst-case Residential Receptor)	7.8	22.8	40 [Note 4]
PM_{10} - Maximum 24-hr (90th%ile) (Worst-case Residential Receptor)	19.4	34.4 [Note 6]	50 [Note 5]
$PM_{2.5}$ - Annual Average (Worst-case Residential Receptor)	0.8	10.6	25 [Note 4]

Note 1: Units: dust deposition - mg/(m^2*day); PM_{10} / $PM_{2.5}$ - µg/m^3

Note 2: Includes background concentrations: dust deposition = 59 mg/(m^2*day); PM_{10} = 15 µg/m^3; $PM_{2.5}$ = 9.8 µg/m^3

Note 3: TA Luft Dust Deposition Limit = 350 mg/(m^2*day)

Note 4: EU Council Directive 2008/50/EC (S.I.180 of 2011). Annual average limit value

Note 5: EU Council Directive 2008/50/EC (S.I.180 of 2011). 24-hr limit of 50 µg/m^3 not to be exceeded >35 times/year (90.4th%ile)

Note 6: Short-term peak concentration calculated in accordance with guidance from the UK DEFRA (UK DEFRA 2009a)

17.5.2.2 Climate Change

The emissions from peat extraction and deposition have been compared with the estimated total GHG emissions in Ireland in 2010 based on compliance with the Kyoto Target (DEHLG, 2000). The contribution to the total GHG emissions (which is assumed to be 62.8 million tonnes CO_2eq in 2010 (i.e. the Kyoto Target) is 0.0005% of the total in Ireland in that year and thus is an insignificant source of greenhouse gas emissions.

17.6 Landscape & Visual

The impact of the *Proposed Road Development* in terms of Landscape and Visual Impacts are described in Chapter 10 of this EIS.

17.6.1 Operational Phase

17.6.1.1 Landscape Effects

With the *Proposed Road Development* a second major transport corridor in addition to the existing N4 will be introduced into this rural working landscape. As outlined above the new road surface and infrastructure will result in the severance of field pattern, hill slopes and interruption of boundaries. It will also introduce additional traffic movement, lighting and noise to the region. Cumulative landscape effects are, however, not considered to be critical in this case, due to the substantial spatial separation between both alignments for the majority of the *Proposed Road Development* and their diverse and undulating marginal farmland setting. The existing bypassed N4 alignment sections are also expected to evolve into a quieter country road which will be clearly subordinate to the much broader proposed new road corridor. For this reason both alignments will appear as largely insulated stand alone route corridors throughout the majority of the offline sections of the *Proposed Road Development*. An increased combined massing of both alignments will be largely limited to the tie in locations of both alignments at Doorly to the north and Castlebaldwin to the south of the *Proposed Road Developments* and at the proposed overpass at Ardloy/ Springfield Hill.

17.6.1.2 Visual Effects

The proposed road development will introduce visual intrusion resulting from the substantial road corridor, associated road infrastructure and the additional traffic movement into the region. The considerable spatial separation between the existing and proposed N4 alignments, the undulating farmland and peatland setting of both alignments and the extensive screening by established roadside vegetation along many parts of the existing N4 will provide a considerable visual separation between both road corridors. In addition there will be a clear visual hierarchy between the dual carriage way corridor functioning as the main transportation link within this wider rural setting and the existing single carriage way which is anticipated to become a much less frequented local access road. For these reasons cumulative visual impacts resulting from additional changes caused by the *Proposed Road Development* in conjunction with the existing N4 alignment are not considered to be critical.

