i. Preface

THIS ENVIRONMENTAL IMPACT ASSESSMENT REPORT 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*	*Fergus Meehan*[1]	*February 2019*	*Emer Concannon*[2]

[1] *B.Eng., PgDip. Env., C.Eng MIEI*

[2] *B.Eng., MBA, C.Eng MIEI*

ii. Acknowledgments

This Environmental Impact Assessment Report (hereafter referred to as **EIAR**), has been prepared and coordinated by the TII National Roads Project Office of Sligo County Council, under the auspices of Transport Infrastructure Ireland. The following are the key bodies responsible for the project delivery. The qualifications and experience of the key team members are outlined in section 1.2 of this EIAR.

Table 1-1: N16 Lugatober, Project Team – Engineering & Project Management

Study/Element	Body Responsible
Engineering & Project Management	TII National Roads Project Office (Sligo County Council)
Ground Investigation (& Factual Report)	Priority Geotechnical
Stage 1 Road Safety Audit	Atkins
Geotechnical Interpretive Report	Roughan & O'Donovan

Table 1-2: N16 Lugatober, Project Team – Environment

Study/Element	Body Responsible
Population & Human Health	Optimize Consulting and Dr. Martin Hogan
Noise & Vibration	Envest Environmental
Air Quality & Climate Change	
Biodiversity	McCarthy Keville O' Sullivan (with input from Denyer Ecology and Dr. Maria Long)
Soils and Geology	Barry Transportation
Hydrology & Hydrogeology	Hydro Environmental (Galway)
Landscape & Visual	RPS Ireland Ltd.
Material Assets and Land – Agriculture	John Bligh & Associates
Material Assets and Land – Non-Agriculture	
Archaeology, Architecture & Cultural Heritage	CRDS

iii. List of Abbreviations

Abbreviation	Meaning
EIAR	Environmental Impact Assessment Report
AADT	Annual Average Daily Traffic
AAP	Area of Archaeological Potential
AQML	Air Quality Monitoring Location
ASL	Above Sea Level
BCI	Bat Conservation Ireland
BOD	Biochemical Oxygen Demand
BS	British Standards
CAFE	Clean Air for Europe
CBR	California Bearing Ratio
CHC	Cultural Heritage Constraint
CIEEM	Chartered Institute of Ecology and Environmental Management
CO	Carbon Monoxide
CPO	Compulsory Purchase Order
CSM	Conceptual Site Model
CTRN	Calculation of Road Traffic Noise
DAU	Development Applications Unit
DEFRA	Department of Environment, Food and Rural Affairs (UK)
DMRB	Design Manual for Roads and Bridges
EC	European Commission
ED	Electoral Division
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EU	European Union
GHG	Greenhouse Gases
GIS	Geographical Information Systems
GSI	Geological Survey of Ireland
GWB	Ground Water Body
HAWRAT	Highways Agency Water Risk Assessment Tool
HGV	Heavy Goods Vehicles
HIA	Health Impact Assessment

Abbreviation	Meaning
IAS	Invasive Alien Species
IEMA	Institute of Environmental Management Agency
IEMA	Institute for Environmental Management and Assessment
IGI	Institute og Geologists of Ireland
ISO	International Standards Organisation
KER	Key Ecological Receptor
LAP	Local Area Plan
LCA	Landscape Character Area
LVIA	Landscape and Visual Impact Assessment
NHA	Natural Heritage Area
NIS	Natura Impact Statement
NMI	National Museum of Ireland
NML	Noise Monitoring Location
NPWS	National Parks and Wildlife Services
NRA	National Roads Authority
OD	Ordinance Datum
OESCP	Outline Erosion and Sediment Control Plan
OPW	Office of Public Works
OSi	Ordinance Survey of Ireland
PM	Particulate Matter
PPV	Peak Particle Velocity
QI	Qualifying Interests
RMP	Record of Monuments and Places
SAAR	Standard Average Annual Rainfall
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SLM	Specific Landscape Mitigation
SPA	Special Protection Area
SUDS	Sustainable Drainage Systems
TII	Transport Infrastructure Ireland
TRP	Threat Response Plan
VRU	Vulnerable Road Users
WHO	World Health Organisation

Abbreviation	Meaning
WRAP	Winter Rainfall Exceedance Potential
ZOI	Zone of Influence
ZTV	Zone of Theoretical Visibility

iv. Glossary of Terms

Below is a partial glossary of some of the more common 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)
Attenuation pond	Pond used for the collection and slow release of run-off
Borrow Pit	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*
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
Embankment (Fill)	Section of earthworks where the indicative road level is above the original/existing ground level
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
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.

v. Additional Information

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

- N16 Sligo to County Boundary Route Selection Report (2017)[3];
- EIAR Screening Report, Sligo County Council, 2017;
- EIA Informal Scoping Report, Sligo County Council, 2018;
- Priority Geotechnical Limited: N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) Road Project Ground Investigation Contract Factual Report No. P18008;
- N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*), Stage 1 Road Safety Audit, October 2018;
- References to the Main Report of the EIAR.

[3] http://www.sligococo.ie/N16/RouteSelectionReport/

vi. MAIN REPORT

TABLE OF CONTENTS

Part 1 – Background Information/General Description

This document represents an EIAR, which can be defined as *… a report of the effects, if any, which proposed development, if carried out, would have on the environment …*[4]

This section of the EIAR provides an introduction to the EIAR (Chapter 1), outlines the need, and related policy (Chapter 2), the alternatives considered (Chapter 3), and the characteristics of the *Proposed Road Development* (Chapter 4).

All proposed works indicated in this EIAR and shown on drawings are part of a design developed in accordance with Phase 3 (Design & Environmental Evaluation) of the TII Project Management Guidelines (2017).

While a decision on the exact contractual arrangements for the construction of the *Proposed Road Development* has not yet been made, the eventual Contractor for the works will be contractually bound within the contract by any conditions arising from the site constraints, the commitments and mitigation measures set out in the EIAR, the employers requirements for the project, any modifications that may be imposed on the *Proposed Road Development* by An Bord Pleanála and any conditions imposed by An Bord Pleanála and or other Statutory Regulations. This may incorporate alternative details, provided it can be demonstrated that these details provide the same performance criteria (or higher) than the design and construction management criteria set out in Chapter 4 of this EIAR (including those management considerations outlined in the Erosion & Sediment Control Plan contained within Volume 4 of this EIAR).

[4] Planning & Development Act (2000) as amended By S.I. No. 296 Of 2018 European Union (Planning And Development) (Environmental Impact Assessment) Regulations 2018.

1 Introduction & Background

1.1 General

Sligo County Council (SCC), under the auspices of Transport Infrastructure Ireland (TII), are developing a project (hereafter referred to as the *Proposed Road Development*) to upgrade a section of the N16 National Primary Route between the townlands of *Drumkilsellagh* and *Lugnagall* in the north-east of County Sligo.

An overview of the location of the *Proposed Road Development* is given in Figure 1.0 contained within Volume 3 of this EIAR. A separate Non-Technical summary of the EIAR (Volume 1) is also available in accordance with statutory requirements.

1.2 Engineering Design and EIAR Study Team

This EIAR has been prepared by experts over a range of disciplines including *inter-alia* Engineering, Project Management and Environmental assessment. The following Table 1-1 outlines the key leaders of each relevant discipline, their main qualifications and level of experience.

Table 1-1: EIAR – Key Team Members

Topic	Specialist Contributor	Organisation/ Company	Relevant Qualifications	Experience (Years)
Engineering and project management.	Fergus Meehan	TII National Roads Project Office (Sligo County Council)	B.Eng (Hons), P.G Dip Env. Eng., C. Eng MIEI.	16
Population & Human Health	Craig Bullock	Optimize Consultants	MSc Env. Econ., PhD Env. Economics	32
	Dr. Martin Hogan	Corporate Health Ireland	MB. BCh BAO, Dip Child Health, Dip Obstetrics.	30
Biodiversity	Pat Roberts	McCarthy, Keville O' Sullivan	Ecology and Environmental Science B.Sc. (Env.) (Hons) NUIG, 2005 MCIEEM, M.Arbor.	13
	John Hynes		M.Sc. (Applied Ecology), MCIEEM	7
Biodiversity (Annex I habitats)	Dr. Joanne Denyer	Denyer Ecology	DPhil, BSc (Hons), MIEEM	17
Biodiversity (Whorl Snails)	Dr. Maria Long	N/A	PhD, MSc (Conservation and Management), BSc (Zoology), MCIEEM	18
Soils & Geology	Deirdre O'Hara	Barry Transportation	BSc, MSc, HDip, PM, CEng MIEI	19
Hydrology & Hydrogeology	Tony Cawley	Hydro Environmental	BE(Civil), MSc.Eng Hydrology & Hydrogeology.	27
Landscape & Visual	Raymond Holbeach	RPS	BSc Hons Env Sc CMLI	27
Noise & Vibration	Mervyn Keegan	Envest Environmental	B.Sc, M.Sc. MIoA	19

Topic	Specialist Contributor	Organisation/ Company	Relevant Qualifications	Experience (Years)
Air Quality & Climate Change				
Archaeology, Architecture & Cultural Heritage	Aislinn Collins	CRDS	BSc. (Hons) MA, PGDip Dip EIA Mgmt	18
Material Assets & Land - Agricultural Property	John Bligh	John Bligh & Associates	MSc Environmental Systems; BAgrSc	20
Material Assets & Land - Non Agricultural Property	John Bligh	John Bligh & Associates	MSc Environmental Systems; BAgrSc	20

1.3 An Introduction to the Environmental Impact Assessment Report and the Environmental Impact Assessment

This EIAR has been undertaken in order to permit an Environmental Impact Assessment (EIA) to be undertaken by the Competent Authority (An Bord Pleanála). It contains information on the likely significant environmental effects (both positive and negative) of the *Proposed Road Development* and the measures proposed to mitigate those effects.

Article 1(2)(g) of Directive 2011/92/EU (on the assessment of the effects of certain public and private projects on the environment) as amended by Directive 2014/52/EU (hereinafter referred to the 'EIA Directive') defines EIA to be that outlined in Quote 1-1.

Quote 1-1: Article 1(2)(g) of the EIA Directive (as amended)

> *(i) the preparation of an environmental impact assessment report by the developer, as referred to in Article 5(1) and(2);*
> *(ii) the carrying out of consultations as referred to in Article 6 and, where relevant, Article 7;*
> *(iii) the examination by the competent authority of the information presented in the environmental impact assessment report and any supplementary information provided, where necessary, by the developer in accordance with Article 5(3), and any relevant information received through the consultations under Articles 6 and 7;*
> *(iv) the reasoned conclusion by the competent authority on the significant effects of the project on the environment, taking into account the results of the examination referred to in point (iii) and, where appropriate, its own supplementary examination; and;*
> *(v) the integration of the competent authority's reasoned conclusion into any of the decisions referred to in Article 8a.*

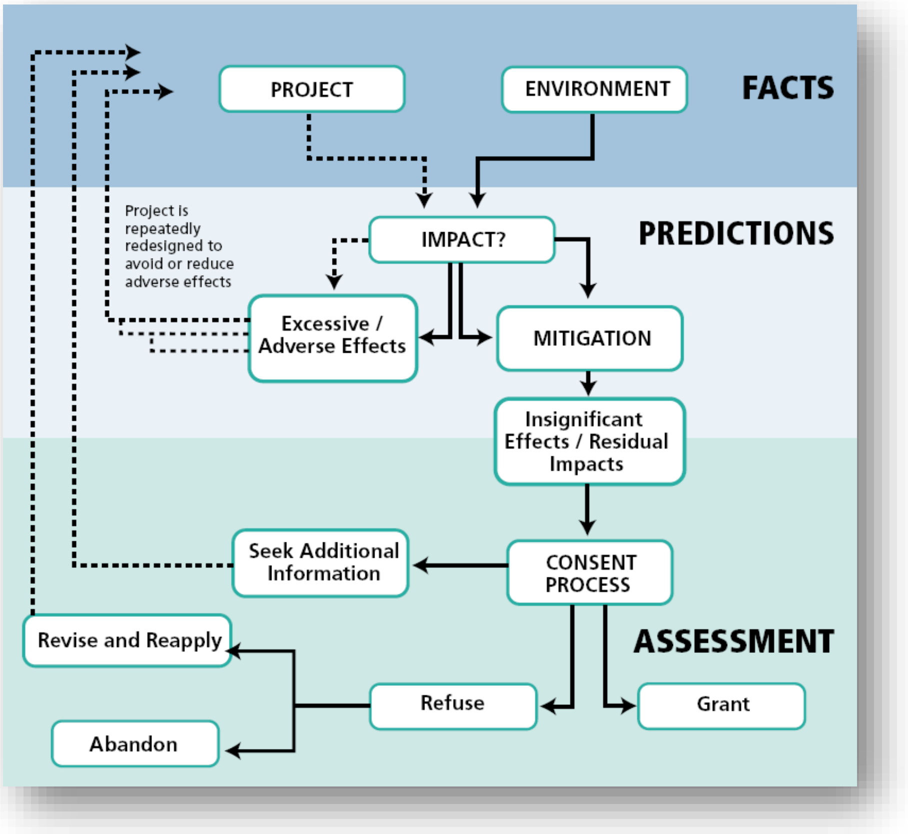
Article 3(1) of the EIA Directive (as amended), as outlined in Quote 1-2, refers further to the provisions of EIA.

Quote 1-2: Article 3(1) of the EIA Directive (as amended)

> *(1) The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors:*
> *(a) population and human health;*
> *(b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC;*
> *(c) land, soil, water, air and climate;*
> *(d) material assets, cultural heritage and the landscape*
> *(e) the interaction between the factors referred to in points (a) to (d).*

The EPA *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (Draft August 2017), describes an EIAR as a process with several clear and distinct stages. The first stage consists of a compilation of facts – i.e. the description of the existing environment and the description of the proposed project. The second stage consists of predictions of likely effects – this may be carried out a few times as the design is improved to eliminate excessive adverse effects. The final stage consists of the assessment of the environmental effects as part of a consent process which may decide to grant, condition, refuse or seek additional information.

Figure 1-1: Key Stages in the preparation of an EIAR and the EIA process.[5]



In accordance with Annex IV of the EIA Directive (as amended), an EIAR is required to present the information outlined in Quote 1-3.

Quote 1-3: Information referred to in Article 5(1) of the EIA Directive (as amended)

> *A Description of the project, including in particular:*
>
> *(a) description of the location of the project;*
> *(b) a description of the physical characteristics of the whole project, including, where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases;*
> *(c) a description of the main characteristics of the operational phase of the project (in particular any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used;*
> *(d) an estimate, by type and quantity, of expected residues and emissions (such as water, air, and soil and subsoil pollution, noise, vibration, light, heat, radiation) and quantities and types of waste produced during the construction and operation phases.*
>
> *(2) A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.*
> *(3) A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.*
> *(4) A description of the factors specified in Article 3(1) likely to be significantly affected by the project: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion,*

[5] As extracted from the EPA *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (Draft August 2017)

compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.

(5) A description of the likely significant effects of the project on the environment resulting from, inter alia:
  - *(a) the construction and existence of the project, including, where relevant, demolition works;*
  - *(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;*
  - *(c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;*
  - *(d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters)*
  - *(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;*
  - *(f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;*
  - *(g) the technologies and the substances used.*

The description of the likely significant effects on the factors specified in Article 3(1) should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium- term and long-term, permanent and temporary, positive and negative effects of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project.

(6) A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.

(7) A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases.

(8) A description of the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council or Council Directive 2009/71/Euratom or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met. W here appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.

(9) A non-technical summary of the information provided under points 1 to 8.

(10) A reference list detailing the sources used for the descriptions and assessments included in the report.[6]

1.4 EIA Screening

EIA Screening in relation to the *Proposed Road Development* took place with the submission of a screening report to An Bord Pleanála in December 2017 and followed with a direction from the Board to prepare an EIAR in April 2018.

The following paragraphs present a synopsis of the main European (Section 1.4.1) and National (Section 1.4.2) legislative triggers for EIA. It then provides an overview of the basis for the direction (Section 1.4.3) received from An Bord Pleanála.

1.4.1 **EIA Directive**

The requirements for Screening are contained in Article 4, Annex IIA, and Annex III to the EIA Directive (as amended). The relevant provisions of these sections are outlined in the proceeding paragraphs.

1.4.1.1 Article 4

Quote 1-4: Article 4 of the EIA Directive (as amended)

1. *Subject to Article 2(4), projects listed in Annex I shall be made subject to an assessment in accordance with Articles 5 to 10.*
2. *Subject to Article 2(4), for projects listed in Annex II, Member States shall determine whether the project shall be made subject to an assessment in accordance with Articles 5 to 10. Member States shall make that determination through:*

[6] Annex IV of the EIA Directive (as amended)

> a. *a case-by-case examination; or*
> b. *thresholds or criteria set by the Member State.*
>
> *Member States may decide to apply both procedures referred to in points (a) and (b).*
>
> 3. *Where a case-by-case examination is carried out or thresholds or criteria are set for the purpose of paragraph 2, the relevant selection criteria set out in Annex III shall be taken into account. Member States may set thresholds or criteria to determine when projects need not undergo either the determination under paragraphs 4 and 5 or an environmental impact assessment, and/or thresholds or criteria to determine when projects shall in any case be made subject to an environmental impact assessment without undergoing a determination set out under paragraphs 4 and* 5.
> 4. *Where Member States decide to require a determination for projects listed in Annex II, the developer shall provide information on the characteristics of the project and its likely significant effects on the environment. The detailed list of information to be provided is specified in Annex IIA. The developer shall take into account, where relevant, the available results of other relevant assessments of the effects on the environment carried out pursuant to Union legislation other than this Directive. The developer may also provide a description of any features of the project and/or measures envisaged to avoid or prevent what might otherwise have been significant adverse effects on the environment.*
> 5. *The competent authority shall make its determination, on the basis of the information provided by the developer in accordance with paragraph 4 taking into account, where relevant, the results of preliminary verifications or assessments of the effects on the environment carried out pursuant to Union legislation other than this Directive. The determination shall be made available to the public and:*
>   a. *where it is decided that an environmental impact assessment is required, state the main reasons for requiring such assessment with reference to the relevant criteria listed in Annex III; or*
>   b. *where it is decided that an environmental impact assessment is not required, state the main reasons for not requiring such assessment with reference to the relevant criteria listed in Annex III, and, where proposed by the developer, state any features of the project and/or measures envisaged to avoid or prevent what might otherwise have been significant adverse effects on the environment.*
> 6. *Member States shall ensure that the competent authority makes its determination as soon as possible and within a period of time not exceeding 90 days from the date on which the developer has submitted all the information required pursuant to paragraph 4. In exceptional cases, for instance relating to the nature, complexity, location or size of the project, the competent authority may extend that deadline to make its determination; in that event, the competent authority shall inform the developer in writing of the reasons justifying the extension and of the date when its determination is expected.*

1.4.1.2 Annex I

In terms of road projects, Annex I to the Directive, requires a mandatory EIA for those projects outlined in Quote 1-5.

Quote 1-5: EU Directive; Annex I, Projects referred to in Article 4(1)

> *7. ...*
> *(b) Construction of motorways and express roads;*
> *(c) Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road or realigned and/or widened section of road would be 10 km or more in a continuous length...*

The *Proposed Road Development* did not fall within the mandatory requirements of either 7 (b) or 7 (c).

1.4.1.3 Annex II

Annex II to the Directive outlines the project types in respect of which discretion is afforded to Member States to determine whether the project shall be made subject to an EIA, either by the imposition of:

(a) a case-by-case examination; or
(b) thresholds or criteria set by the Member State.

Ireland has set thresholds for the projects listed in Annex II of the Directive. EIA is mandatory for any project which equal or exceed these thresholds. Projects which fall below these thresholds are subject to a screening process, to determine whether the project would be likely to have significant effects on the environment. Annex IIA of the Directive outlines the information which must be provided by the developer when a project is to be screened for EIA.

In terms of Infrastructure projects the *Proposed Road Development* falls within this category as it constitutes the *...Construction of roads...* as per Quote 1-6.

Quote 1-6: EU Directive; Annex II, Projects referred to in Article 4(2)

> *10. INFRASTRUCTURE PROJECTS...*
> *...(e) Construction of roads, harbours and port installations, including fishing harbours (projects not included in Annex I);...*

Considering the foregoing, thresholds set by Ireland are examined in section 1.4.2.

1.4.2 Irish Legislation

In relation to roads projects, the requirements of the EIA Directive[7] had been transposed into Irish legislation by, *inter alia*, Sections 50 and 51 of the Roads Act (as amended) 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 as outlined in *Table 1-2* and where, therefore, there is a mandatory requirement to undertake an EIA; and
- Those projects that are sub-threshold (Table 1-3) 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.

Table 1-2: Summary of Mandatory Legislative Requirements for EIA (Pre transposition of the 2014 amendment to the Directive)

Mandatory Threshold	Regulatory Reference
Construction of a Motorway	S. 50(1)(a) of the Roads Act, 1993, as substituted by S. 9(1)(d)(i) of the Roads Act, 2007
Construction of a Busway	S. 50(1)(a) of the Roads Act, 1993, as substituted by S. 9(1)(d)(i) of the Roads Act, 2007
Construction of a Service Area	S. 50(1)(a) of the Roads Act, 1993, as substituted by S. 9(1)(d)(i) of the Roads Act, 2007
Prescribed type of proposed road development: • *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* • *The construction of a new bridge or tunnel which would be 100 metres or more in length*	Article 8 of the Roads Regulations, 1994 (Road development prescribed for the purposes of S. 50(1)(a) of the Roads Act, 1993.)

Table 1-3: Summary of Sub-threshold Requirements for EIA (Pre transposition of the 2014 amendment to the Directive)

Sub-Threshold Requirements	Regulatory Reference
Where An Bord Pleanála (ABP) considers that a proposed road development would be likely to have significant effects on the environment it shall direct the road authority to prepare an EIS.	S. 50(1)(b) of the Roads Act, 1993.
Where a road authority considers that a proposed road development would be likely to have significant effects on the environment it shall inform ABP in writing and where ABP concurs it shall direct the road authority to prepare an EIS.	S. 50(1)(c) of the Roads Act, 1993.
F41[8][(*d*) Where a proposed road development (other than development to which paragraph (*a*) applies) consisting of the construction of a proposed	S. 50(1)(d) of the Roads Act, 1993, as amended.

[7] Transpositions of the 2014 amendment in relation to the Roads Act had not taken place at the time of EIA Screening.

[8] Inserted (1.05.1999) by European Communities (Environmental Impact Assessment) (Amendment) Regulations 1999 (S.I. No. 93 of 1999), reg. 14(a) and (c)

Sub-Threshold Requirements	Regulatory Reference
public road or the improvement of an existing public road would be located on: F42[9][(i) a European Site, meaning (I) a candidate site of Community importance, (II) a site of Community importance, (III) a candidate special area of conservation, (IV) a special area of conservation, (V) a candidate special protection area, or (VI) a special protection area] (ii) F43[10][...] (iii) F43[...] (iv) F43[...] (v) land established or recognised as a nature reserve within the meaning of section 15 or 16 of the Wildlife Act, 1976 (No. 39 of 1976), (vi) land designated as a refuge for fauna under section 17 of the Wildlife Act, 1976 (No. 39 of 1976), the road authority concerned shall decide whether the proposed road development would or would not be likely to have significant effects on the environment, and if the authority decides that the proposed road development would be likely to have such effects, paragraph (*c*) shall apply accordingly.	

1.4.3 EIA Direction

The *Proposed Road Development* did not meet any legislative triggers for the undertaking of an EIA; therefore, a case-by-case assessment was required to be undertaken. Following the completion of an EIA Screening Report, Sligo County Council referred the matter to An Bord Pleanála for Direction.

The Board subsequently concluded that the *Proposed Road Development* would be likely to have significant effects on the environment and that the preparation of an EIAR was required. This was with regard to the following items:

(i) *article 27 of the European Communities (Environmental Impact Assessment) Regulations, 1989 (as amended);*
(ii) *EU Directive 2014/52/EU of 16th April 2014, amending Directive 2011/92/EU (the EIA Directive) on the Assessment of the Effects of Certain Public and Private Projects on the Environment;*
(iii) *the Roads Act, 1993 (as amended);*
(iv) *the document 'EIA of Projects - Guidance on Screening' (2017) issued by the European Commission;*
(v) *the document 'Environmental Impact Assessment (EIA) Guidance for Consent Authorities regarding Sub-Threshold Development' issued by the Department of Environment, Heritage and Local Government in August 2003,*
(vi) *the ecological and hydrogeological sensitivity of the receiving environment, including the Annex I Priority Habitats the EU Habitats Directive, Petrifying Springs (Code: 7220) and*

9 Substituted (21.09.2011) by European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011), reg. 56(7)(a).

10 Repealed (21.09.2011) by European Communities (Birds and Natural Habitats) Regulations 2011

(S.I. No. 477 of 2011), reg. 56(7)(b)

Alkaline Fens (Code:7230), and the Crockauns/Keelogyboy Bogs pNHA (Site Code: 002435);

(vii) *the nature, scale and characteristics of the Proposed Road Development, including significant engineering embankment and cut works;*

(viii) *the characteristics of the potential environmental impacts on ecology, protected habitats, the fabric and settings of features of cultural heritage and the visual impact within a sensitive rural landscape;*

(ix) *the information provided by the developer to An Bord Pleanála;*

(x) *the report and recommendation of the Board's Inspector.*

1.5 EIA Informal Scoping

An informal EIA Scoping report has been prepared for the *Proposed Road Development* to avail of the opportunity for consultation prior to the publication of the EIAR. The report described the project and identifies any potential significant environmental impacts which may arise. The report was issued to all members of the project team outlined in section 1.2; it was also issued to a range of statutory and non-statutory bodies including:

- Commissioners of Public Works in Ireland;
- Fáilte Ireland;
- An Taisce -The National Trust for Ireland;
- The Arts Council/An Chomhairle Ealaíon;
- The Heritage Council;
- Inland Fisheries Ireland;
- Córas Iompair Éireann;
- Transport Infrastructure Ireland;
- Environmental Protection Agency;
- Department of Communications, Climate Action and Environment;
- Department of Culture, Heritage and the Gaeltacht (c/o the Development Applications Unit);
- Irish Aviation Authority;
- Health Services Executive;
- Electricity Supply Board Head Office;
- ESB Networks;
- ESBi;
- Irish Central Border Area Netwoek (ICBAN) Ltd;
- Leitrim County Council;
- Irish Water; Border, Midland & Western Regional Assembly; and
- the Department of Housing, Planning and Local Government.

Responses outlining an input to the EIAR were received from the HSE and IFI, both of which are included in Volume 4 to this EIAR.

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

1.6 EIAR Structure

The EIAR as already outlined in the preface is structured within 4 separate volumes. The Main Report is included within Volume 2 and comprises a discrete set of Chapters as outlined in Table 1-4.

Where there is a potential for interactions between two or more environmental topics, these potential interactions have been taken into account within the individual chapters. This aspect of the assessment has been facilitated by round table discussions at 3 no. EIAR workshops.

Table 1-4: Structure of the Environmental Impact Assessment Report

Volume	Part	Description	
Volume 1	Non-Technical Summary	A Non-Technical Summary of the key issues of the project	
Volume 2: Main Report	Chapter 1	Introduction & Background	
	Chapter 2	The Need for the *Proposed Road Development*	
	Chapter 3	Consideration of Alternatives.	
	Chapter 4	Description of the *Proposed Road Development*.	
	Chapter 5	Impact Assessment, An Introduction and Inter-relationships	
	Chapters 6-15	*Environmental Assessment Chapters*	
		Chapter Title	*Terminology Reference (Art. 3(1) of the EIA Directive)*
		Population & Human Health	*Population & Human Health.*
		Noise & Vibration	*Population & Human Health.*
		Air Quality & Climate Change	*Population & Human Health; Air and Climate.*
		Biodiversity	*Biodiversity.*
		Soils and Geology	*Land; Soil.*
		Hydrology & Hydrogeology	*Water.*
		Landscape & Visual	*Landscape; Population & Human Health.*
		Archaeology, Architecture & Cultural Heritage	*Material Assets; Cultural Heritage*
		Material Assets and Land – Agriculture	*Material Assets; Land.*
		Material Assets and Land – Non-Agriculture	*Material Assets; Land.*
	Chapter 16.0	Schedule of Commitments.	
Volume 3: Figures	Figures	The figures referred to in this EIAR are contained within Volume 3.	
Volume 4: Appendices	Appendices	Information in support of that contained in this EIAR is contained within Volume 4.	

1.7 Background to the *Proposed Road Development*

1.7.1 General

The section of the N16 being improved by the *Proposed Road Development*, forms part of a wider N16 National Primary route which links the Republic of Ireland with Northern Ireland and more specifically, Sligo on the west coast with Belfast and Dundalk on the east coast.

The N16 emanates from Sligo and passes through Manorhamilton in Co. Leitrim and Blacklion in Co. Cavan, before it connects with the A4 at the border with Northern Ireland. It extends as the A4 to Enniskillen and Dungannon, before it becomes the M1 motorway, which passes Lurgan, Craigavon and Lisburn before terminating in Belfast.

At 49 kilometres (30 miles), the N16 is one of the shorter National Primary routes, as it forms only part of a major route from Sligo to Enniskillen and onwards to Belfast.

In terms of the Trans European Road Network, the EU have designated[11] the Belfast/Sligo road as part of a:

> *...comprehensive network of routes, feeding into the core network at regional and national level. The aim is to ensure that progressively, throughout the entire EU, the TEN-T will contribute to enhancing internal market, strengthening territorial, economic and social cohesion and reducing greenhouse gas emissions.*

This emphasises the routes strategic importance in linking the peripheral north-west of Ireland with Belfast and the north-eastern ports.

In County Sligo, the route carries modest volumes of traffic in comparison to other routes, with typical values of between 2,800 and 3,400 Average Annual Daily Traffic on the rural sections. Traffic Assessments (based on the National Transport Model and a site-specific assessment) have concluded that the primary destination point for traffic on the N16 is the urban centre of Sligo, or, its environs.

From an economic perspective (as will be outlined later in this report), journey times on the route are particularly poor, with a typical average of circa 67kph. This factor is reflective of the existing geometric parameters, which are more akin to 50kph, 60kph and 70kph design speed standards, rather than the design speed objective for a National Primary route, which would typically be 100kph.

1.7.2 Physical Characteristics

The Physical Characteristics of the *Proposed Road Development* are contained within the townlands of *Drumkilsellagh*, *Doonally (ED Drumcliff East)*, *Castlegal (ED Glencar)*, *Drum East*, *Lugatober* (occurring predominately within), *Collinsford* and *Lugnagall*. These characteristics are expanded upon in detail within Chapter 4 of this report; however they generally comprise *inter-alia*:

- Circa 2.54km of Realignment to the existing N16 National Primary Route (c. 0.79km online and c. 1.75km offline);
- Junction Improvements including:
  - One At Grade Roundabout;
  - Six Simple T Junctions, including two Right/Left Staggered T Junctions;
- Circa 1.5km of realignment to the existing local road network (tie-in works);
- Three Direct Access connections to the National Primary network;
- Circa 1.5km of Vulnerable Road Users (Unsegregated cycle and pedestrian) tracks located predominately with the mainline verge space, interlinking as necessary with alternative offline routes;
- One Vulnerable Road Users Subway underpass;
- One River/Stream Clear Span Structure;
- Culverts and associated diversions of existing minor watercourses and drainage ditches;
- All the necessary drainage works associated with the *Proposed Road Development;*
- The diversion of services and utilities;
- Earthworks operations;
- One no. steepened cut side slope in the townland of *Lugatober*;
- One no. Soil Repository/Borrow Pit;

[11] Trans-European Transport Network; Annex I Maps of the Comprehensive and the Core Network

- Environmental mitigation works;
- The other consequential construction works necessary in order to complete the project.

1.8 Relevant Figures and Appendices

1.8.1 Figures contained in Volume 3

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

Fig. 1.0: *Proposed Road Development* Location Map;

1.8.2 Appendices contained in Volume 4

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 1.1: Chapter 1 (Main Report Reference); Informal Scoping Responses;

2 The Need for the *Proposed Road Development*

2.1 General

The following section of this EIAR sets out the 'Need' for the *Proposed Road Development.* This 'Need' is described under policy context (Section 2.2), existing geometric conditions (Section 2.3) and problem definition (Section 2.4).

2.2 Policy Context

2.2.1 European Policy

The N16 emanates from Sligo and passes through Manorhamilton in Co. Leitrim and Blacklion in Co. Cavan, before it connects with the A4 at the border with Northern Ireland. It extends as the A4 to Enniskillen and Dungannon, before it becomes the M1 motorway, which passes Lurgan, Craigavon and Lisburn before terminating in Belfast.

At 49 kilometres (30 miles), the N16 is one of the shorter National Primary routes, as it forms only part of a major route from Sligo to Enniskillen and onwards to Belfast.

In terms of the Trans European Road Network, the EU have designated[12] the Belfast/Sligo road as part of a:

> *...comprehensive network of routes, feeding into the core network at regional and national level. The aim is to ensure that progressively, throughout the entire EU, the TEN-T will contribute to enhancing internal market, strengthening territorial, economic and social cohesion and reducing greenhouse gas emissions.*

This emphasises the routes strategic importance in linking the peripheral north-west of Ireland with Belfast and the north-eastern ports.

2.2.2 National Policy

1.1.1. Building Irelands Future, National Planning Framework

The National Planning Framework (NPF) is the Government's high-level strategic plan for shaping the future growth and development of Ireland out to the year 2040. Its overarching visions are to:

- Develop a new region-focused strategy for managing growth;
- Linking this to a new 10-year investment plan, the Project Ireland 2040 National Development Plan 2018-2027;
- Using state lands for certain strategic purposes;
- Supporting this with strengthened, more environmentally focused planning at local level;
- Backing the framework up in law with an Independent Office of the Planning Regulator.

The goals and objectives of the NPF (See *Figure 2-1*) are expressed within the Plan as 'National Strategic Outcomes', which include:

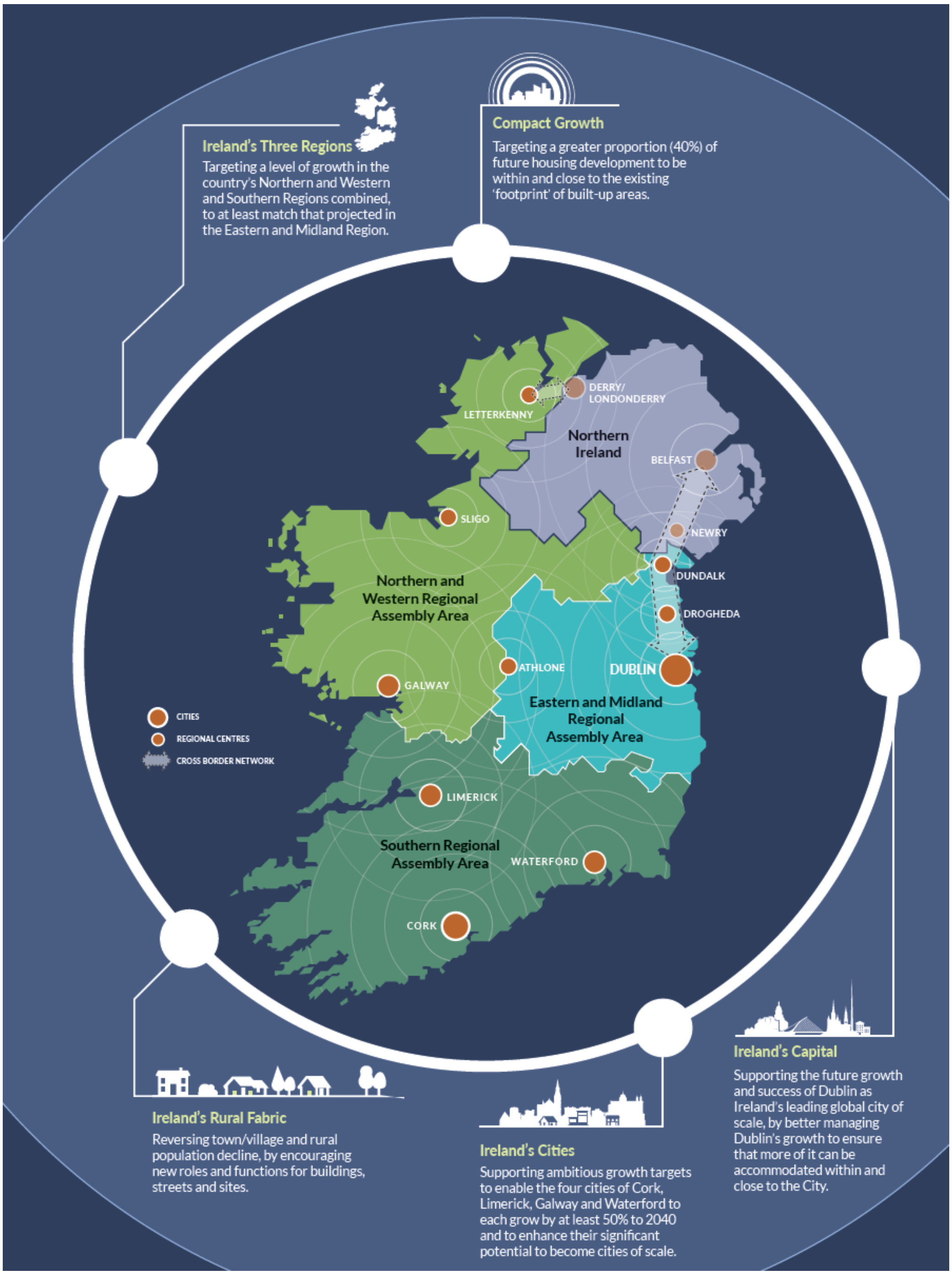
- Compact Growth;
- Enhanced Regional Accessibility;
- Strengthened Rural Economies and Communities;
- High Quality International Connectivity;
- Sustainable Mobility;

[12] Trans-European Transport Network; Annex I Maps of the Comprehensive and the Core Network

- A Strong Economy, supported by Enterprise, Innovation and Skills;
- Enhanced Amenities and Heritage;
- Transition to a Low Carbon and Climate Resilient Society;
- Sustainable Management of Water, Waste and other Environmental Resources;
- Access to Quality Childcare, Education and Health Services.

The urban centre of Sligo is identified within the plan as a regional centre for economic growth.

Figure 2-1: Overview of the National Planning Framework Strategy



The proposed upgrade of the N16 will support certain objectives of the plan in terms of improving connectivity and accessibility to Sligo. The following extracts from section 3.3 and 4.3 of the plan demonstrate such relevance:

Section 3.3 of the National Planning Framework

> *As a regional centre, Sligo serves a large hinterland that extends beyond County Sligo into surrounding counties, to include parts of Donegal, Leitrim, Mayo and Roscommon, supported in particular by nearby county towns. Sligo's significance as a centre of employment and services is much greater than its scale in terms of population. The presence of strong employment sectors such as Pharma and Engineering, Higher Education Institutes (HEIs), cultural institutions and health services indicate latent capacity for Sligo to enhance its regional role. This can be achieved through building critical mass of population and further employment, in tandem with* **[*enhanced accessibility*]**[13] *and quality of life…*

Key future planning and development and place-making policy priorities for the Northern and Western Region include:

> *…Enhancing the city-region like functions performed by Sligo in line with its statutory development plan, activating the potential for further rejuvenation and renewal of its core and further enhancing its* **[*connectivity in a national and regional context to ensure wider accessibility of relevant services and amenities…*]**

Section 4.3 of the National Planning Framework, National Policy Objective 7

> *…Strengthening Ireland's overall urban structure, particularly in the Northern and Western and Midland Regions, to include the regional centres of Sligo and Letterkenny in the North-West, Athlone in the Midlands and* **[*cross-border networks*]** *focused on the Letterkenny-Derry North-West Gateway Initiative and Drogheda-Dundalk-Newry on the Dublin-Belfast corridor;*

2.2.3 Regional Policy

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

The Regional Planning Guidelines were prepared by the former Border Regional Authority (which was dissolved on 1st June, 2014). The new Northern and Western Regional Assembly now encompasses County Sligo.

Notwithstanding the foregoing, in order to demonstrate the policy context of the route, the Guidelines recognised that creating competitive capacity and critical mass requires supporting economic development and improving economic infrastructure across the region.

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. The N16 is listed as one of the road projects in planning which will have a significant influence on the Border Region in the coming years.

The Regional Planning Guidelines identified the N16 as a Strategic Link in a West/North Central Corridor which:

> *Links the Gateway of Sligo and the Gateway of Enniskillen in Northern Ireland and forms part of the Northern Cross (See Section 3.7.4.3* **[Quoted below]**[14]*). The Sligo to Enniskillen route also provides access to the international access point of Belfast/Larne and links to the Key Transport Corridor of Enniskillen/ Dungannon/ Craigavon/ Belfast, as identified in the RDS. Improvements to this route in recent years have been limited to short isolated sections. The route requires substantial investment as a matter of priority.*[15]

[13] Authors emphasis added.

[14] Authors insertion

[15] Regional Planning Guidelines for the Border Region, 2010-2022, Border Regional Authority

Additionally it states that a priority for this route is the development of the:-

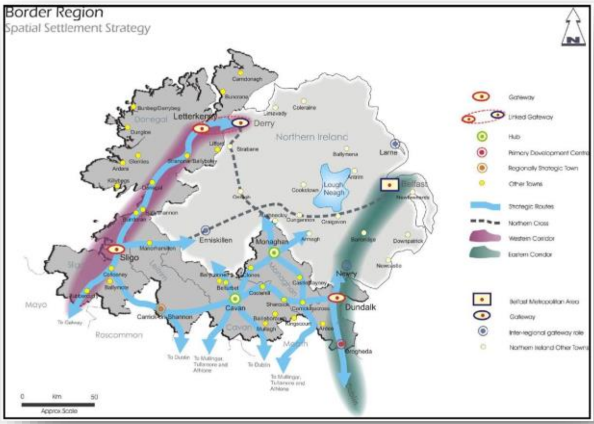
- N16 Sligo to Enniskillen (including Manorhamilton Bypass and the southern Bypass at Enniskillen (outside the Border Region))

In terms of the Central Border Region and the Northern Cross described above (See Figure 2-2); the Guidelines state the following:

> *The Central Border Region is an integral area which will benefit greatly from the implementation of the balanced settlement model. The aim of the model is to reposition the spatial perception of the central and western portions of the Border Region from that of a peripheral area, to that of an area which is pivotal to the future development of the island and regeneration of its economy. At a practical level, the Central Border Region will emerge as a spatial and economic entity in its own right. Its future functionality has the potential to provide a central connective, economic and infrastructural endoskeleton; linking East with West, and creating wider added value. With strategically supported and co-ordinated development, the Central Border Region has the capacity to increase the impact and benefits across the Border Region, of predicted and evidenced growth in the Eastern Corridor and the Atlantic Arc. It will reciprocally benefit these growth corridors on the basis of connected complementarity. It will no longer function largely at the extremities of wide catchment influences of Dublin and Belfast, but will develop and retain strong connections to both city regions, and provide a further link to other key settlements in the North and North West. Development of the model will also link this Region with adjoining Regions, particularly the Midlands and West Region...*
>
> *...In seeking to ensure the balanced development of the Central Border Region, and in acknowledgement of this Region's role in providing connectivity and added value to neighbouring growth corridors, the* ***Northern Cross****, (see Spatial Settlement Strategy map), is an important infrastructural element in developing this Region as well as others. The Northern Cross, providing strategic high speed road access from Dublin to Letterkenny/Derry (N2/A5), and from Belfast to Sligo/Enniskillen (M1, A4,* ***[N16]****[16]), has the potential to spatially reintegrate much of the entire historic province of Ulster, including the south and west of Northern Ireland and the counties within the Border Region. Since 2004, these key corridors have gained strong political support in both jurisdictions, with advanced works already on-going on some routes, particularly on the extension of the M1 from Belfast to Ballygawley, and the A4 towards Enniskillen. The further development of the Northern Cross will act as the conduit for the economic re-invention of the Border Region both north and south. Not only is the Northern Cross a key infrastructural concept for the Central Border Region, but it is also one which provides an essential infrastructural link between both jurisdictions on the island.*[15]

[16] Authors Emphasis

Figure 2-2: Spatial Settlement Strategy



2.2.4 Local Policy

The Sligo County Development Plan (2017-2023), under objective O-NR-1, states that Sligo County Council will:

> *Undertake programmed improvements to the national road network, including the programme of realignments and upgrades, as set out in Table 8.B and subject to compliance with the Habitats Directive.*

Table 8.B as referred to above highlights the 'N16 Sligo to County Boundary' section as one which requires improvement over the period of the plan.