17.6.2 Construction Phase

Section 10.2.5.3 of chapter 10 outlines potential cumulative impacts as a result of the *Proposed Road Development*. This includes six sites outside of the CPO which include areas such as conifer plantations and low lying agricultural lands. Residual landscape and visual impacts for deposit areas identified in section 10 of the Spoil Management Report (appendix 4.3 in volume 4 of this EIS) are considered to range from 'Imperceptible' to 'Slight Adverse' within existing conifer plantation and agricultural sites with the exception of one site, which is considered to result in 'Slight to Moderate Adverse' impacts. In the case that all 6 sites should be utilized cumulative residual landscape and visual impacts are considered to be 'Slight to Moderate Adverse'

17.7 Agricultural Property

The impact of the *Proposed Road Development* on Agricultural Properties is described in Chapter 11 of this EIS.

17.7.1 Operational Phase

Cumulative impacts following the construction of the *Proposed Road Development* and implementation of mitigation measures includes in the main cumulative impacts on properties affected by a reduction in traffic levels along the existing N4. Movement of agricultural traffic will continue to use the local road network including the existing N4. The reduced traffic levels using the existing N4 will have a beneficial impact on agriculture.

There are also cumulative impacts in consideration of recent road upgrades particularly in relation to the recent N4 Ardloy Bends upgrade, where additional landtake is now required on the landowner group 228 which is depicted on Figure 11.1.6 contained within volume 3 of this EIS. Impacts from the *Proposed Road Development* on these properties are described in appendix 11.2 contained within volume 4 of this EIS.

17.8Flora, Fauna and Fisheries

The impact of the *Proposed Road Development* on Flora, Fauna and Fisheries is described in Chapter 12 of this EIS.

17.8.1 Operational Phase

Cumulative impacts affecting the flora and fauna within the zone of influence of the *Proposed Road Development* include pressures arising from agriculture, land drainage, one off housing, forestry operations, drainage maintenance works on the aquatic habitats within the Unshin River catchment (particularly within the cSAC) and also further agricultural land reclamation works affecting the fen and wetland habitats within the study area. Further cumulative impacts would be expected to affect mobile fauna within the study area, particularly arising from the continued use of the existing N4 corridor, with further traffic disturbance and habitat fragmentation along the proposed new road corridor. The study area is relatively free of non-native invasive species; however, Japanese knotweed was recorded at a number of discrete locations along the existing N4 during the survey work undertaken during 2012.

17.8.2 Construction Phase

Construction impacts which may arise as a result of potential offsite spoil management activities are assessed within Chapter 12 of this EIS. These sites which include LDCP 01, 04, 05 & 06 and LDAG01 & 02 have been assessed from an ecological perspective and are not considered to give rise to any significant cumulative impacts with respect to the *Proposed Road Development*.

17.9 Soils and Geology

The impact of the *Proposed Road Development* on Soils and Geology is described in Chapter 13 of this EIS. The main cumulative impacts as a result of the *Proposed Road Development* are in relation to Construction Phase Impacts as described below.

17.9.1 Construction Phase

The cumulative impacts of the *Proposed Road Development* are the combination of many minor impacts creating one, larger, more significant impact. The potential impacts of the N4 Collooney to Castlebaldwin *Proposed Road Development* on the geological aspects of the environment must be considered in combination with the potential impacts of the N17 Collooney to Tobercurry Bypass and the N17 Tobercurry Bypass *Proposed Road Developments*. The upgrade to the N17 Collooney to Tobercurry Bypass is approximately 14km in length and the upgrade to the N17 Tobercurry Bypass is approximately 11km in length.

The attribute ratings and potential impacts are considered to remain the same, as these routes are underlain by similar soil, subsoil, bedrock and structural geology, have a similar occurrence of karst features and are underlain by a similar proportion of soft soil material. However no potentially contaminated sites have been identified along these routes.

The change to the soil structure of soft materials is a likely indirect impact to the soil geology on any lands outside of the CPO which could potentially be used for the disposal/recovery of 'unsuitable' geological materials. Potential sites which are considered to be broadly suitable for such a purpose are described in section 10 of the Spoil Management Report (appendix 4.3 of volume 4) and include adjacent conifer plantations and low lying agricultural lands.