2.2.5 Regional Corridor Studies

Over the course of the past number of decades, numerous studies have been undertaken, which demonstrate the deficiency of the existing N16 corridor (within the Republic of Ireland) in terms of its function as a North-South and East-West Strategic Route. The following provides an overview of some of the more significant findings of some of these studies.

Improving the section encompassing the limits of the Scheme will remove one of the most geometrically deficient sections of this strategic route.

2.2.5.1 The EU Socio-Economic Case for Improvements to the N16/A4 Sligo to Ballygawley and N2/A5 Monaghan to Letterkenny Transport Corridors, October 2012;

This report sets out the socio-economic case for improvements to transport infrastructure in the Border Area of Northern Ireland (NI) and the Republic of Ireland (RoI). Through undertaking a thorough and objective-led review of options, the document established the economic justification and sequencing for investing in new transport links in the Border Area.

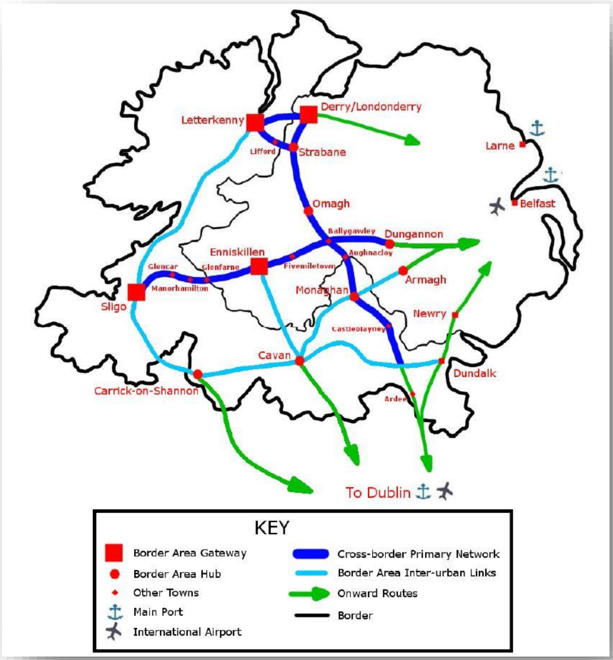
The report was set in the context of the wider 'Central Border Region Spatial Planning Initiative' being developed by ICBAN. The Spatial Planning Initiative was supported by the European Union's INTERREG IVA Programme managed by the Special EU Programmes body to facilitate the move to a new level of strategic planning and coordinated action for regional development in the border areas. The evidence in this socio-economic and business case suggests that the border area performed poorly in economic terms when compared to the wider island of Ireland and it can be strongly argued that this is at least in part attributable to its low quality transport infrastructure.

Key transport problems in the Border area were identified within the report as being:

- *Long travel times and hence poor accessibility to key economic centres;*
  - *average speeds from the Border Area towns to Dublin is **71kph**, compared to **85kph** from the other towns; and*
  - *average speeds from the Border Area towns to Belfast is also **71kph**, compared to **76kph** from the other towns.*
- *Under-investment in transport infrastructure in the area – recent NRA spending per head on transport infrastructure in the Border area is around 45% of that of other Irish regions;*
- *Some routes in the area **[(notably the N16)]**[17] are not of the required standard for a designated National Primary Road;*
- *Issues with journey time reliability, particularly for traffic passing through the town of Enniskillen; and*
- *Conflicts between local and strategic traffic.*[18]

Figure 2-3 below summarises the principal recommendations of the study in context. The dark blue lines represent the principal recommended improvements identified in the report. In addition the roads linking the principal border area towns should be reviewed and improved in order that the target average inter-urban speed of 80 kph is achievable.

Figure 2-3: Principal recommendations of EU Socio-economic case for improvements to the N16/A4 and N2/A5



2.2.5.2 The Border Region East-West Corridor study

In 2009 Cavan County Council procured a Roughan 'O' Donovan/Aecom alliance to undertake a review of a previous strategic study conducted in 2001 (Strategic Study of the Development of the East –West Link). A Steering Committee comprising representatives from the Department of Transport, Cavan County Council,

[17] Authors Emphasis

[18] The EU Socio-Economic Case for Improvements to the N16/A4 Sligo to Ballygawley and N2/A5 Monaghan to Letterkenny Transport Corridors, October 2012

Monaghan County Council, Louth County Council, Sligo County Council and Leitrim County Council, together with the project consultants, was established to monitor the progress of this phase of the project.

In terms of a Planning Context the report made the following general observations:

There are a number of common themes in all of the national policy documents, namely:

- *The importance of balanced regional development, in order to avoid congestion in some areas, and provide for development in other more remote areas.*
- *A development strategy which is based on the development of a hierarchy of settlements, including Gateway, Hubs and clusters.*
- *The need for greater cross border co-operation and linkages, which will benefit the border areas, but also key urban areas in both the north and south.*
- *The requirement for a quality strategic road network, which is a key requirement to maintain regional, national and international competitiveness.*

In order to assist in balanced regional development, the strategy is to target investment at regional weakness, in particular infrastructural deficiencies…

Arising from the policy review; consideration was given to the provision of a core route as well as other additional links to serve the population within the study area, in order to redress the historical deficit from which the region has suffered.

An appraisal carried out under criteria including Economic, Environmental, Accessibility, Integration and Safety recommended that a Strategic Core East West Route linking Sligo to Dundalk should encompass the N16 between Sligo and Enniskillen as outlined in *Figure 2-5*.

Figure 2-4: Study Area

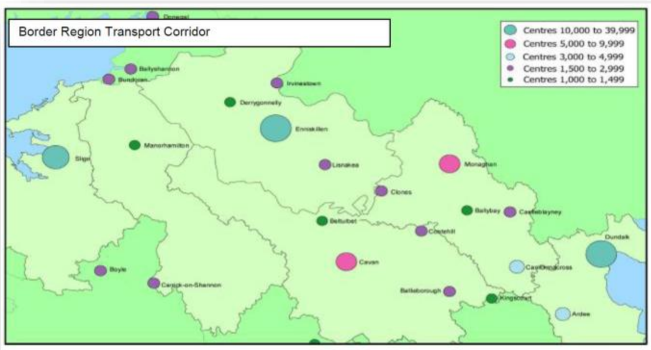
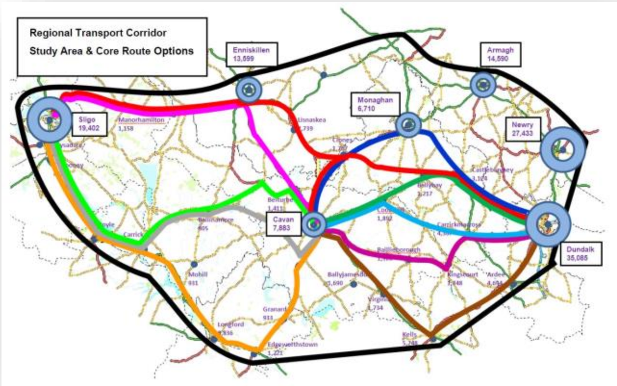


Figure 2-5: East – West potential corridors (Border Region East-West Corridor)



2.2.5.3 Analysis of Need for up-grading of N16-A4 Arterial Route.

An 'Analysis of Need for up-grading of the N16/A4 Arterial Route' was undertaken by Peter Quinn Consultancy on behalf of Sligo and Fermanagh County Councils in 2008.

The report relates to how some of those same issues and implications affect the economies and societies of Sligo (and by extension, other parts of North-West Connacht, especially Mayo and North Galway), North Leitrim (with some implications for the rest of that County too), parts of West Cavan, most of Fermanagh and a small part of South Tyrone (in Dungannon and South Tyrone District Council area). It identifies how the opportunities, which exist for more sustainable regional development in these areas are being inhibited by the inadequacies of the roads system, and what needs to be done to make improvements.

In an encompassing review of the County Development Plans, Local Area Plans and Regional Plans (for the Regions/Counties in proximity of the N16/A4) the report outlined the obvious awareness to upgrade the route, as the primary road link between the North-East and the West of Ireland. The report states that the main arguments for such an upgrade include the following:

(i) *there is an excessive dependence on road transport (for both goods and people) on both sides of the border; in respect of goods, it represents over 99% of the total movements involved, and over 96% for passenger movements;*

(ii) *businesses in this region (particularly those involved in the transportation sector and those, whose businesses involve the transportation of heavy goods) perceive the inadequacy of the roads infrastructure as the single most important problem they encounter; it was ranked as the single most pressing issue at a recent meeting of Chief Executives of businesses in Fermanagh;*

(iii) *the absence of joined-up roads planning, both within each jurisdiction and on a cross-border basis, and of accessible and convenient public transport facilities, combine to increase the cost of doing business in these areas, by a significant percentage, and reduces the competitiveness of businesses located in such areas – thereby inhibiting the achievement of 'balanced regional development' on a polycentric basis*[19]*, as enshrined in the European Spatial Development Perspective and the Lisbon Strategy, both of which have been accepted in principle by the two governments and by the European Parliament;*

[19] In European terms, 'polycentric' tends to relate to transnational links (primarily between national capitals), but the concept has equal validity, on a regional basis, in the context of an Island like Ireland.

(iv) basing infrastructural investment decisions on current traffic counts perpetuates a bias against more remote areas, because they take no account of the traffic and business which could be attracted, if the roads system was better;

(v) there is, according to a number of studies, a close correlation between the standard of a region's transport infrastructure and its development status; internationally, a poor transport infrastructure has been shown to have a major inhibiting impact on investment and both economic and social development, including in the areas of the quality of life, access to both fundamental and specialist amenities (quoting health care as an example), international access and access to major local and national social events.

Essentially, virtually all the previous studies emphasised the impact of an inadequate roads infrastructure on the economy of such areas, but there was also an underlying theme of its contributing to social disadvantage and general deprivation, with disparities in regional development being explained largely in those terms.

2.2.5.4 Transport Research & Information Note; Impact of Improvements in the Road Network on the Accessibility & Economic Potential of Counties, Urban Areas, Gateways & Hubs

In 2012, Aecom undertook a study on behalf of the National Roads Authority which looked at the contribution that the road network makes to improving accessibility and developing the economic potential of counties, gateways and hubs throughout the island of Ireland. The report examines the concept of effective density and sets out the relationship between this measure of agglomeration and productivity; it utilises results from the National Transport Model (NTM) to measure the accessibility of a given location to other geographic areas and so provide an insight into economic potential.

A general summary of the findings of the report indicate that

...firms in dense urban areas have higher productivity and lower costs than those in more rural settings, other things being equal. The scale of a firm's "locality" is in part determined by accessibility...

... If transport system improvements bring geographic areas closer together through accessibility enhancements, then the "effective density" of that area is raised. Thus, economic productivity gains can be realised through transport system improvements that raise effective density...

...Studies in the UK and New Zealand support the view that increasing the effective density of a given area increases the productivity of firms with the area. The evidence is that a doubling of effective density leading to a 4 to 7% increase in productivity of firms overall, with very much higher impacts in the service sector...[20]

More specifically in relation to Sligo Gateway City, significant findings include the following statement:

The Gateways and Hubs identified in the National Spatial Strategy, other than Dublin, have benefitted substantially in terms of improved employment accessibility. However, **[*Sligo is a notable exception:*]**[21] *the lack of a significant upgrade to the N4 in the period under review prevented an improvement in employment accessibility.*

In addition to the N4 which is quoted in the study; the lack of upgrades to the N16 would be considered to be equally important as this route is a strategic North/South and East/West corridor.

[20] Transport Research & Information Note; Impact of Improvements in the Road Network on the Accessibility & Economic Potential of Counties, Urban Areas, Gateways & Hubs, Aecom/NRA, 2014

[21] Authors Emphasis

2.3 Existing Geometric Conditions

The following sets out the existing geometric condition of the existing N16, pertaining to the section to be replaced by the *Proposed Road Development*. The condition has been determined with reference to:

- TII Standards & Technical Publications;
  - Cross Section;
  - Geometry;
  - Junctions;
  - Stopping Sight Distance; and
  - Drainage

2.3.1 TII Standards & Technical Publications

In describing the existing geometric conditions, the TII design standards provide an appropriate scale to measure the deficiency of the existing network against.

The standards specify 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.

> *This Standard defines a sequence of parameter values in the form of a hierarchy of geometric design criteria related to Design Speeds. This three tier hierarchy enables a flexible approach to be applied to a range of situations where the strict application of Desirable Minimum standards would lead to disproportionately high construction costs or severe environmental impacts upon people, properties or landscapes. Designs with at least Desirable Minimum standards will produce a high standard of road safety and should be the initial objective….*[22]

The following provides a summary of the results of this analysis. The proceeding paragraphs, where applicable, measure the existing characteristics against the aforementioned hierarchy.

2.3.2 Cross Section

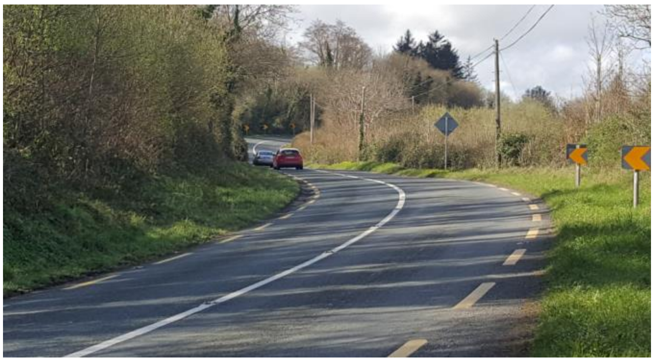
The cross section of the route, generally varies from 6m to 6.5m, with marginal verge widths of circa 0.5m to 1m, interspersed with sections which are devoid of any verge area. The following figures provide examples of the existing route in the general townland of *Lugatober*. This overall cross sectional width is circa 50% less than the desired Type 2 Single Carriageway cross section, which is described in section 4.2.1 of this report.

[22] DN-GEO-03031, Section 1.8 (http://www.tiipublications.ie/)

Figure 2-6: Existing N16 – Lugatober

Figure 2-7: Existing N16 - Lugatober

Figure 2-8: Existing N16 - Lugatober



2.3.3 **Geometry**

The geometric properties of the existing route, have been established, using the Road Design computer package MXRoad. The proceeding sections of this chapter describe the horizontal and vertical characteristics of the route, while also comparing them to the Desirable Minimum standards.

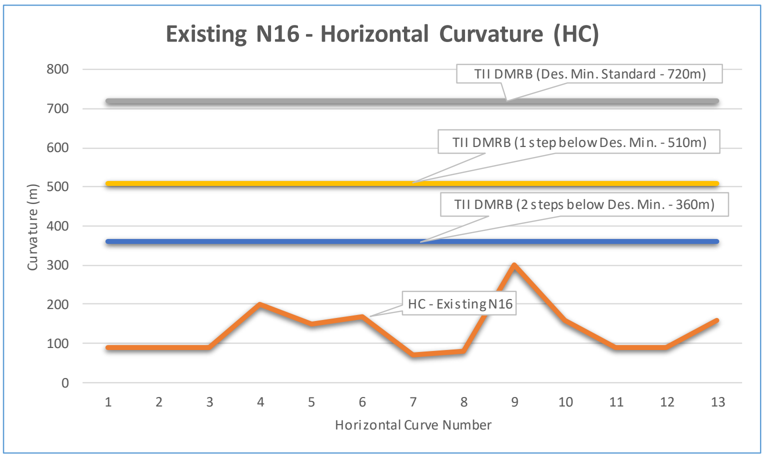
Horizontal Curvature

In relation to Horizontal Curvature; the curvilinear nature of the route, which generally follows the contours of the topography, results in a proliferation of 13 tight radius bends. These bends, which occur on average every c. 210m, range in Horizontal Curvature values of between 70m and 300m. As outlined in Table 2-1 and Figure 2-9, such values fall well below the desired requirements of the TII standards and consequently also result in poor Stopping Sight Distance (SSD), a point which is expanded upon in section 2.3.5 of this report.

Table 2-1: Existing N16 – Horizontal Alignment

Horizontal Curvature	Townland Location	No. of Steps below Des. Min Standard
90m	*Drumkilsellagh*	6 steps
90m	*Drumkilsellagh*	6 steps
90m	*Castlegal*	6 steps
200m	*Castlegal*	4 steps
150m	*Lugatober*	4 steps
170m	*Lugatober*	4 steps
70m	*Lugatober*	7 steps
80m	*Lugatober*	7 steps
300m	*Lugatober*	3 steps
160m	*Lugatober*	4 steps
90m	*Lugatober*	6 steps
90m	*Lugatober*	6 steps
160m	*Lugnagall*	4 steps

Figure 2-9: Horizontal Curvature of the Existing N16



Vertical Curvature

In a similar manner to the Horizontal Curvature; the Vertical Curvature generally follows the topography resulting in 31 vertical curves, an average of 1 every circa 90m. As outlined in Figure 2-10 all the HOG (crest) values fall well below the TII standards; while as outlined in Figure 2-11 only one SAG curve has a value above 2 steps below the Desirable Minimum.

The deficiency and intensity of these curves is a further significant inhibition on safety and efficiency and in a number of cases severely impacts upon Stopping Sight Distance values.

Figure 2-10: Vertical HOG (Crest) Curvature of the Existing N16

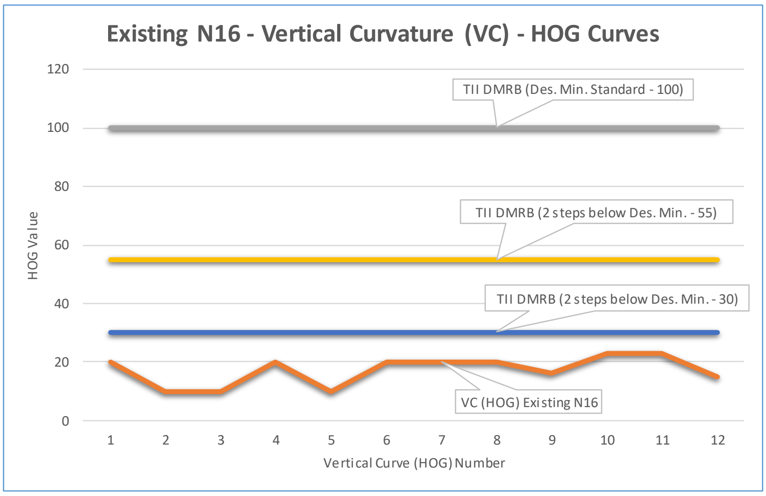
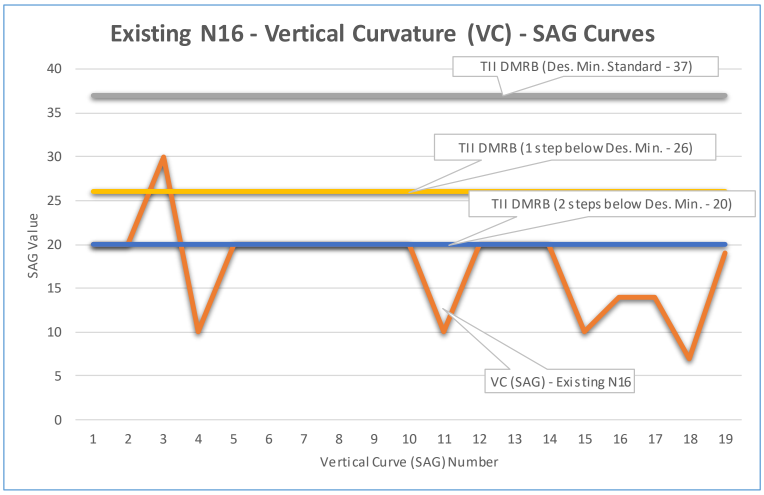


Figure 2-11: Vertical SAG (Dip) Curvature of the Existing N16



2.3.4 Junctions

There are 6 local road junctions occurring along the section of the existing N16 to be replaced by the *Proposed Road Development*. A significant safety issue in relation to these junctions relates to the siting and the Stopping Sight Distances which are attainable (in most instances well below the desirable minimum of 215m – see Table 2-2).

Table 2-2: Junctions on Rural Section (3) of the existing N16

Junction Number	Townland Location	Stopping Sight Distance	
		SSD to the west/south	SSD to the east/north
L-3406-0	*Drumkilsellagh*	130	325
L-7415-0	*Castlegal*	90	65
L-74151-0	*Drum East/Castlegal*	90	160
L-7413-0	*Lugatober*	90	195
L-34041-0	*Collinsford*	220	160
L-3404-0	*Lugnagall*	125	110

There are a further 8 direct (domestic) accesses and 14 agricultural entrances onto the existing route. From a safety point of view, these types of entrances are especially problematic as they create an intensification of right turning movements on the national primary route.

Figure 2-12: Junction with Drum Road (L-3406-0)

2.3.5 Stopping Sight Distance

Stopping Sight Distance (SSD) in relation to junction accessibility has already been outlined in section 2.3.4. In relation to SSD on the mainline, it has been established from an assessment undertaken in MX Road that:

- Circa 95% of the existing route does not achieve a desirable minimum Stopping Sight Distance of 215m;
- Circa 82% of the existing route does not achieve a one-step below desirable minimum Stopping Sight Distance of 160m;
- Circa 66% of the route does not achieve a two-step below desirable minimum Stopping Sight Distance of 120m;

These statistics are further compounded by the fact that junctions and house entrances occur frequently over much of the route; a fact which in new design circumstances would require the full desirable minimum value to be achieved. Moreover, there are three locations along the route where the Stopping Sight Distance envelope is below 50m.

2.3.6 Drainage

The existing N16 is generally devoid of a dedicated drainage system. Along the route, verge cuts provide the only means of escape for road runoff, meaning flash floods and aqua-plaining is a common feature following heavy rainfall events. This is exacerbated by the topography of the area, where in some cases the road intercepts sheet flow (following heavy storm events) from the adjacent Copes Mountain.

Figure 2-13: Existing N16 - Flooding/Aqua-plaining

2.4 Problem Definition

The following section of the EIAR sets out the Problem Definition in the context of the section of the N16 being replaced by the *Proposed Road Development*.

The Problem Definition is measurable in terms of the Common Appraisal Framework and the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

Economy

The N16 is a key national and cross border international corridor and delays to traffic have a negative impact upon the economy. From a geometric perspective; in terms of bendiness this particular section of the N16 is significantly deficient and has a greater intensity of tight radii, twists and turns than any other section of the national primary network within county Sligo.

This results in a poor level of service and a very low average journey speed. The N16 *Lugatober* section has been calculated as having, an average journey speed of approximately 67 kilometres per hour.

This is particularly relevant, considering the dependency on road based transport in the region and the lack of a public transport alternative.

Safety

In general, safety deficiencies of the existing route are reflective of the geometric conditions, which have already been described in section 2.3 of this report and summarised in Table 2-3.

Table 2-3: Existing Network, Design Observations

Criteria	Design Observation
Horizontal Geometry	The existing network is proliferated with horizontal curves, which are well below any design standard. This impacts on driver comfort and safety.

Criteria	Design Observation
Vertical Geometry	Existing vertical curvature consists of a series of crests and sags, which are almost all, well below any design standards. This impacts on driver comfort and safety.
Junction Siting	All the junctions and direct accesses along the route are sited within locations where a desirable minimum Stopping Sight Distance is not achievable.
Stopping Sight Distance	Almost all of the route has Stopping Sight Distances which are at least 2 times less than what is required on a national primary route. This causes safety issues in terms of reduced breaking time upon visibility of an obstruction/ hazard.
Cross Section Widths	The existing pavement width is only 6-6.5m, with verge widths of between 0.5m and 1m commonly occurring. These factors present some locations which may cause driver alarm, where the existing topography falls away sharply away the road, this factor would be exacerbated during icy conditions
Drainage	There is no dedicated drainage system along the route. Aquaplaning routinely occurs following rainfall events.

There have been 3 minor collisions, on this section of the national primary route between 2009 and 2015. In addition, a fatality also occurred on the N16 in 2016 at *Drumkilsellagh*.

This equates to approximately 14.75 accidents per 100 Million Kilometres of travel, which is almost twice the national average between the years 2009 to 2014.

Environment

There currently are no provisions for drainage along the existing N16 corridor. An environmental problem associated with this fact is that existing runoff from the road surface, is not subjected to treatment and attenuation, prior to discharge to the receiving environment.

Accessibility and Social Inclusion

The condition of the existing route, which is grossly substandard (See Table 2-3), presents a network which is difficult to gain access to, difficult to drive upon and difficult to egress from. These factors inhibit Accessibility and Social Inclusion for both local trips and for longer inter-regional international trips.

Integration

The current condition of the existing N16, inhibits the provision of a '…*safe and efficient...*' road network and in its current form, does not support the various national, regional and county planning policies.

Physical Activity

Pedestrian and Cyclist activity on the existing route is inhibited by the daily flow of traffic and the geometrically deficient nature of the route.

2.1 Relevant Figures and Appendices

2.1.1 Figures contained in Volume 3

There are no figures associated with this chapter of the EIAR contained within Volume 3.

2.1.2 Appendices contained in Volume 4

There are no appendices associated with this chapter of the EIAR contained within Volume 4.

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. Article (5)(1)(d) of the EIA Directive (as amended) provides that the information presented in the EIAR shall include:

> *(d) a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment;*

In the context of the *Proposed Road Development,* the study and consideration of alternatives, commenced at an early stage, in advance of the identification of the project extents or location.

This initial study took the form of a route selection assessment for the full N16 between Sligo City and the county boundary with Leitrim. The wider corridor was examined and appraised in order to ensure that prioritised sectional improvements to the N16 would tie in, in the long term, with what is considered to be the most desirable and optimal corridor for the entire route. The following chapter of this EIAR initially describes how environmental effects were considered during the process (Section 3.1.1), it then briefly describes the wider corridor route selection process with reference to the published *'N16 Sligo to County Boundary Route Selection Report'*[23] (referred to hereafter as the N16 SCB RSR) (Section 3.2). It then describes the evolution of the consideration of alternatives as the project advanced through the design process; this includes the 'N16 (Sligo) Route Improvement Strategy' (Section 3.3) and the subsequent more discreet 'Consideration of Design Alternatives' (Section 3.4).

3.1.1 The Effects of the Project on the Environment

The effects of the project on the environment have been considered throughout the process as part of the Multi Criteria Analysis carried out at each particular stage, as will be further explained in the proceeding sections of this chapter. Prior to describing the selection process, the following provides a general overview as to how the nature of the design process facilitated the reduction of environmental effects.

N16 Sligo to County Boundary, Route Selection Report

A multidisciplinary team of specialists, by way of environmental assessment informed the selection process contained within the N16 SCB RSR. The full suite of environmental assessments are contained within Volume 3[24] (Environmental Appendices) to the aforementioned Route Selection Report. This volume was provided in three parts as outlined below:

Part A - Human Environment; covering aspects relating to: Population & Human Health, Non Agricultural Property; Noise & Vibration; Air Quality & Climate Change; Agricultural Property; and, Urban Planning.

Part B: The Natural Environment; covering aspects relating to: Biodiversity; Soils & Geology; and, Hydrology & Hydrogeology.

Part C: Landscape & Visual, and Cultural Heritage; covering aspects relating to: Landscape & Visual; Archaeology & Cultural Heritage; and, Architectural Heritage.

[23] http://www.sligococo.ie/N16/RouteSelectionReport/

[24] http://www.sligococo.ie/N16/RouteSelectionReport/Volume3/#d.en.43481

The first stage of the assessment focussed on identifying the environmental constraints[25] within the study area and establishing where particular sensitivities lay. The avoidance of environmental effects was promoted by the nature of the ensuing iterative and dynamic design process, which as described in section 3.2.1.1.2 of this report was completed in parallel with the environmental assessment. Collaboration on specific issues, was achieved through the interaction between individual specialists, on a one-to-one and group basis. The success of this approach was also facilitated via a full team, round-table workshop. Discussions at the workshop were guided initially by the outputs of impact scorecards developed as part of the route selection process. This allowed for targeted in depth critical analysis of particular options. The aim was to establish a consensus in relation to which options were less preferable to others, or, if there were situations where some options could be improved via design changes. The opinion's of each particular specialist was provided, with a particular focus on core aspects of the particular studies, i.e. those areas which were expected should, or could, influence the selection of a Preferred Route. Interactive group discussions, focussed generally on the following aspects:

- Initial ranking of route options (in terms of the scorecards);
- Clusters of positive ranks;
- Clusters of negative ranks;
- Profound, or Significant localised impacts;
- Desirable and undesirable lines; and
- Potential amalgamated, modified options.

This process eventually resulted in the selection of an option, which was considered, to be a good fit into the existing environment.

N16 (Sligo) Route Improvement Strategy

The nature of the N16 SCB RSR, which segmented the environmental assessment into three distinct sections ('South', 'Central' and 'North') coupled with the extents of the coincidental final options for possible improvement, permitted the environmental results from the N16 SCB RSR to be used as part of a Multi Criteria Analysis. This process, which is expanded upon in section 3.3 of this report, allowed for the determination of the optimal option to progress in the short to medium term.

Consideration of Design Alternatives

As described in section section 3.4 of this report; the consideration of alternatives evolved into the design process (Phase 3 of the TII PMG) as more discrete options were considered. The environmental effects associated with differing options were established arising from environmental assessment carried for the purposes of this EIAR and included in the appraisal process as part of a Multi Criteria Analysis which also included 'Economy' and 'Safety'. The consideration of various options was again facilitated in a collaborative manner through various means of interaction, this included:

- One-to-one specialist (environmental) engagement;
- Specialist to project design team engagement;
- Project design team engagement with statutory bodies (IFI);
- Targeted multi-disciplinary workshops:
    - Design, Biodiversity, Hydrology & Hydrogeology (x2);
    - Design, Archaeology, Soils & Geology, Biodiversity, Noise & Vibration, Air Quality, Population & Human Health, and Property;

[25] As outlined in Chapter 5 of the N16 SCB RSR[23]

- Design, Agricultural Property;

- Targeted multi-disciplinary conference calls (numerous):
  - Design, Biodiversity, Hydrology & Hydrogeology;

3.2 N16 Sligo to County Boundary, Route Selection Report

An appraisal (in the form of a route selection study) of the full N16 route corridor as it occurs in County Sligo commenced in Q4 of 2015 with the establishment of a Constraints Study Area and concluded in Q2 of 2017 with the publication of the N16 SCB RSR and the selection of an Emerging Preferred Route.

The following section of this EIAR summarises the background and findings of the N16 SCB RSR. Figures 2.1, 3.1, 3.2, 3.3, and 3.4 contained within Volume 3 outline the various options considered in the context of the wider corridor study.

This process was undertaken in accordance with the October 2016 version of the TII Project Appraisal Guidelines[26] (TII PAG).

3.2.1 The consideration of alternatives

The methodology for considering alternatives was in accordance with the guidelines set out in the TII Project Management Guidelines (TII PMG) 2010 and the TII PAG Unit 4.0 (Consideration of alternatives and options). The initial process commenced with a study of the various forms of likely alternatives, as outlined below.

3.2.1.1 Option's selection and appraisal

3.2.1.1.1 *Range of alternatives*

The range of alternatives considered, were generally classified under the following headings:

- 'Do-Nothing' and 'Do-Minimum' alternatives;
- 'Do-Something' alternatives, including:
  - Public transport alternative;
  - Traffic management alternative;
  - Upgrade in accordance with TII Publications (Design Standards);

Do-Nothing & Do-Minimum alternatives

Do-Nothing

The 'Do-Nothing' alternative comprised an appraisal (as described in section 3.5.2 of the N16 SCB RSR) of the existing road infrastructure and its ability to meet future demands for traffic and safety without any upgrade or junction improvement works, other than routine maintenance.

The appraisal concluded that the 'Do-Nothing' was not an alternative, which would provide a safe and efficient national road network, due to the significant deficiencies it departed, under the general headings of:

- Journey time assessment; and
- Safety:
  - Cross section;
  - Drainage;

[26] The TII PAG incorporates the requirements of project appraisal which are set out in the following governmental publications:

- "The Public Spending Code", Department of Public Expenditure and Reform, publicspendingcode.per.gov.ie; and
- "Common Appraisal Framework for Transport Projects and Programmes", Department of Transport, Tourism and Sport (2016).

- Geometry;
- Junctions;
- Overtaking opportunities and stopping sight distance; and
- Accidents & collision rates;

The foregoing deficiencies also contribute to environmental effects; including in particular effects upon people, insofar as, the nature of the existing road and in particular the siting of side road connections make it difficult for people (particularly the more vulnerable) to access or cross the route, thereby contributing to restrictions in terms of accessibility and community continuity. It also restricts the through usage of the route by pedestrians, cyclists and other vulnerable road users.

Do-Minimum

The aforementioned version of the TII PAG states that the 'Do-Minimum' alternative, should include those transportation facilities and services that are either committed, or planned within the appraisal period. To provide a basis of comparison, the 'Do-Minimum' alternative includes the following features:

- The maintenance of existing facilities and services in the study area;
- The completion and maintenance of committed projects, or, policies in the study area that have successfully completed their environmental review; and
- The continuation of existing transportation policies.

The 'Do-Minimum' alternative for the N16 corridor was based on the definition that only 'committed' improvements are included, meaning typically those that have been progressed through planning. They are either under construction, or, programmed into the capital expenditure budget.

Funding for the construction of a new bridge over the Garvogue River in the east of Sligo was at the time granted through the government's capital expenditure programme. This river crossing will supplement the three existing bridges in the City whilst increasing traffic permeability and thereby route choice within the urban area. It was also identified as a strategy transport objective in the Sligo and Environs Development Plan 2010 – 2016. Consequently, the proposed Eastern Garvogue Bridge (EGB) was included in the 'Do Minimum' scenario for the N16 Route Selection. This is most relevant in terms of traffic modelling and any ensuing effects arising.

The 'Do-Minimum', from an N16 road network perspective, was considered to be similar to the 'Do-Nothing' scenario as outlined above, and therefore was not considered a viable alternative.

From an environmental perspective, the Do-Minimum scenario provides the baseline for the Do-Something assessments.

'Do-Something' alternatives

Public transport alternative;

Public transport can generally be defined as bus and train transport available for shared use by the general public. In the case of the N16/A4 strategic route (between Sligo and Belfast), the only form of public transport available is the operating bus service provided by both public and private operators.

In this regard, the N16 SCB RSR concluded that the public transport alternative would not satisfy the 'Need' (Section 3.1 of the Route Selection Report) for the following reason:

> *Point to Point 'Public Transport' will not adequately cater for the dispersed nature of the geographical zone which is attracted to the N16;*

Traffic management alternative;

Overview

The traffic management alternative, as defined in the aforementioned TII PAG …*represent those which seek to respond to transportation problems by maximising the value of existing infrastructure*[27]. As recommended by PAG, 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 Do Something design upgrade outlined in the proceeding section.

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...*

The deficiencies (as set out in section 3.5 and 6.4.1 of the N16 SCB RSR) requiring intervention in the road network, determine the form of any traffic management alternative, i.e. the latter four categories described above would not resolve the safety and efficiency deficiencies imparted by the route.

In this regard, possible traffic management alternatives for the N16 were determined to include local road safety measures and the removal of bottlenecks[28] through targeted local investment.

Assessment

In order to establish if the N16 would lend itself to targeted local investment, or local road safety improvements, a geometric design assessment was carried out, to establish the extent and associated effects ...*of the best that can be done*... with the existing alignment.

The approach taken, to satisfy the foregoing, was to develop design's which would match as far as was practicable, the corridor of the existing N16, while at the same trying to improve the significant geometric deficiencies.

It was clear that a design, prepared for a 100kph road (which is standard for national primary roads) would require greenfield realignment; therefore it was considered appropriate to reduce the tiers of design standards, from that which would normally be appropriate on national primary roads. This approach would establish if any greater benefits over the standard approach would be provided, specifically in terms of cost and environmental effects.

In order to achieve this, two separate design options were prepared for the rural section between the AbbVie Roundabout and the county boundary with Leitrim. The first design option; was a one-step reduction in design speed terms, from 100kph to 85kph (a typical design speed for regional roads and good quality local

[27] TII PAG, Unit 4.0, Definition of Alternatives (http://www.tiipublications.ie/).

[28] 'Bottlenecks', for the purposes of the N16 SCB RSR, are defined to be a serious of substandard horizontal and vertical curves, resulting in 'Stopping Sight Distances' which have the effect of reducing speeds and causing platoon's of traffic;

primary roads). The second design option, was a two-step reduction in design speed terms from 100kph to 70kph (a typical design speed for lower quality regional roads and local primary roads).

The characteristics of these designed options were then tabulated to establish if they provided viable options which would be economically, or environmentally better solutions to a standard 100kph design option. The resulting effect is outlined broadly in Table 3-1, the main observations as outlined in the N16 SCB RSR were:

> *Between 51%[29] and 46%[30] of the route will still require greenfield realignment. This is owning to the poor nature of the existing horizontal geometry;*
> *Of the remaining sections which are online, full vertical reconstruction[31] would be required over approximately 42%[30] and 48%[29]. This is primarily as a result of the poor nature of the existing vertical geometry;*

The foregoing points, from an engineering perspective, meant that a reduction in 'Design Speed' would not significantly reduce the engineering aspects associated with the realignment. In addition, it was considered that the 42% to 48% of online improvements would only (due to the vertical differences) serve to require a closing of the national primary route in order for upgrade works to be undertaken. Further points which were also of significance included:

> *There were significant impacts on property at locations where road widening and realignment was required;*
> *A significant number of direct access arrangements remained, particularly around cluster locations such as at Barroe and Doonally townlands;*

Additionally, the aforementioned designs would not be, as 'safe' or 'efficient' as the comparable 100kph designs, and considering the proportion of greenfield realignment still required (as per *Table 3-1*) were expected to carry similar environmental effects in comparison with a 100kph design speed road.

Table 3-1: Traffic management alternative – Some Characteristics

Characteristics of TMA	***Design Speed***	
	70kph	**85kph**
Length of Option (m)	7,985m	7,943m
Length of Option which requires greenfield realignment (m)	4,070m	3,650m
Length of Option ONLINE BUT which requires full vertical reconstruction (km)	3,395m	3,814m
Domestic properties potentially required under a CPO (no.)	8	13
Domestic properties where garden space is required (no.)	30	22
No. of Direct Accesses which remain (no.)	38	27

[29] 70kph Design Speed

[30] 85kph Design Speed

[31] Full reconstruction considered where the vertical alignment deviates from the existing by greater than 0.6m

In consideration of the foregoing assessment, it was concluded that the traffic management alternative was not a viable intervention.

Design upgrade in accordance with TII Publications (Design Standards)

The process evolved to indicate, that the only viable solution to the interventions required, on the N16 in County Sligo, was an upgrade which was consistent with the requirements of a national primary route and the appropriate design standards. The following sections, outlines the process used to develop the 'Feasible Route Options' for this solution.

Pre Constraints Study Alternatives

The first step in this stage of the process, was the consideration of potential options for the realignment of the N16 and the likely maximum geographical extents of any such realignment. The broad ranging options included:

- Consideration of historical route options examined in a 1996 Report[32];
- Potential regional road corridors[33]; and
- N16/N15 inter connection.

Sections 6.3.1, 6.3.2 and 6.3.3 of the N16 SCB RSR outlines the assessment of these foregoing options, which resulted in only the most desirable route in 1996, being brought forward to the initial route option design process which is described below.

3.2.1.1.2 *Key Design Stages*

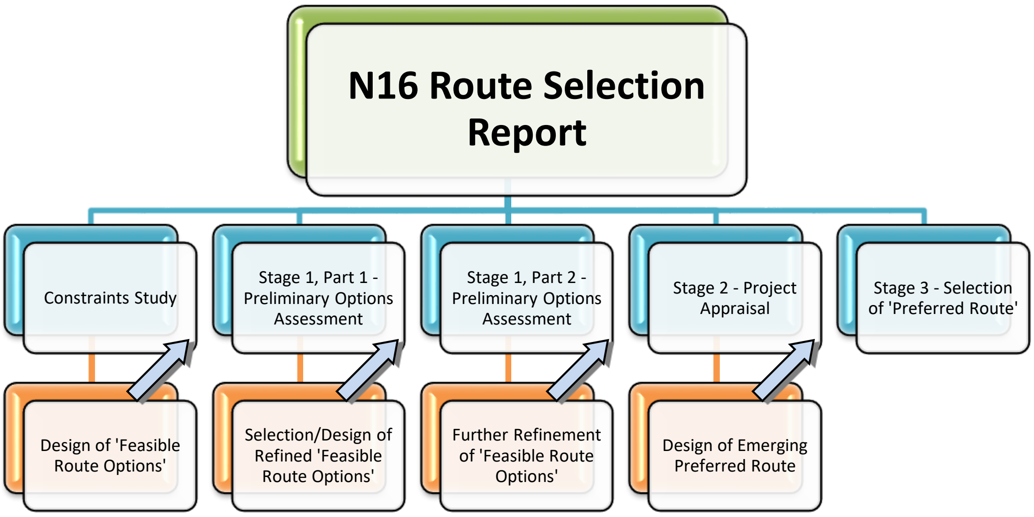
The ensuing selection of the preferred route for the N16 was an iterative process, supported by a number of key stages as summarised in *Figure 3-1*. These stages as described below included:

(1) Establishment of a Constraints Study Area;
(2) Design Phase 1 – Feasible Route Options;
(3) Stage 1, Part 1; Preliminary Options Assessment;
    a. Design Phase 2 – Refined Feasible Route Options;
(4) Stage 1, Part 2: Preliminary Options Assessment;
    a. Design Phase 3 – Refined (2) Feasible Route Options;
(5) Stage 2; Project Appraisal;
    a. Design Phase 4 – Further refinement of Feasible Route Options;
(6) Selection of Preferred Route.

[32] As outlined in section 6.3.1 of the N16 SCB RSR – A route selection was previously considered for the N16 in 1996.

[33] This included an examination of the regional road corridors between Sligo and Manorhamilton.

Figure 3-1: Stages of N16 SCB RSR



Constraints Study

The first stage of the appraisal included the establishment of a Constraints Study Area (See Fig. 2.1 contained within Volume 3) and the subsequent examination of constraints located therein. Some of the main constraints as identified within the N16 SCB RSR included *inter-alia*:

- The existing urban and rural built environment;
- The ground topography particularly to the north of the L-3406-0 (Drum Road) which can be described as hilly to mountainous[34];
- Sensitive Landscape Character Areas including:
  - the Copes Mountain Upland Landscape Character Area which is determined to fall within the category of a 'Highest Quality' landscape; and
  - Glencar Lake Valley which is considered to be a 'Very Attractive' landscape;
- Designated ecological sites proximate to the study area including in particular:
  - Crochauns/Keelogyboy Bogs NHA (002435);
  - Sligo Leitrim Uplands SPA (004187), and
  - Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623).
- Undesignated ecological sites considered to be of national and county importance;
- The existing road network including the N16 itself, which by its twisty nature makes realignment difficult;
- Various Archaeological, Architectural and Cultural Heritage Sites;
- Land Use including zoned lands in the Sligo & Environs Development Plan;

Design Stage 1 - Feasible Route Options (FRO)

The second stage of route appraisal involved the identification of a range of Feasible Route Options, 13 of which went forward for assessment. These options are described figuratively in Fig. 3.1 contained within Volume 3 and were separated into four strategic options as follows:

[34] This factor is particularly relevant in terms of the *Proposed Road Development*, insofar as any potential corridor is largely constrained by the hilly/mountainous nature of the topography.

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A;
  - Red – Feasible Route Option 01A/01B[35];
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A
  - Yellow - Feasible Route Option 02A/2B[36];
- *Rathbraghan* to the County Boundary:
  - Green - Feasible Route Option 03
  - Light Blue - Feasible Route Option 04
  - Lime Green - Feasible Route Option 10
  - Grey – Feasible Route Option 11
- AbbVie Roundabout to the County Boundary:
  - Blue - Feasible Route Option 05;
  - Pink - Feasible Route Option 06;
  - Brown - Feasible Route Option 07;
  - Black - Feasible Route Option 08;
  - Purple - Feasible Route Option 09;

Stage 1, Part 1; Preliminary Options Assessment

The Feasible Route Options described above, were then subjected to a Stage 1, Part 1: Preliminary Options Assessment.

The assessment was undertaken by a multi-disciplinary range of specialists under the categories as outlined in *Table 3-2*.

Table 3-2: Preliminary Options Assessment

POA Framework Category	Discipline
Engineering	Road Engineering, Road Safety Impact Assessment, Traffic & Transport.
Economics	Options Comparison Estimate
Environment	Landscape & Visual, Flora, Fauna & Fisheries, Agricultural Property, Non-Agricultural Property (Domestic, Industrial, Commercial etc.), Noise & Vibration, Air Quality & Climate Change, Hydrology & Hydrogeology, Soils & Geology, Archaeology & Cultural Heritage, Architectural Heritage, Socio Economic and Urban Planning.

A 'Framework Matrix' ranking template and an associated 'Scorecard' was developed by the project team and applied by each individual specialist to the various assessments being undertaken. Each route was relatively ranked in order of preference from 1 to 13. These ranks were then applied to the 5 separate 'Preferences' as outlined in Table 3-3.