The integration of surplus materials for the purpose of disposal/recovery of 'unsuitable' geological materials may cause compaction of the underlying indigenous topsoil. The importance of this attribute is rated low, the magnitude of this impact is rated as moderate adverse, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated slight.

The change to the soil structure of soft subsoil materials is a likely indirect impact to the soil geology on any lands outside of the CPO used for the disposal/recovery of 'unsuitable' geological materials. The integration of surplus materials for the purpose of disposal/ recovery of 'unsuitable' geological materials may also cause compaction of the underlying indigenous topsoil. The importance of this attribute is rated medium, the magnitude of this impact is rated as moderate adverse, where a moderate proportion of peat and soft materials require excavation and replacement, and therefore the significance of this impact is rated moderate.

The change in soil chemistry as a result of the integration of surplus peat materials is a likely indirect impact on the soil chemistry during the construction phase. In particular, the introduction to an area, which does not naturally contain peat may reduce soil pH and increase soil Total Organic Carbon. The importance of the soil geology and subsoil geology is rated low and medium respectively; the magnitude of this impact is rated as small adverse, and therefore the significance of this impact on the soil and subsoil geology is rated

imperceptible and slight respectively. The associated impacts on water quality are discussed in the Hydrological and Hydro-geological Impact Assessment Chapter.

17.10 Hydrology and Hydrogeology

The impact of the *Proposed Road Development* on Hydrology and Hydro-Geology is described Chapter 14 of this EIS. The main cumulative impacts as a result of the *Proposed Road Development* are in relation to Construction Phase Impacts as described below.

17.10.1 Construction Phase

Section 10 of the Spoil Management Report (appendix 4.3 of volume 4) considers that although unlikely there is some potential that the deposition of materials offsite may be required. In order to consider such an activity; numerous sites are identified in the aforementioned section of the Spoil Management Report to be broadly suitable for such a purpose and are considered in terms of both cumulative and indirect impacts.

Potential sites which are considered to be broadly suitable for such a purpose are described in section 10 of the Spoil Management Report (appendix 4.3 of volume 4) and include adjacent conifer plantations and low lying agricultural lands. These impacts are considered negligible and imperceptible in nature.

17.11 Archaeology, Architecture and Cultural Heritage

The impact of the *Proposed Road Development* on Archaeology, Architecture and Cultural Heritage is described in Chapter 15 of this EIS. The main cumulative impacts as a result of the *Proposed Road Development* are in relation to Construction Phase Impacts as described below.

17.11.1 Construction Phase

A potential cumulative impact of the *Proposed Road Development* is the potential spoil management activity which may be required offsite (outside the CPO of the *Proposed Road Development*) as outlined in Chapter 4 of this EIS. An assessment has been undertaken in accordance with the Spoil Management Report (appendix 4.3 in volume 4), which outlines a Range of Options in the vicinity of the *Proposed Road Development* which may be considered suitable in principle to accept land spreading/deposition operations, insofar as, placement of subsoil and peat materials on those sites would not pose a threat to human health or the environment. It will be a matter for the contractor to source such sites (if it is deemed required), however, the established potential sites (outside the CPO) described below and in section 10 of the *aforementioned* Spoil Management Report allows for the cumulative impacts (in the context of this Chapter) of such an activity to be assessed. The potential sites include those options which are described as Options 2 (Conifer Plantations) and 4 (Agricultural Lands) in the aforementioned report.

17.11.1.1 Option 2 Sites (Conifer Plantations)

There are no known built heritage sites within the identified *Option 2* areas. The potential Option 2 areas are all potentially located in wetland areas and are thus considered to have archaeological potential. These areas and any sub-surface archaeological sites, features or artefacts that may be within them would be directly impacted upon. In order to mitigate for this direct and potentially significant impact archaeological testing will be required. This will ensure that archaeological sites are identified and where such sites cannot be preserved *in situ* then they should be preserved by record by means of archaeological excavation. Any artefacts removed from their wetland context during excavation will probably require conservation prior to being curated in a museum. The site of a possible structure is located in area LD CP 02 and area LD CP 03 is located just south of a barrow (SL027-173). Testing in these areas will identify any features that may be associated with these sites.