[35] The represents an extension of option 01A, from its connection point with the N15 and along the existing N15 to its connection point with the existing N16 at Ash Lane.

[36] The represents an extension of option 02A, from its connection point with the N15 and along the existing N15 to its connection point with the existing N16 at Ash Lane.

Table 3-3: Application of Ranks to 'Preferences'

Preference	Preference Rank
Very High Preference	1
High Preference	2
Medium Preference	3
Low Preference	4
Very Low Preference	5

In consideration of the fact that the establishment of a 'Preferred Route' is best done on an iterative basis, whereby, the establishment of an optimal route location becomes clearer as the process evolves and more detailed information becomes available, it was considered appropriate to establish 'Sectional Splits' which would allow for the breaking up of 'Feasible Route Options' and the subsequent amalgamation of preferential sections.

These 'Sectional Splints' (See Figure 2.1.1. contained within Volume 3 of this EIAR), included 3 sections described for the purposes of the N16 SCB RSR as the:

- 'Southern' section;
- 'Central' section (Predominately the section within which the *Proposed Road Development* is located); and
- 'Northern' section.

As the location of the *Proposed Road Development* is influenced more by the assessments conducted in the 'Southern' and 'Central' (within which it is predominately located) sections, this section of the EIAR focuses on these areas rather than the 'Northern' section.

Refinement of Route Options

In the South Section, the refinement process, which is described in detail within section 9.6 of the N16 SCB RSR focussed mainly on 2 principal aspects; firstly the demand requirements of the N16 traffic, and secondly on the environmental aspects associated with the various route options. At a strategic level, the results of the Traffic Model provided a calculated assessment of how traffic would be attracted to various destination points from the N16.

The results showed evidence, that approximately 30% of traffic coming from the north in the case of options 01A/01B and 02A/02B (See *Figure 3-2* for an indicative outline of this effect in the subsequent refined design situation) would be attracted off the proposed routes at their junction's with the Drum Road (L-3406-0). In addition, the model showed in the case of the foregoing options and Option 03 (including also Options 04, 10 and 11) that there was a significant pull of traffic (upwards of 85% of the traffic which remains on the routes following its intersection with the Drum Road) off the route options to the L-9005-0 (Ballytivnan Road), either at their junctions with this road itself, or via the L-7421-0 and L-7422-0. There are a number of consequences arising from this, including:

(1) A resulting inefficiency of the particular 'Feasible Route Option'; and
(2) An indirect impact on the local networks in terms of *inter-alia* amenity, noise & vibration and air quality.

Considerations in relation to the Central section, were focussed predominately on Environmental effects. In general, it was noted that there were negative impacts on people, arising from a number of differing route options. Of most significance, is this regard were property impacts arising from option 01A. Impacts were generally observed to increase in significance as route options moved away from the existing N16, such as for example in the case of option 04. There were notable impacts also discussed during the full team workshop, which due to their isolated nature did not get fully reflected in the aforementioned score cards, this includes for example impacts on agricultural (including farm house) property in the townland of *Lugatober* – it was also recommended during the aforementioned workshop that these impacts if possible should be avoided/reduced as far as practicable. In addition, the assessment process, also focussed on the avoidance of potential impacts on Groundwater Dependent ecosystems such as at Lugnagall Flush.

It was generally agreed that the design approach to achieve an optimal solution should be one which maintains proximity as far as possible to the existing N16.

The following tables, in addition to describing the options to progress in the appraisal process (Table 3-6) also set out the reasons why certain options were discounted (Table 3-4) and where other options could be subjected to design modifications (Table 3-5) prior to progression in the appraisal process.

Table 3-4: Discounting of Options

Section	Option(s)	Reason(s) for discounting
South	03, 04, 10 & 11	Options 03, 04, 10 & 11 were discounted for the following reasons: ➢ Impacts in relation to Urban Planning and the zoning objectives of the Sligo & Environs Development Plan; ➢ Non-Agricultural Property impacts including impacts on lands with significant development potential; ➢ Agricultural Property impacts including impacts on a Key Dairy Enterprise; ➢ Noise and Vibration Impacts as a result of increased traffic flows in the Ballytivnan Area; ➢ Air Quality Impacts as a result of increased traffic flows in the Ballytivnan Area; ➢ Hydrology impacts including the potential impacts on an area of Floodplain Storage; ➢ The east/west local connectivity of these options could be tested, via the utilisation of the east/west link as an additional element of options which tie into the AbbVie Roundabout; and ➢ There is an absence of significant design mitigation measures available to reduce the impacts arising from these options.
	06	Option 06 was discounted for the following reason: ➢ It has a similar arrangement to option 05 with the exception of a double roundabout system to the south. Arising from the Traffic Model assessment, this alternative arrangement had the effect of increasing journey times on option 06, over option 05, with the resulting effect that some of the traffic would divert to the local network. For this reason, it was considered that option 05 would be more preferable to option 6 in a direct comparison.
	07 & 09	In terms of the 'Preliminary Options Assessment' and from an 'Environmental' perspective, FRO's 07, 08 and 09 appeared from the viewpoint of the scorecards to achieve overall the best results; they did however each provide very similar strategic objectives. In this regard, a direct comparison was carried out on each of these options. In the case of options 07 and 09, there was little room to manoeuvre design changes which would further reduce impacts on existing residential properties; however, in the case of option 08, it was considered that potential existed to modify the design in order to achieve a physical clearance of circa 8-10m from AHC 06, which is a protected structure and an existing Alzheimer's Day Care Unit. It was therefore agreed to undertake the foregoing assessment, prior to making an informed decision on the viability of these options. The resulting conclusion was that such a change was possible and should in this regard be considered as a modified alternative to FRO 08; additionally it was also established that the southern portion of this route could be amalgamated with the southern tie in alignment of option 07, thereby reducing impacts on agricultural property. A Grade 1 Architectural assessment was undertaken on the aforementioned protected structure; this provided recommendations which could be applied in the 'Design' Phase which may reduce impacts on the curtilage and setting of the structure, in addition and notwithstanding

Section	Option(s)	Reason(s) for discounting
		the legal nature of the protected status of the structure, this assessment observed the following in relation to the structure itself: *The significance of the former Dunally School is primarily of social interest although there are also surviving ventilation features at the building that may be of scientific interest. There is little of interest from an architectural heritage perspective, except the picturesque accumulation of several periods of development. There is no single period of historic development that has survived completely intact and many original features have been removed...* Based on the results of the foregoing, it was considered that options 07 and 09 provided higher negative impacts (particularly in relation to domestic property) than the modified version of option 08. In this regard, it was proposed that they be discounted from the process.
Central Central	01	Option 01A was discounted for the following reasons: ➢ Negative impacts arising, in relation to Non-Agricultural and Agricultural property aspects.
	02 & 03	Options 02A and 03, were discounted for the following reasons: ➢ Negative impacts arising, in relation to Agricultural property aspects, including impacts on a dwelling associated with farm property. However, as an alternative comparable, it was considered that the junction arrangement proposed as part of these options and occurring in *Collinsford/Lugnagall*; should be retained for the next stage of the assessment process.
	04	Option 04 was discounted for the following reasons: ➢ Impacts arising in relation to *inter-alia*; Flora, Hydrology and Hydro Geology, Noise & Vibration and Landscape & Visual. Similar to options 02A and 03, it was proposed that the proposed junction arrangement (at *Collinsford/Lugnagall*) should be considered further.
	10	Option 10 was discounted for the following reasons: ➢ Negative impacts arising, in relation to Agricultural property aspects, including impacts on a dwelling associated with farm property. However, the northern portion of option 10 (including the proposed junction arrangement at *Collinsford/Lugnagall*) was to be considered further as a modified design option.

Table 3-5: Design Modifications

Section	Option(s)	Reason(s) for and nature of Design Change(s)
South	01A, 01A/01B, 02A, 02A, 02A/02B	There were notable impacts associated with options 01A, 01A/02B, 02A and 02A/02B, however it was apparent from the 'Preliminary Options Assessment' and discussions at the subsequent workshop, that it may have been possible to mitigate some of these impacts by alternative designs, which effectively would reduce the volume of additional traffic being attracted to the local network from the national network. In this regard, given the strategic nature of these options, it was considered that it would be inappropriate to discount them without extending the assessment. The extended assessment considered the benefits of: ➢ Establishing modified designs, which separate the National and Local Network on the approaches to Sligo – i.e. modification of the vertical design to provide road underbridges;
	08	As already referred to, the modified version of option 08 was generally considered a desirable option. However, considering noticeable alignment design changes and for reasons for clarity and ease of assessment, it is considered that this modified design would be more appropriately considered in a re-labelled situation as option 12.

Section	Option(s)	Reason(s) for and nature of Design Change(s)
	12 (Amalgamated Option)	An amalgamated design option was, developed in the 'South' section arising from the 'Preliminary Options Assessment' and the subsequent discussions at the Multi Disciplinary Workshop. This option utilises aspects of option 07 (tie in to the AbbVie Roundabout) and modified aspects of option 08 (Horizontal alignment change) at *Faughts* townland.
	13 (Amalgamated Option)	The east/west link previously considered under options 03, 04, 10 and 11, progressed to the next stage of the assessment as a potential supplementary addition to the options which tie into the AbbVie roundabout.
Central	08	Arising from the 'Preliminary Options Assessment', it was recommended that option 08 should progress to the next stage of the assessment. However, it was considered given the difficulty in establishing junction arrangements in *Collinsford/Lugnagall* that an alternative solution should be considered as part of a modified option 08 – this was in cognisance of the undesirable junction arrangement initially proposed. This modified design involves bridging the L-3404-0 in an underbridge arrangement (An option which was further considered in the later design process).
	12 (Amalgamated Option)	An amalgamated design option was developed in the 'Central' Section arising from the 'Preliminary Options Assessment' and the subsequent discussions at the Multi Disciplinary Workshop. This option was based on desire lines generally following amalgamated sections of options 05 and 10. As part of this option, 3 separate junction arrangements will be considered in *Collinsford/Lugnagall*.

Table 3-6: Retain Design and progress to the next stage of assessment

Section	Option(s)	Reason(s) for and nature of Design Change(s)
South	05	In the South section, it was acknowledged that option 05 did provide negative impacts which could be conceived to be of a higher magnitude (than other options in the South) in relation to some environmental aspects including Agricultural property (impacts on a key dairy enterprise) and Architectural Heritage (impacts on a demesne and visual setting impacts to a protected structure). However; considering the routes shorter nature in comparison to option 08 which also ties into the AbbVie Roundabout, it was considered that the economic benefits should be more accurately measured and then balanced against the environmental impacts before proceeding to make a decision on the route option. In this regard, it was recommended that option 05 should proceed to the next stage of the assessment.
Central	05	It was recommended that option 05 should progress to the next stage of the assessment.

In summary and considering the details set out in the foregoing tables; this first stage of the process resulted in the following route options remaining following assessment:

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A – v2;
  - Red – Feasible Route Option 01A/01B – v2[37];
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A – v2;
  - Yellow - Feasible Route Option 02A/02B – v2[38];
- AbbVie Roundabout to the County Boundary:

[37] The represented an extension of option 01A-v2, from its connection point with the N15 and along the existing N15 to its connection point with the existing N16 at Ash Lane.

[38] The represented an extension of option 02A-v2, from its connection point with the N15 and along the existing N15 to its connection point with the existing N16 at Ash Lane.

- Blue – Feasible Route Option 05;
- Black - Feasible Route Option 08 – v2;
- Brown - Feasible Route Option 12 (and option 12-v2)

These foregoing options, as presented in Fig. 3.2 contained within Volume 3 of this EIAR, proceeded to Part 2 of the Preliminary Options Assessment as described below.

Stage 1, Part 2; Preliminary Options Assessment

The refined 'Feasible Route Options' described above were subjected to a second stage of 'Preliminary Options Assessment' defined within the N16 SCB RSR as Stage 1, Part 2.
The assessment process was carried out to a similar level of detail which has already been outlined for Stage 1, Part 1; that is with the exception of the Traffic and Transport Assessment which expanded in detail to consider further Key Performance Indicators at a Strategic and Specific level.

Notably during the assessment process, it was observed, in the south section that Option 01A-v2 and Option 02A-v2 would continue to lose approximately 50% of their traffic at each routes intersection point with the Drum Road (L3406-0) as outlined in *Figure 3-2* below. This continued (from initial assessments) to indicate the desire lines of traffic to be to the central urban centre of Sligo. Considering this and further analysis included in the N16 SCB RSR, Table 3-7 outlines options discounted in the South and Central sections.

Considering the discreet nature of differences between the various route options in the Central and section, it was recommended that all options proceed to the Stage 2 Project Appraisal.

Figure 3-2: SATURN Model Select Link Analysis overview

Output from SATURN Traffic Model – Select Link Analysis – Direction of travel is North to South

(Thickness of black line indicates level of usage)

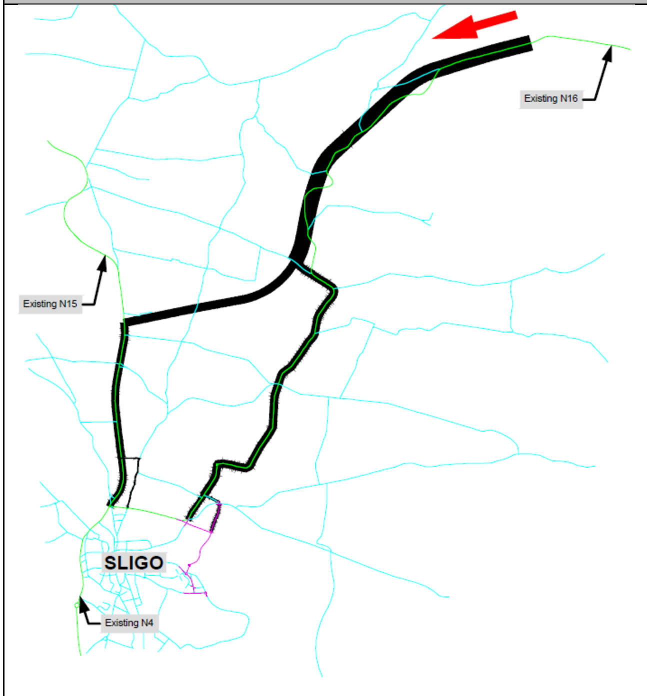
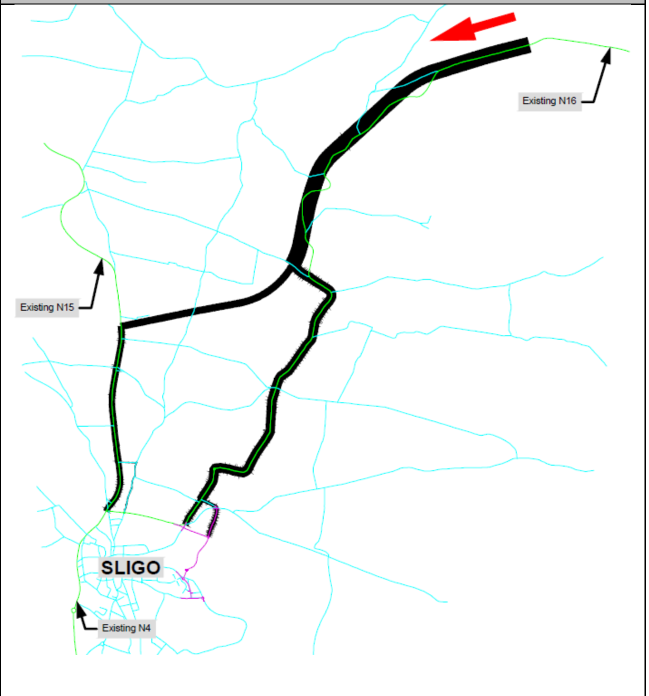
Option 01A-v2	Option 02A-v2
	

Table 3-7: Discounting of Options

Section	Option(s)	Reason(s) for discounting
South	01A/01B-v2 (the N15 extension to option 01A-v2).	The extension to Option 01A-v2 which included the online upgrade of the existing N15 increased the level of associated environmental impacts. Considering the fact that this option (for the specific purpose of the N16 upgrade) did not offer any notable Traffic and Transport benefits over Option 01A-v2, it was considered that it should not proceed to the Stage 2 Project Appraisal Stage.
	02A/02B-v2 (the N15 extension to option 02A-v2.)	The extension to Option 02A-v2 which includes the online upgrade of the existing N15 increased the level of associated environmental impacts. Considering the fact that this option (for the specific purpose of the N16 upgrade) did not offer any notable Traffic and Transport benefits over Option 02A-v2, it was considered that it should not proceed to the Stage 2 Project Appraisal Stage.
	02A-v2	As outlined in Figure 3-2, both option 01A-v2 and option 02A-v2 lose approximately 50% of their traffic at their connection points with the Drum Road. Considering this fact which suggested a likely economic inefficiency of both options, which are broadly similar on a strategic level, it was not considered necessary to subject both options to the Stage 2 Project Appraisal. It was also observed from the assessments undertaken, that option 02A-v2 did not offer any notable Traffic and Transport benefits over other options; moreover it carried a higher density of economic and environmental effects, particularly in comparison with option 01A-v2 and most notably in relation to the Options Comparison Estimate, Urban Planning, Agriculture and Architectural Heritage. In this regard, option 02A-v2 was discounted prior to the undertaking of the Stage 2 Project Appraisal.

Further Refinement of 'Feasible Route Options'

Similar to Part 1, Stage 1, the outcome of the 'Preliminary Options Assessment' (Part 2) resulted in a further refinement of the route options down to 3. The routes can be separated into two Strategic Options as outlined below and described figuratively in Fig. 3.3 contained within Volume 3:

- N15 (connection at *Teesan Td.*) to the N16 County Boundary:
  - Red – Feasible Route Option 01A – v2;
- AbbVie Roundabout to the County Boundary:
  - Blue – Feasible Route Option 05;
  - Brown - Feasible Route Option 12 (and option 12-v2)

3.2.1.1.3 *Stage 2 – Project Appraisal & the Emerging Preferred Route*

Multi Criteria Analysis (MCA)

The three Refined Feasible Route Options were appraised (Stage 2 of the assessment) in accordance with national transport planning policy, using the Common Appraisal Framework based on the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

These criteria were used to measure and compare the ability of each particular route option to deliver the defined objectives which were also established under the aforementioned criteria.

The Multi Criteria Analysis performance matrix for this stage of the appraisal is outlined in *Table 3-8*. This is a similar integer system to that recommended in *PE-PAG-0203, Project Appraisal Guidelines for National Roads Unit 7.0 - Multi Criteria Analysis.*

Table 3-8: TII PAG – MCA Criteria

Score Index	Impact Level
7	Major, or Highly Positive
6	Moderately Positive
5	Minor, or Slightly Positive
4	Not significant, or neutral
3	Minor, or slightly negative
2	Moderately negative
1	Major or highly negative.

Following the analysis, certain issues specific to each of the three options were established. Each route option was generally considered to be similar under the headings of Accessibility & Social Inclusion and Integration headings. Environmental criteria were also generally similar with minor variances.

The main differences between the route options occurred under the headings of Economy and Safety. There were marginal differences between Options 05 and 12 which both achieved the objectives; while it was established that Option 01A-v2, did not achieve objectives specifically in relation to Economy (Efficiency & Effectiveness and Transport Quality & Reliability). The route option did not achieve a Benefit to Cost Ratio which was close to, or greater than '1'.

Pair Wise Comparison & the Emerging Preferred Route

Prior to concluding on the selection of an Emerging Preferred Route, a direct Pair Wise comparison was undertaken on both of the aforementioned viable options. In advance of same, it was considered appropriate arising from the environmental assessment, to merge option 05 in the south with option 12 (north of *Castlegal* townland), this corresponded with the iterative nature of the process and allowed to further reduce the potential for environmental impacts. In addition, it ensured that bias was removed from a direct comparison of both options. This new route was re-labelled as option $05^{(S)}/12^{(N)}$.[39]

The results of the 'Pair Wise' comparison as outlined in Table 3-9 directly compared the viable route options. In terms of the overall Multi Criteria Analysis (MCA) assessment, Option $05^{(S)}/12^{(N)}$, achieved an overall index of 5.07 while option 12 achieved an overall index of 4.99. Option 12 was considered to be slightly less intrusive from an environmental perspective (See comparisons outlined in Table 3-10); However as already outlined, the more positive scores for option $05^{(S)}/12^{(N)}$, relate to the fact that it is a shorter route by approximately 600m which has consequential benefits in term of Economy (Efficiency & Effectiveness and Transport Quality & Reliability) and Safety.

In this regard the Emerging Preferred Route put forward, was Option $05^{(S)}/12^{(N)}$ as described in Fig. 3.4 contained within Volume 3. Prior to the Public Display of this route, the Route Selection Process as outlined in this Chapter was subjected to a TII Peer Review.

Table 3-9: Multi Criteria Analysis Results

Multi Criteria Analysis Summary		
Sub Criteria	Option 12	Option 05/12
	Index	Index
Environmental average Index	2.98	2.86
Safety average Index	6.50	6.75
Economy average Index	4.22	4.50
Accessibility/Social Incl. average Index	4.50	4.50
Integration average Index	6.75	6.75
Average	4.99	5.07

The Emerging Preferred Route is c. 7.7km in length with a cross section corresponding to a Type 2 Single Carriageway (as determined from studies undertaken in the N16 SCB RSR[40]). Junction arrangements proposed, included simple T-junctions and right left staggered junctions.

39 $^{(S)}$ Denotes 'South', $^{(N)}$ Denotes 'North'

40 Section 6.5.3.3

Table 3-10: Pair Wise Comparison – Environmental Effects

Category	Narrative in relation to Environmental Effects
General Note	In terms of the Environment, disparities between the 2 route options occur generally in the area south of *Lugatober;* therefore the Pair Wise comparison is focussed on this particular section.
Urban Planning	In terms of Urban Planning; option 12 did not impact on the planned development areas in the Sligo and Environs Development Plan, while option 05 traverses/subdivides a small portion of planned urban areas. In terms of Multi Criteria Analysis (MCA) Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '3.5' corresponding to 'Minor, or Slightly Negative, <u>to</u> Neutral, or Not Significant', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.
Human Beings	The main difference between the two options occurs in the area south of the L-7422-0/L-3407-22. Option 12 severed the existing N16 to the north, requiring the occupants of 18 properties to detour up to one kilometre north to a connection with the L-3407-22, while option $05^{(S)}/12^{(N)}$ introduced new severance for *Barroe* properties and maintains some existing severance at *Doonally* Bridge, although the introduction of a staggered junction between the L3407-0 and L3407-22 reduced this relative to the existing or do-nothing situation. Although, it may be possible to provide an additional access to the proposed route in the case of option 12, which would reduce the severance for the *Barroe* properties, it was considered that this would adversely impact the Safety and Collision Reduction Index score; in this regard such a design amendment was not considered at this stage. In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '4.5' corresponding to 'Neutral, or Not Significant, <u>to</u> Minor, or Slightly Positive', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.
Noise & Vibration	Both options were considered similar in terms of Noise & Vibration.
Air Quality	Both options were considered similar in terms of Air Quality.
Agricultural Property	In terms of Agricultural Property; In the case of option $05^{(S)}/12^{(N)}$, there would be a High impact on a farm holding on the L-3406-0 resulting from a direct impact on a farmyard comprising of animal housing and other facilities. There would also be a High impact on a Key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance and the proximity of the alignment to the farmyard. There was also a High impact on one farm holding in *Barroe* arising from landtake and severance. In terms of option 12, there would be a High impact on five farm holdings in *Barroe, Faughts* and *Doonally* (Calry ED) due to landtake and severance. There would be a Medium impact on a key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance. In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1' corresponding to 'Major, or Highly Negative', while option 12 received a score of '1.5' corresponding to 'Moderately Negative, <u>to</u> Major, or Highly Negative'.
Non Agricultural Property	In terms of Non-Agricultural Property, there were only slight differences between the 2 options in the section south of *Lugatober*. In the case of option $05^{(S)}/12^{(N)}$ the more notable impacts are a Medium impact on a property in *Barroe* due to the impact on the property curtilage and existing access. There would be a Medium impact on a second property in *Barroe* due to the impact on the property curtilage and existing access. In the case of option 12, there will be a Medium impact on a property (currently a Day Care Centre) in *Faughts* due to the impact on the property curtilage, existing property access and garden. There will be a Medium impact on a second property in *Doonally* due to the impact on existing access. There will be a Low impact on the remaining properties. In terms of MCA Indexing, both options received an Index of '3' corresponding to 'Moderately Negative'.
Flora, Fauns & Fisheries (Biodiversity)	Both options were considered similar in terms of Flora, Fauna & Fisheries (Biodiversity).
Hydrology & Hydrogeology	Both route options were generally similar in terms of their impact on the Hydrological & Hydrogeological environment. A slight difference occured in the case of option $05^{(S)}/12^{(N)}$ over option 12, as it may potentially result in the proposed road running almost parallel and in close proximity to the Willsborough stream channel and within the Floodplain for c. 200m, this is balanced against the fact that option 12 traverses an extensive area of pluvial flood risk.

Category	Narrative in relation to Environmental Effects
	In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.5' corresponding to 'Minor, or Slight Negative to Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.
Soils & Geology	Both route options were generally similar in terms of their impact on the Soils & Geology environment; that is with the exception of a more sizeable deficit of fill required for option $05^{(S)}/12^{(N)}$ over option 12. In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2' corresponding to 'Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.
Waste	Both options were considered similar in terms of Waste activities.
Landscape & Visual	Both route options were generally similar in terms of their impact on the Landscape & Visual environment; that is generally with the exception of a long cut section in the south of option 12. In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.25' corresponding to just above 'Moderately Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.
Archaeology & Cultural Heritage	In terms of Archaeology & Cultural Heritage; Option $05^{(S)}/12^{(N)}$ would result in Significant Negative Impacts on CHC47 (Mill Race) and Moderate Impacts on CHC62 & CHC63 which are both demesne landscapes. Option 12 would result in Moderate Negative Impacts on CHC16 (Ringfort), CHC28 (Ringfort), CHC34 (Enclosure), CHC62 (Demesne landscape), CHC63 (Demesne landscape) and CHC64 (Demesne landscape). In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.
Architectural Heritage	In terms of Architectural Heritage; Option $05^{(S)}/12^{(N)}$ would result in a significant impact on AHC 14 (Demesne landscape), AHC 15 (Demesne landscape) and AHC 35 (Bridge). There would be a Moderate impact on AHC 19 (Mill Race). Option 12 would result in Moderate negative impacts on AHC 6 (Former *Doonally* School), AHC 15 (Demesne landscape) and AHC 16 (Demesne landscape). In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

3.3 N16 (Sligo) Route Improvement Strategy

3.3.1 N16 Sligo – Route Improvement Strategy

Following the establishment of the Emerging Preferred Route, a 'Route Improvement Strategy' assessment was carried out for the N16 within County Sligo. The objective of this report was to determine how the N16 should be improved over the years to follow and what the priority should be. As outlined below, this was examined in the context of either:

- A full route improvement; or
- Targeted short term minor Improvements.

3.3.1.1 Full route improvement

The likelihood of a full improvement to the N16 (which would result in it becoming a major scheme), was examined in a direct comparison with other potential major schemes requiring improvement within the county.

The assessment generally revealed the following points of interest in terms of the national primary network:

(1) Sligo has received a historically tight funding envelope (over the past 20 years) with regard to major projects which has seen just over 21km (out of a possible 106km) of the national primary network developed over a period of 20 years prior to the assessment;

(2) In a major scheme context, the N16, has significantly lower AADT values when compared against other national primary routes. Therefore it was unlikely to provide greater benefits in a Benefit to

Cost Ratio than other potential major schemes (such as the N17 or N15) and as a result would not be a high priority in terms of a county wide hierarchy of major projects;

(3) The N16 was not included within the Capital Investment Plan (2016-2021). This indicates that a full improvement is not an objective for the government in the short to medium term.

Considering the foregoing, in a major scheme context, the full N16 Sligo to County Boundary Emerging Preferred Route would be unlikely to bring greater economic benefits over other competing major road schemes within the county. In this regard it was determined to be at the lower end in terms of a major scheme project hierarchy list. It was thus considered unviable to progress the project in this manner.

3.3.1.2 Targeted short term minor improvement

The N16's physical characteristics (including its difficult topography) and the selected Emerging Preferred Route, differentiate it from other potential national primary route upgrades within County Sligo. It is the only route which lends itself to targeted minor improvements (over its full length) on a phased basis in a short to long term scenario, as and when funding becomes available (See Figure 3.5 contained within Volume 3). This factor is based on an engineering assessment undertaken, post the selection of the Emerging Preferred Route, which identified suitable internal tie in points, at *Drumkilsellagh* and at *Lugnagall*. This allows the route to be developed in three separate projects, which for the purposes of appraisal were described as N16 *Doonally*, N16 *Lugatober* and N16 Gortnagrelly.

Based on historical funding profiles and likely future priorities within County Sligo; it was considered likely that completion of these targeted minor schemes would take place over a time horizon which would span up to approximately 20-25 years from the time of the assessment. The subsequent project priority assessment is outlined below.

3.3.1.2.1 *Project priority assessment*

A project priority assessment was carried out to establish which was the optimal project to progress at the time of assessment (short term) and whether such project could present 'value for money'.

In a similar manner to that outlined in section 3.2.1.1.3, the assessment was carried out in a multi criteria assessment format with regard to the Common Appraisal Framework criteria headings.

In general, the appraisal[41] was informed by environmental assessment results determined during the N16 SCB RSR. In addition, additional specific assessments were undertaken in relation to the 'Economy' and 'Safety' criteria.

Multi Criteria Analysis (MCA)

The results of the assessment are outlined below with regard to each of the CAF criteria headings.

Economy;

The economic appraisal utilised the TII Simple Appraisal Tool. This revealed that over a 30 year horizon, the *Lugatober* Project provided the best results (excluding Safety) with an Net Present Value (NPV) of €1.17m and a Benefit to Cost Ratio (BCR) of 1.15 (increasing to 1.68 for residual benefits[42]). The *Doonally* Project provided the next best benefits with an NPV of €0.94m and a BCR of 1.08 (increasing to 1.56 for residual benefits. However, notably the *Doonally* Project would require an investment, which is approximately €4.21m greater than the *Lugatober* investment costs to achieve these benefits.

[41] While assessments undertaken as part of this appraisal; are considered accurate in terms of comparing various alternatives, they were undertaken at an early stage in the design process and thus should not be considered to accurately predict the final out turn of any particular project, particularly in terms of Cost Benefit Analysis results, or, predicted Accident Savings.

[42] Which considers benefits from a further 30 years of operation.

The Gortnagrelly Project was least desirable from an economic perspective providing an NPV of -€2.33 and a BCR of 0.68 (increasing to 1 for residual benefits).

Safety

The safety assessment comprised a generic spreadsheet analysis, which revealed monetary benefits for a 30 year life time of:

- €3.691m equating to €1.06m/km for the *Doonally* Project;
- €3.164m equating to €1.159m/km for the *Lugatober* Project; and
- €0.04m equating to €0.017m/km for the Gortnagrelly Project.

In this regard; although the *Doonally* provided the greatest overall potential benefits, it does so over a longer section of the network. The *Lugatober* Project provided the greatest benefits on a per km basis.

Environment

The Environmental assessment was informed by assessment results established during the N16 SCB RSR.

The results demonstrate[43] the *Doonally* and *Lugatober* Projects, to be broadly similar from an environmental perspective with the Gortnagrelly Project providing a slightly lesser degree of overall non-weighted impacts.

Accessibility & Social Inclusion

Each project was considered to provide similar benefits.

Integration

Each project was considered to provide similar benefits.

Conclusion

Based on the foregoing assessment and as outlined in *Table 3-11*, the *Lugatober* Project provided the best overall benefits from a multi criteria analysis perspective. This is due mainly to benefits derived under 'Safety' and 'Economy'. In this regard, it was considered that this project should be first to be brought forward in the short term and now represents the *Proposed Road Development* described in this EIAR.

Table 3-11: Project Priority Assessment, MCA

Multi Criteria Analysis Summary			
Sub Criteria	**Doonally**	**Lugatober**	**Gortnagrelly**
	Index	**Index**	**Index**
Environmental average Index	2.69	2.65	3.06
Safety average Index	5.06	5.16	4.00
Economy average Index	4.16	4.30	3.36
Accessibility/Social Incl. average Index	4.50	4.50	4.50
Integration average Index	6.75	6.75	6.75

[43] The Environment Assessment was not weighted, i.e. for example, Landscape Impacts are likely to be of a higher magnitude in the Gortnagrelly section and thus of perceived greater importance than other environmental criteria (such as Soils & Geology). This would likely result in the Gortnagrelly Project receiving a higher degree of impacts than is reflected in the assessment referenced in this report.

Multi Criteria Analysis Summary			
Sub Criteria	Doonally	Lugatober	Gortnagrelly
	Index	Index	Index
Sum (Total)	23.16	23.35	21.67
Average (Total)	4.63	4.67	4.33

3.4 Application of Design Alternatives

The consideration of alternatives continued into the design process of the *Proposed Road Development*, evolving in tandem with the increasing detail of the design and focusing more closely on discreet considerations. Section 1 contained within Volume 4 (Appendices) provides an overview of this approach which is summarised in the proceeded section of this EIAR.

The design alternatives considered include:

- Junction siting and side road arrangement;
- Vulnerable Road Users; and
- Siting of other ancillary infrastructure.

Where appraisal was required, same was generally conducted in a similar manner to that already outlined in section 3.2.1.1.3.

3.4.1 Junction siting and side road arrangements

Representing a supplementary appraisal to the initial N16 SCB RSR, the Emerging Preferred Route Corridor (within the project extents) was initially assessed for various options which could be considered as reasonable design alternatives in terms of junction siting and side road arrangements.

This process which is described in the aforementioned section of Volume 4, resulted in an examination of the options described in *Table 3-12*, and a conclusion in each case of the most appropriate form of treatment as also outlined in *Table 3-12*.

Table 3-12: Overview of Junction Arrangements considered

Junction Arrangement	Description	Option	Description	Selected Option
JA 01	Southern Tie In	Option A	Online Tie-In to the existing network	Option A
		Option B	N16 Roundabout with the L-3406-0 (Drum Road)	
JA 02	N16/L74515-0	Option A	Simple T Junction (L74515-0	Option A
		Option B	Underbridge Arrangement (L-74515-0)	
JA 03	Existing N16 at *Castlegal*	Option A	Link Road to the L-3406-0	Option B
		Option B	Simple T Junction at *Castlegal*	
		Option C	Simple T Junction at *Lugatober*	
JA 04	N16/L7413-0 at *Lugatober*	Option A	Simple T Junction at *Lugatober*	Option A
JA 05	Existing N16 at *Lugatober*	Option A	Simple T Junction at Ch. 1,315m	Option B
		Option B	Simple T Junction at Ch. 1,150m	
JA 06		Option A	Simple T Junction, L3404-0 (North/West Offline)	Option E

Junction Arrangement	Description	Option	Description	Selected Option
	N16/L3404-0/L34041-0	Option B	Simple T Junction, L3404-0 (Online)	
		Option C	Simple T Junction, L3404-0 (Online) & L34041-0 (Offline)	
		Option D	Simple T Junction, L-3404-0 (Online, collecting L34041-0)	
		Option E	Simple T Junction, L3404-0 (Online) & L34041-0 (Offline)	

3.4.2 Vulnerable Road Users

In a similar manner to the junction siting and side road arrangements, an appraisal of various design alternatives was also undertaken for the infrastructure required for vulnerable road users (Section 1.3 of Volume 4).

Section 3.17 of TII DN-GEO-03036[44] outlines the general principles in relation to the design of facilities for Cyclists and Pedestrians. As there is no existing infrastructure in proximity to the *Proposed Road Development* which permits the consideration of a cycleway remote from the mainline, the application of design alternatives considered the latter two options described in Quote 3-1.

Quote 3-1: DN-GEO-03036, Section 3.17, Rural Areas Cycle and Pedestrian Facility Layouts

> *3.17 General Principles*
>
> *Cycle/Pedestrian Facilities shall be provided as part of all Type 2 and Type 3 Single Carriageway and Type 2 and Type 3 Dual Carriageway national road schemes and shall be provided as follows:*
>
> - *As a Cycleway remote from the road designed in accordance with DN-GEO-03047. This may include the use of suitable disused railways, canal tow paths or forest trails where appropriate.*
> - *Within the maintenance strip or verge of the national road in accordance with the design details outlined in this document.*
> - *Using a suitable existing alternative route incorporating appropriate signage. This option shall require a Departure from Standards which shall outline the justification for the use of this option.*
>
> …

The availability of feasible existing alternative routes was first considered, with the severed sections of the exiting N16 (due to the low volume of AADT) firstly being considered.

Figure 1-30 contained within Volume 4 provides an overview of the two respective severed sections which include:

(1) Severed N16 – *Drumkilsellagh* to *Castlegal;* and

(2) Severed N16 – *Castlegal* to *Lugatober*.

The assessment which examined Horizontal and Vertical Geometry concluded that Section (1) was appropriate for use as an alternative route. Section (2) was not considered appropriate due to the difficulties in achieving a desirable gradient on the northern most tie in point to the proposed new N16 (the tie-in gradient would be in the order of 14%).

In this regard, the preferred approach was that a dedicated online two way cycle facility be integrated with an offline facility between *Drumkilsellagh* and *Castlegal*, which will incorporate appropriate lining and signage.

[44] http://www.tiipublications.ie/

The design was also appraised with a focus on reducing the number of conflicts which arise. The optimal manner to achieve this (as outlined in section 1.3 of Volume 4) was considered to be one which as far as is reasonably practicable separated vulnerable road users from conflicts with road traffic. In this regard, an appraisal of potential options for grade separation took place in order to achieve a 2.7m high subway for vulnerable road users in accordance with *DN-GEO-03040, Subways for Pedestrians and Pedal Cyclists Layout and Dimensions*[44]. This resulted in the provision of a subway underpass where the proposed route intercepts the L7413-0 (See Section 4.7 of this EIAR for specific details).

3.4.3 Siting of other ancillary infrastructure

3.4.3.1 Wetland Attenuation Ponds

The surface water drainage system for the *Proposed Road Development,* as outlined in section 4.4 of this EIAR requires the provision of wetland attenuation ponds in order to treat the road runoff. The positioning of these ponds and the consideration of alternative locations is generally influenced by:

- Their proximity to sag points in the mainline alignment;
- The elevation of the topography which allows discharge to adjacent watercourses;
- The availability of lands in order to achieve the treatment and storage volumes required; and
- The ability to access these ponds from the local, or national road network.

A general approach in the identification of suitable lands, has been to identify areas of land where severed plots may exist. However, a further influencing factor includes specific environmental constraints located in these lands, such as for example the considerations around the pacing of a pond to treat runoff emanating from the sag point at c. 1,800m. Although the southern side of the alignment provides a severed area of land, these lands also include Annex I Priority Habitat (Petrifying Springs); in this regard the pond at this location has been sited on the north side of the alignment thereby avoiding impacts on this sensitive ecological receptors.

3.4.3.2 Surplus Soil material arising from the *Proposed Road Development*

Following the analysis of Geotechnical Ground Investigation results (described in section 4.5 of this EIAR), it was established that construction of the project would lead to the generation of circa c. 59,000m^3 of soft soil material, predominately consisting of glacial till sub-soil, which was not deemed to be of sufficient quality for the construction of road embankments - this material does not satisfy the Class 2, or Class 6 structural fill requirements for embankment construction.

Options Considered and the Alternative

The following outlines the options considered to handle this material and how it is assessed in this EIAR:

Option A

As outlined later in this EIAR (Section 4.10.2), there is a fill requirement of circa 198,000m^3 required to construct the project, which in the absence of an onsite solution is only balanced by circa 111,000m^3 being provided in the form of suitable material arising from road cuttings. This creates a deficit of suitable material in the absence of an onsite solution, which leads to a potential requirement for importation from external sources.

The optimum solution therefore (from an environmental and economic perspective) to deal with the combination of unsuitable material generated onsite and the defecit of suitable material, is an ancillary construction feature which could provide a dual purpose. This dual purpose is one which will provide suitable material to reduce the deficit of fill requirements (in the form of a borrow pit) and then via backfilling of this same borrow pit, reduce, or eliminate the need to export soft soil offsite.

This approach has previously been adopted within County Sligo in the Environmental Impact Statement for the N4 Collooney to Castlebaldwin Road Development, which received approval from An Bord Pleanála in 2014. The benefits such an approach provides include *inter-alia* the following:

- Earthworks operation's are reduced predominately to the site limits with only a marginal requirement for earthworks importation. This has the benefit of reducing construction time, construction emissions and the construction cost of alternatively exporting and importing the relevant materials;
- The activity is contained within the extents of the *Proposed Road Development*, therefore environmental effects are contained within a given boundary;
- The material is stored predominately below ground level, therefore:
    - There is no risk of impacting on flooding;
    - There is no risk of a material slide;
- Considering the depth of material which such a pit can accept, it provides for a much smaller land area requirement when compared with other potential land spreading options; and
- The approach provides the potential for the effected lands to be returned to agricultural use post construction.

In this regard, the study area was scoped from a geotechnical perspective for potential Soil Repository/Borrow Pit sites: i.e. sites which could accept the unsuitable material[45] generated by the project but which could also provide balancing quantities of suitable material for road construction purposes.

This assessment, which utilised GSI mapping and site investigation information obtained from the Geotechnical Contract, determined there to be only one suitable site in the townland of *Castlegal.* This site was subsequently assessed (in the form of group workshops and site walkovers) by the full range of specialists undertaking the EIAR and was considered appropriate for such a purpose, considering the absence of likely significant effects.

Considering the already described benefits which the solution provides, it was considered this was the optimum solution given the project specific characteristics. In this regard section 4.10.2.1 of this EIAR sets out site specific considerations in relation to the Soil Repository/Borrow Pit at *Castlegal*.

The alternative to this solution is described in Option B below.

Option B

The alternative considered in relation to the foregoing, as a worst case scenario, was the possibility of disposing this surplus soil offsite at a suitably licensed landfill site. This was not considered feasible for the following reasons:

- It was established that there were no licenced premises proximate to the *Proposed Road Development* which could readily accept the importation of this unsuitable soil material. As outlined in Chapter 10 of this EIAR, there are two historic quarries to the south of the site at the foothills of Copes Mountain, which have been previously used for the disposal of soil, stone and inert construction and demolition (C&D) waste. Neither of these were considered suitable for the importation of fill due to their positioning within and likely direct effects on:
    - Sligo Leitrim Uplands SPA (004187);
    - Crochauns/Keelogyboy Bogs NHA (002435); and
    - Copes Mountain Upland Landscape Character Area.

[45] The soft soil material which although not of sufficient quality for structural fill requirements, is of sufficient quality for landscaping and backfilling of landscape areas.

- The sensitivity of the wider study area, was also considered to constrain the selection of potential sites; this is with regard to those environmental sites described above and the Glencar Lake Valley Landscape Character Area which also occurs to the north.

  In addition, extending any potential disposal operations to sites further away (10-20km) from the *Proposed Road Development* would: increase construction time; increase construction costs; increase journey trips on the wider road networks thereby increasing emissions particularly those of a CO^2 nature. Therefore; given the onsite solution available it was considered that this alternative was an unnecessary and unsustainable use of natural resources.

3.5 Public Consultation

The following outlines the nature and extent of non-statutory Public Consultation carried out to date in the design of the *Proposed Road Development*. These consultations generally took place as part of the N16 SCB RSR.

3.5.1 N16 Sligo to County Boundary, Route Selection – Public Consultation

Public Consultation No. 01 – Constraints Study Area

In order to initiate the participation of the public at the earliest possible opportunity; a Public Consultation process in relation to the Constraints Study Phase was conducted between the 29th of July and the 14th of August, 2015. This process included two information days held in the Clarion Hotel (Sligo) on the 29th and 30th of July, 2015. As part of this process, this consultation period encouraged feedback from the general public in relation to aspects of the project. In this regard a predefined questionnaire was completed by 31 respondents (See Section 5.5.1 of the Sligo to County Boundary Route Selection Report for further details) prior to the closing date for submissions.