The macro effect of developing *Option 2* is that the number and size of wetland areas in the environs of the proposed road will be reduced. Works may impact directly on previously unknown archaeological sites and may necessitate preservation by record of such sites.

Table 17-2: Option 2 sites; Potential Impacts and Potential Mitigation.

Townland	Site Type	Type of Impact	Relevant area/s	Distance from individual LP CD area (metres)	Impact Significance	Possible Mitigation
Spotfield	Wetland AAP	Direct	LD CP 01	0m	Potentially moderate	Test trenching
Turnalaydan	Wetland AAP	Direct	LD CP 02	0m	Potentially moderate	Test trenching
Turnalaydan	Site of possible outhouse or structure	Direct	LD CP 02	0m	Potentially moderate	Test trenching
Murillyroe/ Cooperhill	Stream as townland boundary	Direct	LD CP 03	0m	Potentially moderate	Wade survey and Townland Boundary Survey
Coolbock	Possible Barrow SL027-173	Indirect	LD CP 03	20m	Slight	Test trenching and excavation if necessary.
Murillyroe	Wetland AAP	Direct	LD CP 03	0m	Potentially moderate	Test trenching
Clooneen/ Branchfield	Wetland AAP	Direct	LD CP 04	0m	Potentially moderate	Test trenching
Clooneen	Wetland AAP	Direct	LD CP 05	0m	Potentially moderate	Test trenching
Cloonlurg and Cloneen	Stream as townland boundary	Direct	LD CP 06	0m	Potentially moderate	Wade survey and Townland Boundary Survey
Cloonlurg and Clooneen	Wetland AAP	Direct	LD CP 06	0m	Potentially moderate	Test trenching
Cloonlurg and Carrownagark	Wetland AAP	Direct	LD CP 07	0m	Potentially moderate	Test trenching

17.11.1.2 Option 4 sites (Agricultural Lands)

There are no known built heritage sites within the identified *Option 4* areas. These two areas are located in wetland and are thus considered to have archaeological potential. These areas and any sub-surface archaeological sites, features or artefacts that may be within them would be directly impacted upon. In order to mitigate for this direct and potentially significant impact archaeological testing will be required. This will ensure that archaeological sites are identified and where such sites cannot be preserved *in situ* then they should be preserved by record by means of archaeological excavation. Any artefacts removed from their wetland context during excavation will probably require conservation prior to being curated in a museum.

The macro effect of developing *Option 4* is that the number and size of wetland areas in the environs of the proposed road will be reduced. Works may impact directly on previously unknown archaeological sites and may necessitate preservation by record of such sites

Table 17-3: Option 4 sites; Potential Impacts and Potential Mitigation.

Townland	Site Type	Type of Impact	Relevant area/s	Distance from individual LP CD area (metres)	Impact Significance	Possible Mitigation
Cloonymeenaghan	Wetland AAP	Direct	LD AG 01 LD AG 02	0m	Potentially moderate	Test trenching
Cloonymeenaghan/Cloongad	Townland boundary as stream	Direct	LD AG 02	0m	Potentially significant	Wade survey and Townland Boundary Survey

17.11.1.3 Macro impact post mitigation

Mitigation in the form of targeted test trenching would allow for the identification of any archaeological features within the possible waste areas. The test trenching would also assess the impact of the waste area on such sites/features and based on the results of test excavations the Heritage Authorities will advise on the appropriate mitigation; either preservation *in situ* or preservation by record by means of archaeological excavation. Once this mitigation has been completed the overall impact is that where archaeological sites or features or parts thereof have been removed these will be preserved by record. In a wider context the setting of such features or sites will be permanently altered.