The following statutory and non-statutory bodies were also written to as part of this consultation period:-

- Commissioner of Public Works in Ireland;
- Fáilte Ireland;
- An Taisce- The National Trust for Ireland;
- The Arts Council/An Chomhairle Ealaíon;
- The Heritage Council;
- Inland Fisheries Ireland;
- Córas Iompair Éireann;
- National Roads Authority;
- Údarás na Gaeltachta;
- Environmental Protection Agency;
- Department of Communications, Energy and Natural Resources;
- Department of Arts, Heritage and the Gaeltacht;
- Minister for the Environment, Community and Local Government;
- Irish Aviation Authority;
- Border Midlands and West Regional Assembly;
- National Parks and Wildlife Service;
- Health Services Executive;

- Minister for Justice and Equality;
- Electricity Supply Board;
- Irish Central Border Area Network (ICBAN) Ltd.;
- Leitrim County Council;

Local Representatives were briefed on the proposed project via:

- Information letters issued in June 2015; and
- A presentation in the Council Chamber on the 27th of July 2015;

Public Consultation No. 02: Feasible Route Options

The 2nd Public Consultation for the Route Selection Process commenced on the 13th of January, 2016, with 2 open days/evenings in the Clarion Hotel, Sligo. The consultation period, extended to the 12th of February, during which time, submissions were requested from the Public. During this period, the design team were available to discuss and explain aspects of the Route Selection Process, to the Public.

In order to garner information, a questionnaire was also prepared with the objective as outlined in Quote 3-2.

Quote 3-2: Extracted Text from the Questionnaire

> *...With cognisance of identified significant constraints, the Design Team have since established a number of 'Feasible Route Options'. An assessment will now commence of these options, with the objective being to refine them down to a smaller number of viable options. The ultimate objective will be to establish the optimum route location, which may be, one of the current 'Feasible Route Options', or, an alternative amalgamation of a number of different routes. Additionally, further Routes may also be considered during this time.*
> *This process will enable prioritised sections (3 to 4km) of the route to be targeted for upgrading works over the coming years. In this regard, Sligo County Council wishes to consider all viewpoints in relation to the scheme. You are invited to give your opinions on the 'Feasible Route Options' by completing the following questionnaire...*

The methodology for collecting information within the questionnaire, was via a number of closed and open questions as outlined below:

(1) Is your property impacted by one of the Routes?
(2) If you answered 'Yes' to (1), please outline the relevant Route Number(s) and the townland location(s) if different to your address:
(3) Please specify the type of impact:
  a. Loss of Domestic Property;
  b. Potential new route is within 50m of Domestic Property;
  c. Potential new route is within 100m of Domestic Property;
  d. Severance of Agricultural Lands;
  e. Community Severance (i.e. the arrangement of the new road will impact on travel patterns);
  f. Other – To include Commercial, Industrial, Retail, or other property types;
  g. Other – Indirect Impact
(4) Please elaborate on the impact:
(5) Please provide some additional broad information in relation to your property, e.g. in the case of a Farm property this may include information on your general practice, i.e. Dairy, Dry Stock, etc. and stock numbers;
(6) Please rank the routes in order of your preference:
(7) In relation to Q6, Please specify the general reasons for your top marking Rank (Rank 1):
(8) In relation to Q6, Please specify the general reasons for your worst marking Rank (Rank 13):

(9) If you have any additional comments in relation to the Route Selection, or in relation to alternatives, please write them here _____:

In total, there were 63 submissions, of which 47 took the general form of the questions set out in the questionnaire, the balance of submissions were generally related to the severity of impacts, on particular properties. Each submission was examined and information, where made available, was used to inform the assessment process (e.g. Socio Economic, Agricultural and Non-Agricultural Property). Of the submissions made, 90% related to property, or community impacts

Statutory and Non Statutory Bodies as already outlined under 'Public Consultation No. 01' were also again written to for observations during this Consultation Period.

Public Consultation No. 03: Refined 'Feasible Route Options'

A third Public Consultation for the Route Selection Process commenced on the 27th of July, 2016, with 2 open days/evenings in the Clarion Hotel, Sligo. The consultation period, extended to the 8th of September.

Although questionnaires did not form part of this particular consultation, additional submissions were encouraged. 16 submissions were received, each of which were subsequently considered in the proceeding Stage 1, Part 2; Preliminary Options Assessment.

Public Consultation No. 04: Emerging Preferred Route'

A fourth Public Consultation commenced in the Clayton Hotel (previously Clarion Hotel), Sligo, on the 06th of June, 2017. The purpose of this consultation, which extended to the 21st of July, was to inform the public of the 'Emerging Preferred Route Corridor'.

Further submissions were encouraged from the Public during this process, which it was articulated, would assist in further refinements during the design phase. Submissions received during this stage were retained on file and were (or will depending on location) be referred to during the design stage.

3.1 Relevant Figures and Appendices

3.1.1 Figures contained in Volume 3

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

Fig. 2.1: N16 Sligo to County Boundary RSR, Constraints Study Area [];

Fig. 3.1: N16 Sligo to County Boundary RSR, Feasible Route Options;

Fig. 3.2: N16 Sligo to County Boundary RSR, Refined Feasible Route Options;

Fig. 3.3: N16 Sligo to County Boundary RSR, Refined Feasible Route Options (2);

Fig. 3.4: N16 Sligo to County Boundary RSR, Emerging Preferred Route;

Fig. 3.5: N16 (Sligo) - Route Improvement Strategy.

3.1.2 Appendices contained in Volume 4

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 3.1: Chapter 3 (Main Report Reference); Application of Design Alternative - Junction Siting and Side Roads Arrangements

4 Description of the *Proposed Road Development*

4.1 Introduction

This Chapter provides a description of the Design[46] for the *Proposed Road Development* including *inter-alia* details of:

- Road Type and Cross Section;
- Description of the Mainline Alignment;
- Existing and Projected Traffic Conditions;
- Road Safety;
- Structures;
- Drainage Design;
- Geotechnical;
- Route Lighting;
- Vulnerable Road Users;
- Boundary Fencing;
- Utilities and Services;
- Construction of the *Proposed Road Development*;
- Operation and Maintenance;
- Other Statutory Considerations.

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

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

4.2 The road type and cross section

The following outlines the road type and cross section of the *Proposed Road Development*.

4.2.1 Mainline cross section

4.2.1.1 Cross section

The cross section for the N16 was established following an assessment undertaken as part of the N16 Sligo to County Boundary Route Selection Report[47] to be a Type 2 Single Carriageway arrangement as outlined in Figure 4.4.1 contained within Volume 3 of this EIAR.

This arrangement will include provision for cycle tracks where alternative off road routes are not available.

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

[47] http://www.sligococo.ie/N16/RouteSelectionReport/Volume2/N16SCB_RSRVol2EngPARTB.pdf

4.2.1.2 Verge widening

The desired verge width of 3m along the mainline, has been widened as required and as represented in Figure 4.1.1 and 4.1.2 for a number of reasons, including the provision of Stopping Sight Distance, the provision of cycle/pedestrian tracks within the verge, the widening of verge spaces for the provision of safety barrier, or to achieve a clear zone[48] within the verge space.

4.2.2 Junction strategy, side roads and access tracks

As outlined in section 3.4.1 of this EIAR, the design of the *Proposed Road Development* has included detailed consideration of the local roads which the proposed N16 intercepts. The junction strategy for each of these junctions is described in the table below and presented figuratively in Figures 4.1.1 to 4.1.2 and Figures 4.3.1 to 4.3.7 contained within volume 3.

Table 4-1: Side Road Treatment

Side Road Ref	Severance		Severance Treatment
	Chainage (m)	Side (m)	
L3406-0	0m	LHS	Reconnected via roundabout at c. Ch. 0m
Existing N16	0m	RHS	Reconnected via roundabout at c. Ch. 0m
Existing N16	380m	LHS	Reconnected via simple T junction at c. Ch. 840m
L7415-0	700m	RHS	Reconnected via simple T junction at c. Ch. 685m
Existing N16	1,140m	LHS	Reconnected via simple T junction at c. Ch. 840m
Existing N16	1,140m	RHS	Reconnected via simple T junction at c. Ch. 1,155m
L7413-0	1,380m	LHS	Reconnected via simple T junction at c. Ch. 1,350m
Existing N16	2,050m	RHS	Reconnected via simple T junction at c. Ch. 1,155m
L34041-0	2,100m	LHS	Reconnected via simple T junction at c. Ch. 1,955m
L3404-0	2,180	LHS	Reconnected via simple T junction at c. Ch. 2,155m

With the exception of the roundabout selected for the southern tie-in, all the junctions selected for the project are simple T junctions. Considering traffic volumes and turning movements, there is no requirement for a ghost island at any of the junction locations; however, each junction, will be supplemented with 2m wide nearside passing bays.

Figure 4-1 is referenced from TII DN-GEO-03060[49] and provides an indicative pictorial overview of the proposed junctions.

[48] An area adjacent to the road carriageway within which there are no hazards.

[49] http://www.tiipublications.ie/

Figure 4-1: DN-GEO-03060; Simple T Junction with Right/Left Stagger

The dwell area (15m approach) of the junctions as they intercept the national primary route, will be either 7m, or 8m wide (0.5m hard strip). Outside the dwell area, the cross section considers the existing cross sectional width of the local road's (which in some cases are less than 3m) and applies in most cases similar road widths, with a minimum defined width of 4m; the verges are considered in a similar way with an applied minimum width of 2m. The cross sections of local roads are shown figuratively in 4.4.2 contained within volume 3 of this EIAR.

4.2.2.1 Access tracks (agricultural, domestic and drainage service)

Direct accesses are defined in DN-GEO-03060[49], as accesses which *…connects directly to a national road including field accesses and accesses serving one or more properties….*

The existing situation has 22 direct accesses connecting to the national network. The overriding principle during the design process was to ensure direct vehicular accesses onto the proposed N16 could be avoided insofar as was reasonably practicable. However, due to the fact that the project predominately follows the existing alignment (although of a generally greenfield nature), there are instances where the provision of direct agricultural access are unavoidable due to existing access arrangements. In this regard, there are four no. direct accesses proposed along the c. 2.54km realigned section; this includes two agricultural accesses, one combined agricultural/maintenance access, and one further maintenance access. These accesses are described in Table 4-2 and are outlined in Figures 4.1.1 and 4.1.2 contained within Volume 3.

Table 4-2: Direct Accesses to Proposed N16

Access Type	Access Location
Agricultural	c. Ch. 550m (RHS)
Agricultural/Maintenance	c. Ch. 1,600m (LHS)
Agricultural	c. Ch. 2,225m (RHS)
Maintenance	c. Ch. 2,4601m

The cross sections proposed for direct accesses will be generally 4m overall carriageway widths, with 2m wide verges provided on each side, for agricultural/maintenance access tracks.

4.3 Description of mainline alignment

The mainline alignment which is indicated in plan and geometric terms in Figures 4.1.1-4.1.2 and 4.2.1-4.2.2 respectively (Volume 3 of this EIAR) 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 south to north.

- The mainline alignment commences at a roundabout junction, which connects the proposed N16 to the north, with the existing N16 to the east and the L3406-0 to the west;
- The alignment initially commences at grade, but gradually increases to a fill section (c. 3m[50] high at Ch. 280) between c. Ch. 160m and c. Ch. 480m, diverting offline predominately to the north at c. Ch. 380m;
- The alignment, navigating via a 720m radius horizontal curve, to a very slight north-west axis, crosses the Tully Stream at c. Ch. 610m, again in fill (c. 4.4m high at Ch. 620) between c. Ch. 530m and c. Ch. 720m. It severs the L7415-0 at c. Ch. 700m, reconnecting the local road back into the network via a simple T junction at c. Ch. 680m;
- The alignment begins to twist via a 720m radius horizontal curve to a slight north-east axis from c. Ch. 750m and cuts (c. 13m deep at Ch. 1,000m) into a topographical high between c. Ch. 760m and Ch. 1,120m. It also, at c. Ch. 840m, reconnects a severed section of the existing N16 to the proposed alignment, via a simple T junction;
- The aforementioned 720m radius horizontal curve continues to navigate the alignment in a slight north-east axis as it severs the existing N16 at c. Ch. 1,140m before passing on a high fill section through a valley in the townland of *Lugatober* between c. 1,140m and 1,340m.
- The alignment, severs the L7413-0, via a straight section of geometry at c. Ch. 1,380m, reconnecting the local road back into the network via a simple T junction at c. Ch. 1,350m.
- Prior to passing through a cut section between 1,350m and 1,600m (c. 3.4m deep at c. Ch. 1,400m), the alignment begins to divert to a more pronounced north-east axis, via a 720m radius curve from c. Ch. 1,500m, following the existing topography as closely as possible, but due to the steepness of same, resulting in cut/fill side slopes to the east and west respectively;
- The aforementioned 720m radius curve continues to c. Ch. 1,940m, where it begins to cut through (c. 4.5m deep at Ch. 2,080) a topographical high between c. Ch. 1,990m and Ch. 2,150m, before it continues on a straight section as it severs the L34041-0 at c. Ch. 2,100m reconnecting the local road back into the network via a simple T junction at c. Ch. 1,960m;
- The alignment severs the L3404-0 at c. Ch. 2180, tying the local road back into the existing network via a simple T junction at c. Ch. 2,155m. It then, via a 720m radius curve commencing at c. Ch. 2,200m, begins to reconnect the proposed route into the existing network on a north-east axis before it terminates at grade at Ch. 2,542m.

Embankment and cutting side slopes vary throughout and are generally prescribed as outlined in Table 4-3. The road surface material on the mainline alignment will be Stone Mastic Asphalt.

[50] Vertical clearances are measured from the road centreline.

Table 4-3: Side slope ratios

Scenario	Side slope ratio	
	Horizontal	Vertical
Standard embankment (fill)	3	1
Standard embankment (fill) but requiring safety barrier due to identified hazards	2	1
Standard cut through glacial till	2	1
Standard cut through rock	1	1
Cut slope with landtake minimisation – Reinforced Earth Structure	0.5	1

4.1 Existing and Projected Traffic Conditions

4.1.1 Automatic Traffic Count

An Automatic Traffic Count (ATC) was undertaken in February and March of 2018 at the locations as outlined in Figure 4.5.1 of this EIAR. The results of this ATC are outlined in Table 4-4.

Table 4-4: ATC Traffic Count 2018

Location	AADT	LGV	% HGV
ATC 1	3533	9.39%	5.50%
ATC 2	3456	10.65%	6.15%
ATC 3	740	9.49%	7.02%
ATC 4	109	6.36%	4.66%
ATC 5	155	7.61%	6.90%
ATC 6	337	8.88%	6.90%
ATC 7	2783	9.83%	6.47%

4.1.2 Forecast Demand Growth

The forecast demand growth was carried out in accordance with TII Project Appraisal Guidelines (PAG) Unit 5.3; 'Travel Demand Projections'[51]. A simple link based model was constructed based on the results described in Table 4-5, the geographical regional distributions as described in Figure 5.3.1. of PE-PAG-02017[51] and the associated regional growth rates also as provided in the aforementioned document. Forecasts were determined for the Low, Central and High sensitivity scenarios under the following time horizons:

- 2021 Opening Year;
- 2036 Design Year (Opening Year + 15); and
- 2051 Forecast Year(Opening Year + 30);

This resulted in the derived growth forecasts, which are presented in the following table for the Central growth rate. In effect, the result is that all traffic (other than local direct accesses) on the existing N16 will be transferred to the new route where it is severed. The nature of the alignment and the design of reconnected local roads means that there will be no rerouting as a result of the *Proposed Road Development*.

[51] http://www.tiipublications.ie/

Table 4-5: Traffic Projections – Central Sensitivity Growth Rate

Location	N16 Forecast Years (Total AADT)		Central Growth Rates		
	2018 Base		2021	2036	2051
	AADT	% HGV			
N16 Drumkillsellagh (ATC 1)	3533	6%	3662	4180	4444
N16 *Castlegal* (ATC 2)	3456	6%	3584	4096	4363
L3406-0 (ATC 3)	740	7%	767	879	938
L7415-0 (ATC 4)	109	5%	113	128	136
L7413-0 (ATC 5)	155	7%	161	185	197
L3404-0 (ATC 6)	337	7%	349	400	427
N16 *Lugnagall* (ATC 7)	2783	6%	2886	3301	3519

4.1.3 Journey Times

Journey time calculations as outlined in Table 4-6, shows that the *Proposed Road Development*, in the Do-Something scenario provides a journey time saving of 52.2 seconds over the Do-Nothing situation. At circa 36%, this is an appreciable reduction in journey time.

Table 4-6: Journey Times

Option	Speed (kph)	Length (km)	Time (Sec)	Time Saving (Sec)
Do-Nothing	67	2.73	147	-
Do-Something	96	2.52	94.5	52.2

4.2 Road Safety

From a qualitative perspective, the construction of the project will provide 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. The following engineering improvements will also provide significant safety benefits:

- An overall reduction in road length of circa 250m (c. 10%);
- The transference of 19 existing direct accesses from the national primary route;
- The improvement of Stopping Sight Distances at all junction locations to the Desirable Minimum standard for a 100kph road;
- The provision of dedicated facilities for Vulnerable Road Users;
- The provision of a dedicated drainage system which will remove current aqua plaining conditions on the road surface;

4.3 Structures

4.3.1 Introduction

There are a number of structures associated with the implementation of the *Proposed Road Development*. These structures, are defined within the following categories for the purposes of this EIAR

- Principal Structures:

  - Structures which conform to Category 1, 2 and 3 of DN-STR-03001-03[52];
- Minor Structures:
  - Structures which conform to Category 0 of DN-STR-03001-03.

The following provides an overview of the *maximum design characteristics* of these structures.

4.3.2 Principal Structures

There are three structures associated with the *Proposed Road Development,* which are considered to be Principal Structures satisfying the requirements of Category 1 of the aforementioned DN-STR-03001-03. These are structures which:

> ***…*** *can be analysed by statical methods and where all aspects of design are in accordance with current NRA Standards. Category 1 structures include simple structures, which contain no departures from, or aspects not covered by, current NRA Standards and which are: -*
> *(a) single simply supported spans less than 20m with less than 30o skew;…*
> *(d) …retaining walls with a retained height of less than 7m…*

These structures are described in Table 4-7 and Figures 4.13.1, 4.13.2 and 4.13.3 contained within Volume 3 of this Design Report.

Table 4-7: Principal Structures

Structure	Location	Description
Clear Span River Bridge	Ch. 605m	A 15m clear span structure required to traverse the *Proposed Road Development* across the Tully Stream.
Vulnerable Road Users Underpass	Ch. 1,310	A 2.7m high x 4m wide x 34m long Vulnerable Road Users Underpass
Steepened Side Slope (Reinforced Earth Structure)	Ch. 1,350 – 1,420m	A 45m long x c. 3m-4.5m deep reinforced side slope to reduce impacts to a residential property in the townland of *Lugatober*.

4.3.3 Minor Structures

There are a number of Minor structures required, which satisfy the requirements of Category 0 (Item B) of DN-STR-03001-03:

> ***Category 0*** *- Minor structures, which conform in all respects to current NRA Standards. Individual structures for which all aspects of design and construction are covered by NRA Standards may be classified as Category 0 provided they are: -*
> *(a) …*
> *(b) buried structures less than 3m clear span/diameter, or…*

These structures in general are those which are required to traverse minor stream crossings as outlined in *Table 4-8*.

Table 4-8: Minor Structures

Location (approx.)	ID	Structure Type	Maximum Design Characteristics	
			Width	Height
1230m	Lugatober Stream	Bottomless Arch, or Box Culvert	1.2	1.8

[52] 51

Location (approx.)	ID	Structure Type	Maximum Design Characteristics	
			Width	Height
1925m	Collinsford Stream	Bottomless Arch, or Box Culvert	1.2	1.8
2210m	Lugnagall Stream	Bottomless Arch, or Box Culvert	1.2	1.8

In addition, smaller structures will also be required for:

- The re-connection of land drainage systems with circa 1,200mm diameter pipes;
- Under embankment mammal passes comprising 900mm diameter pipes;
- Low level retaining walls (c. 0.5m high) which will be used in verge spaces to limit landtake on Residential properties, particularly within the townlands of *Drumkilsellagh* and *Doonally*.

4.4 Drainage Design

The following section of this EIAR provides a description of the drainage design associated with the *Proposed Road Development*. Further technical detail, including Design Methodology, Design Checks and Analytical Factors are provided in Section 3 of Volume 4 (Appendices) to this EIAR. The drainage design has been developed with regard to TII publications including *inter-alia*:

- DN-DNG-03022, Drainage Systems for National Roads;
- DN-DNG-03065, Road Drainage and the Water Environment;
- DN-DNG-03063, Vegetated Drainage Systems for Road Runoff;
- DN-DNG-03064, Drainage of Runoff from Natural Catchments;
- DN-DNG-03066, Design of Earthworks Drainage, Network Drainage, Attenuation & Pollution Control;
- DN-DNG-03071, Design of Outfall and Culvert Details;
- DN-DNG-03073, Grassed Surface Water Channels for Road Runoff;

Advice received from the expert undertaking the Hydrological & Hydrogeological Chapter of the EIAR has also influenced the design.

4.4.1 Outline & Objectives

In accordance with the provisions of the DN-DNG-03022[53], *Drainage Systems for National Roads*, the drainage design (Operational Stage[54]) has been developed to achieve the design principles outlined in Quote 4-1.

Quote 4-1: DN-DNG-03022-05 Design Principles for Drainage Systems

Design Principles

1.5 There are three major objectives in the drainage of national roads:

a) the speedy removal of surface water to provide safety;

b) provision of effective sub-surface drainage to maximise longevity of the pavement and its associated earthworks; and

c) minimisation of the impact of the runoff on the receiving environment.

It is also necessary to provide for drainage of earthworks and structures associated with the road.

[53] http://www.tiipublications.ie/

[54] Construction Stage requirements, which includes an Erosion & Sediment Control Plan are also provided within the Environmental Impact Assessment Report (Volume 4).

In achieving these design principles, the methodology for the drainage design[55], considered 2 general criteria:

(1) The interception and diversion of existing land drainage including *inter-alia*;

   a. The separation of intercepted land drainage from the surface water generated by the mainline road surface (and where feasible the local road surfaces);

   b. The direction of that intercepted land drainage under the footprint of the *Proposed Road Development* at a suitable location, which will insofar as is reasonably practicable, maintain the existing surface water catchment of the water body (existing rivers, streams, boundary ditches);

(2) Road surface drainage – Surface water conveyance and site control, including *inter-alia*:

   a. Identification of appropriate outfall locations;

   b. Determination of the most appropriate method of surface water conveyance;

   c. Establishment and design of onsite facilities for water quantity and quality treatment;

The figurative output of the design process is provided in Fig. 4.7.1 to 4.7.2 contained within Volume 3. The following paragraphs provide a summation of its main characteristics.

4.4.1.1 Criterion 1: Infrastructure Provided

The main method of diverting this drainage will be via land drains (Toe-drains and cut-off-drains) while structures in the form of culverts and clear span bridges (in the case of the larger Tully Stream), will direct the surface water under the proposed road embankments.

Toe drain and cut-off drains

Land Drains (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. These drains will prevent runoff from adjacent land flowing onto the proposed works, and the ponding of water at the toe of embankments.

Diversions of Existing Watercourse Channels

The nature of the *Proposed Road Development* requires the diversion and realignment of existing minor watercourses and drainage ditches. The purposes of these diversions is for a number of reasons including in the main ease of construction and reducing the length of culvert span required. The main watercourse crossings requiring diversion are outlined in Figures 4.7.6 (Lugatober Stream), 4.7.7 (Lugatober Drain), 4.7.8 (Collinsford Stream) and 4.7.9 (Lugnagall Stream). These diversions will be carried out in accordance with the requirements of the Outline Erosion and Sediment Control Plan contained with Volume 4 of this EIAR and with the mitigation measures described in Chapter 11 (Hydrology & Hydrogeology) of this EIAR.

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:

- Bridges 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;

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

- 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 already set out. *Table 4-9* describes the maximum design characteristics of the structures on those main watercourses crossed by the *Proposed Road Development*.

Table 4-9: Main Watercourse Crossings

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
600m	Tully River (Stream)	Clear Span	3.3	3m	The structure is oversized from the required Hydrological opening size in order to satisfy IFI requirements (clear span) and construction tolerances (foundations set back from the river/stream bank)
1230m	Lugatober Stream	Box Culvert	1.2	1.8	Depress Invert by a further 300mm in accordance with IFI requirements.
1500m	Lugatober Ditch	Pipe Culvert	1.2m		N/A
1925m	Collinsford Stream	Box Culvert	1.2	1.8	Depress Invert by a further 300mm in accordance with IFI requirements.
2210m	Lugnagall Stream	Box Culvert	1.2	1.8	Depress Invert by a further 500mm in accordance with IFI requirements.

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 Biodiversity Chapter of the EIAR (alternatively, separate 600mm diameter pipes will be placed adjacent to the main watercourse crossing).

In addition to the forgoing, other minor land drains will require diversion under the embankments of the *Proposed Road Development,* these crossings which will be 1200mm diameter circular culverts, which will be squared where possible to minimize the length of culvert require.

All crossings will be constructed in accordance with the requirements of the Outline Erosion & Sediment Control Plan which is appended to the EIAR.

The development of the drainage design has been aided by consultation with the Inland Fisheries Ireland (IFI). This consultation process, will be maintained throughout the detailed design[56] stage.

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

4.4.1.2 Criterion 2 – Infrastructure Provided

The following section of this EIAR describes the infrastructure provided in relation to the Road surface drainage. Further technical details, as already outlined are provided in Volume 4 (Appendices) of this EIAR.

Surface Water Conveyance & Site Control;

The following text describes the Infrastructure provided for Surface Water Conveyance and Site Control.

Conveyance System

The conveyance system for the *Proposed Road Development* is outlined diagrammatically in Figure 4.7.1 to Figure 4.7.2 contained within Volume 3. The proceeding Figure 4-2 and Figure 4-3, provides a rationale to the selection of the various systems which are predominately Grassed and Concrete Surface Water Channels with Kerb & Gully systems, provided at junction locations for demarcation purposes. Each system will incorporate a sealed carrier pipe system where the channel capacity is exceeded.

Figure 4-2: Road in Cutting (Verge-Side Edge Drainage)

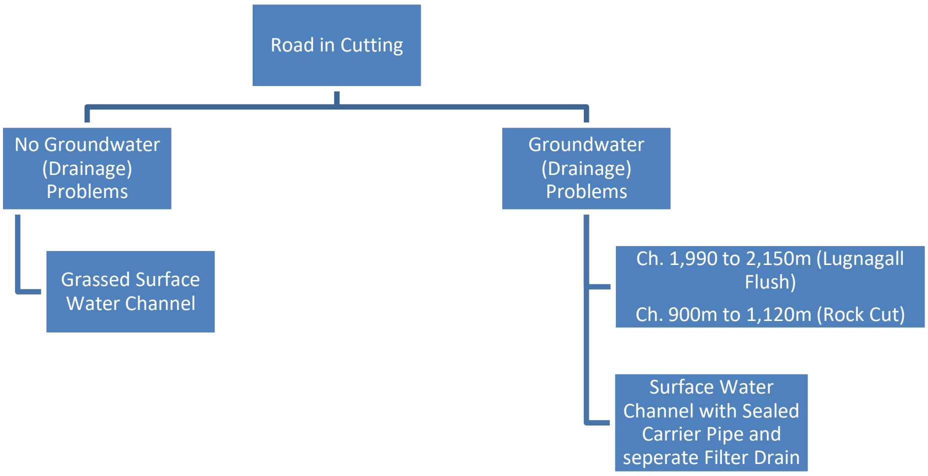


Figure 4-3: Road on Embankment (Verge-Side Edge Drainage)

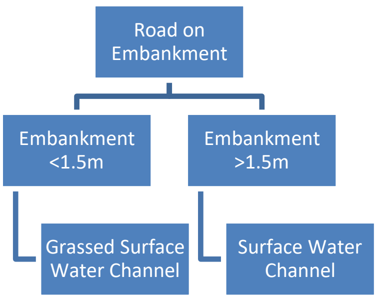


Figure 4-4: Schematic of Concrete Surface Water Channel[57]

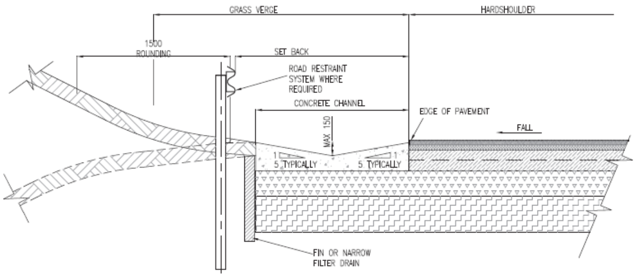
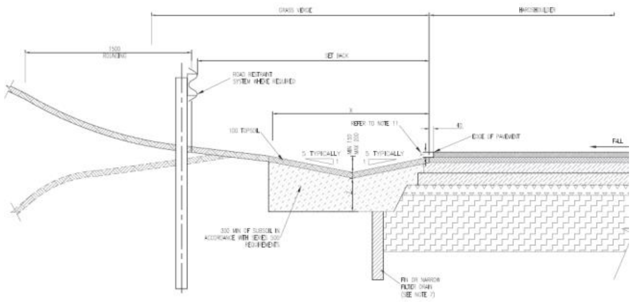


Figure 4-5: Schematic of Grassed Surface Water Channel[58]



Attenuation Ponds - Surface Flow Wetlands

Attenuation Ponds, in the form of Surface Flow Wetlands; will be provided at each outfall point discharging runoff from the paved area of the national primary route. These ponds, which will be in the form of vegetated systems (include Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*) for treatment purposes), will provide the treatment and flood storage requirements as set out in the preceding sections of this report.

Table 4-10 outlines the volume and surface area criteria required for each particular pond based on the various paved road areas contributing. Figures 4.7.3 (contained within Volume 3) present their plan locations while Figure 4.7.4 presents their typical geometric details. The outflows from these facilities will incorporate a penstock valve.

Table 4-10: Pond Volumes and Surface Areas

Outfall No.	Treatment Requirements			Storage Requirements		
	Storage Volume (Treatment)	Depth (B) (m)	Surface Area (m2)	Storage Volume Attenuation	Depth (A) (m)	Surface Area (m2)
Pond No. 01	153	0.4	382	203	0.3	675
Pond No. 02	98	0.4	245	130	0.3	433
Pond No. 03	418	0.7	597	535	0.7	765
Pond No. 04	52	0.4	130	66	0.3	221

Bypass Interceptors

Class 1 Petrol and oil bypass 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;

[57] TII, SRW, Standard Construction Details, CC-SCD-00103

[58] TII, SRW, Standard Construction Details, CC-SCD-00104-01

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.

4.5 Geotechnical

4.5.1 Slope Stability

4.5.1.1 Cutting Slopes in Soil and Rock

A significant cutting of up to 13m depth (measured along the design centreline) in glacial till soils and limestone bedrock occurs between c. Ch. 900m and c. Ch. 1,160m along the route plus other minor cut areas of lesser depth below 5m.

Most permanent soil slopes will be constructed at an inclination of 2H[59]:1V[60] but a local steepening (via a reinforced earth structure with a vegetated facing) of the earthworks eastern cut slope to 0.5H:1V is proposed near Ch. 1,375m.

Rock slopes may generally be formed at slopes of 1H:1V in competent limestone exhibiting RQD greater than 30% and free from clay filled discontinuities or adverse bedding / fracture planes relative to the cutting face. Temporary slopes to excavations may vary and are the responsibility of the Contractor and his earthworks designer.

Cuttings in mixed soil/weathered rock and competent rock will contain compound slopes as appropriate with a horizontal bench of width not less than 2m included at the upper surface of competent rock. Provision will be made for drainage in the cutting slopes where high groundwater is anticipated from Ch. 2,000m to c. Ch. 2,160m.

4.5.1.2 Embankment Slopes

Embankments will be constructed of suitable fill material derived generally from tills and processed rock from the various cuttings or from the Soil Repository/Borrow Pit described in section 4.10.2.1 of this EIAR.

Embankment slopes constructed from such glacial tills and rock fill, constructed on an adequate founding stratum, may generally be built at a minimum inclination of 2H: 1V (from a Geotechnical perspective).

Where a high fill embankment is required in excess of 10m at Ch. 1,160 to 1,320m, an access bench at least 2m wide will be incorporated into the embankment slope geometry at approximately the mid slope height (but not greater than 10m height).

This bench serves to provide access for maintenance and inspection, plus it provides flow break for vertical surface drainage thus limiting the risks of soil erosion on high slopes.

4.5.2 Road embankment design in soft ground areas

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.

[59] Horizontal

[60] Vertical

These areas are outlined in Table 4-11 and Fig. 4.9.1 to 4.9.2 of Volume 3 for indicative purposes. The appropriate construction techniques to deal with these ground conditions will be confirmed during the detailed design and construction stage; however, for the purposes of assessing the environmental effects, the most potentially environmentally significant method of dealing with same has been considered, which is 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.

The volume of soft materials expected to be encountered within these soft ground areas are expanded upon in section 4.10.2 of this Chapter.

Table 4-11: Indicative locations of soft ground conditions anticipated to be encountered

Chainage (m)		Average Depth (m)	Max Thickness (m)
From	To		
240	500	1.3	1.6
550	650	1.1	1.4
1,160	1,330	1.8	4
1,870	1,980	1.4	1.9
2,170	2,300	1.3	1.6

4.5.3 Drainage (For Geotechnical requirements)

A closed drainage system will be provided in areas of cutting occurring within zones of extreme aquifer vulnerability where limestone bedrock will be exposed in cuttings or soil cover reduced to less than 3m and also in areas where open drainage could affect discharge from natural petrifying springs. These sections extend from c. Ch. 750 to Ch. 1,120m; Ch. 1,330 to 1,500m; and from Ch. 1,980 to Ch.2150m. Separate recommendations regarding hydrogeology are outlined in Chapter 11 of this EIAR.

The cutting between c. Ch. 1,980 and 2,150m appears to encounter high groundwater levels in glacial fine grained soils and may require the provision of both slope drains to cutting side slopes plus a drainage blanket.

4.6 Route Lighting

4.6.1 Introduction to lighting

This section describes the lighting (See Figure 4.12.1 contained within Volume 3) along the *Proposed Road Development*. The provisions are preliminary in nature and the final design of the road lighting system will be undertaken as part of the detailed design stage in accordance with the relevant standards as outlined below.

The preliminary lighting design has been undertaken using the performance characteristics of a particular proprietary lantern. This does not preclude proposing an alternative lantern, provided that the proposer can demonstrate equal or better performance with the alternative proposed.

4.6.2 Road Lighting Standards

The lighting shall be designed in accordance with the following standards:

- IS EN 13201-2: 2003 Road lighting Performance requirements;

- BS 5489 -1: 2013 Code of Practice for design of Road Lighting, Part 1: Lighting of Roads and Public Amenity Areas;
- DN-LHT-03038: Design of Road Lighting for the Strategic Motorway and All Purpose Truck Road Network; and
- Other various documentation in accordance with TII policy and associated BS codes of practice.

The design of lighting columns shall include the following;

- Slim galvanised steel construction without outreach brackets;
- 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 10 metres;
- The lighting columns shall not be painted;
- The lanterns shall be light emitting diode (LED) type, fully cut off "Flat Glass" with Electronic control gear, Philips Luma type, or similarly approved. They will be installed with Zero tilt to minimise glare and light spill.
- All cabling associated with lighting will be located underground.

4.6.3 Road Lighting Proposals

The Southern tie-in, which comprises a three arm roundabout arrangement, is the only location which requires lighting on the *Proposed Road Development*.

Southern tie-in - Roundabout

It is proposed to light the roundabout with 10m columns and no bracket arms, situated around the periphery, each carrying a high quality LED lantern. The new route north of the roundabout will be lit with a single sided arrangement of lights to a distance of 139 metres from the roundabout. The single-carriageway south of the roundabout will be lit also to a distance of 139 metres with a single-sided arrangement of lights. The L3406-0 will be lit to a distance of 111 metres from the roundabout.

The lights on each of the roundabout approaches, will be 10 metre columns without bracket arms, and LED lanterns.

The lighting levels on the roundabout and approach roads shall comply with the recommendations for Class CE3 of IS EN13201 (15 lux average, Overall Uniformity Uo 0.4). See Tables A.3 and A.4 of BS 5489-1.

4.6.4 Environmental Impact

The main impact of the proposed installation on the environment is the visual impact by day and night. The lighting will operate on automatic ”dusk to dawn” switching for approximately 4,150 hours of the year. By its nature, public lighting consumes mainly off peak electricity, thus allowing more efficient use of generating plant which might otherwise be underutilised or idle when industrial, commercial and domestic demand is low at night.

Visual Impact by Day

The recommended scheme, consisting of lighting columns of 10m in height throughout the project, will intrude somewhat on the vista of the roads. This effect will be minimised by the use of well-designed slim folded steel columns without outreach bracket arms, and compact LED lanterns. All public lighting circuit cables will be placed underground thus eliminating the visual intrusion of overhead cable systems.

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 mounted at zero degrees tilt to the horizontal, which will eliminate light emission above the horizontal, and effectively limit light spillage beyond the road boundary.

4.6.5 Route Signage and Road Markings

4.6.5.1 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.

4.6.5.1.1 *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.

4.6.5.1.2 *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.

4.6.5.1.3 *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.

4.6.5.2 Design of Signage

Traffic signage, including regulatory, warning and directional signs, are to be implemented following consultations with the TII in compliance with the relevant standards, specifications and guidelines of the TII, Department of Transport, Tourism and Sport, and the Department of the Environment, Community and Local Government, including:

- The tie in at the southern end of 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 circa 2km, 1km and 500m distance prior to the junction, as well as junction off signs 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 to the various new junction arrangements along 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 will include that for Glencar Lake and Waterfall, which will also be provided in accordance with 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.

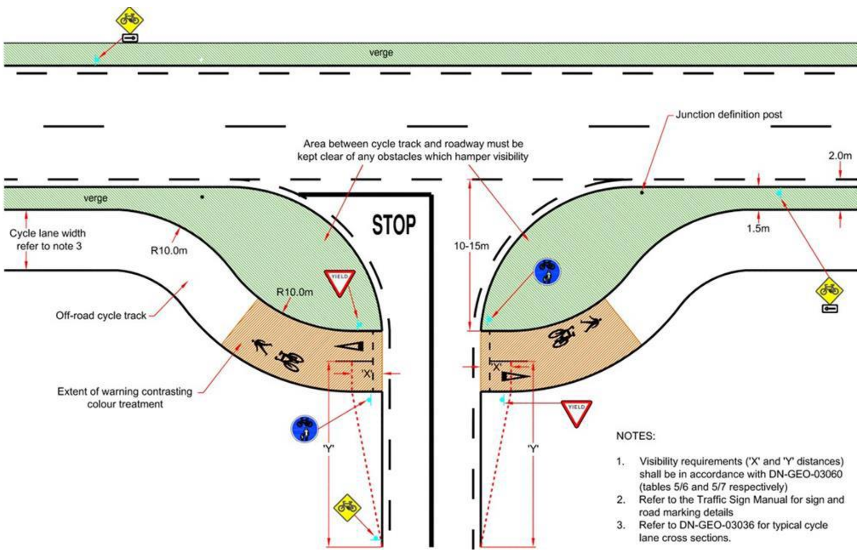
4.7 Vulnerable Road Users

The Vulnerable Road Users, including by extension the Cycleway and Pedestrian Strategy, is presented in Figure 4.8.1 and 4.8.2 contained within Volume 3 of the EIAR.

It is proposed that a dedicated online two way facility (within the verge space) be integrated with an offline facility (incorporating appropriate lining and signage) between *Drumkilsellagh* and *Castlegal*. The connection point between the offline and online sections will be separated via a staggered approach barrier in accordance with Figure 7.5 of TII DN-GEO-03047[51].

Conflict points with the local network and direct accesses are considered, due to the low volume of traffic concerned, to be low risk, and as such are designed as uncontrolled crossings in accordance with the requirements of DN-GEO-03060[51]. These crossings are in this regard designed as bend out crossings in accordance with section 5.4.1 of the aforementioned standard and as outlined indicatively in *Figure 4-6*.

Figure 4-6: Extract from DN-GEO-03060, Figure 5.7, Bend out Crossing

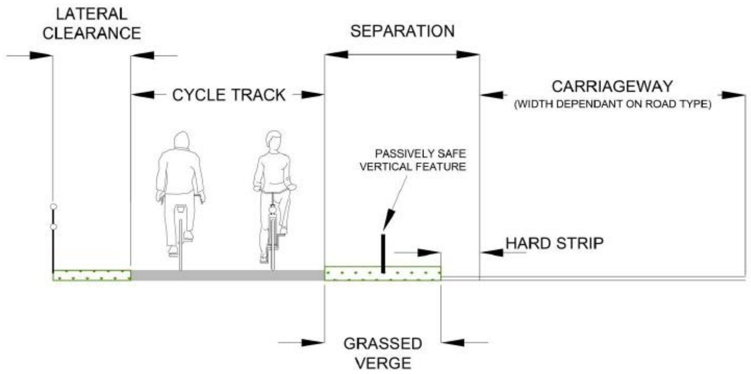


The mainline track will terminate at the proposed N16's junction with the L3404-0; until such time as the remainder of the N16 Sligo to County Boundary Emerging Preferred Route is upgraded.

Table 4-12: Cycle Track Geometry

Element	Width (m)	Notes
Separation	2m (including 0.5m Hard Strip)	N/A
Cycle Track	2m	Shared use Two Way cycle facility with pedestrians
	3m	Mainline Chainage 100m to 370m – Extra 'wobble room' is provided considering the vertical gradient is c. 4.5%
Lateral Clearance	1m	N/A
Total Verge Width Required	4.5m	N/A

Figure 4-7: DN-GEO-03036: Ref. Figure 3.3: Off-Road Two-Way Cycle Track



Safety Barriers where required (see figure 4.11.1 and 4.11.2 contained within Volume 3 of this EIAR) will be positioned between the carriageway and the cycle track. The minimum distance between the cycle track and the safety barrier shall be equal to the working width of the safety barrier and comply with the minimum lateral clearance requirements. In addition, any exposed safety barrier posts facing the cycle track will be of a type that would not snag cyclists. For safety reasons, supplemental boundary fencing (to that outlined in section 4.8) will be provided where these tracks traverse fill slopes; these fences shall be positioned between the edge of the track and the top of the fill slope.

In accordance with Section 3.4 of DN-GEO-03060[51] road markings and signs will be adequately provided at the entry and at suitable distances along the cycle route. Yield signs and road markings will be provided to indicate vehicle priority at junctions.

Table 4-13 outlines the local connectivity considerations where the local network intercepts the *Proposed Road Development,* this as outlined in Section 1.3.2 of Volume 2, has resulted in the provision of the Vulnerable Road Users underpass in the townland of *Lugatober*.

Table 4-13: Vulnerable Road Users – Local Connectivity

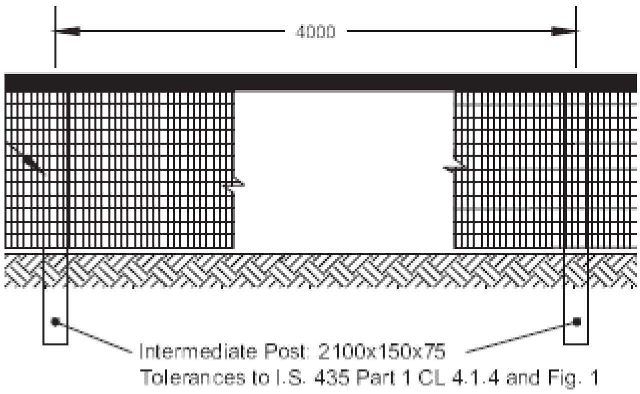
Number	Side Road Ref	Mainline Reference	Design pertaining to Vulnerable Road Users
SR01	L3406-0	Ch. 0m	Bend out crossing as per Figure 4-6, which in accordance with section 6.5 of DN-GEO-03060 is located between 10 and 15 metres from the circulatory carriageway of the roundabout.
SR02	Existing N16	Ch. 0m	
SR03	L7415-0	Ch. 685m	Diversion of Vulnerable Road Users to a mainline crossing point at c. Ch. 840m. Reconnection to the north/south is then provided via the dedicated cycleway with no further requirement to cross the mainline, other than at the southern tie in described above.

Number	Side Road Ref	Mainline Reference	Design pertaining to Vulnerable Road Users
SR04	Severed N16 (*Castlegal*)	Ch. 840m	Reconnection to the north/south via the dedicated cycle with no further requirement to cross the mainline, other than instances where VMU's wish to access the L7415-0 as outlined above.
SR05	Severed N16 (*Castlegal*)	N/A	As above
SR06	Severed N16 (*Lugatober*)	Ch. 1,155m	This Side Road will be closed to VMU access via the provision of signing.
SR07	L7413-0	Ch. 1,350m	Reconnection to the north/south via the dedicated cycle with no requirement to cross the mainline, other than in the instances described above. Local access is maintained via a subway underpass.
SR08	L34041-0	Ch. 1,955m	Reconnection to the north/south via the dedicated cycle with no requirement to cross the mainline, other than in the instances described above. Local access is maintained via diversion and via the underpass (subway design) described above at the L7413-0.
SR09	L3404-0	Ch. 2,155m	Reconnection to the north/south via the dedicated cycle with no requirement to cross the mainline, other than in the instances described above. Local access is maintained via diversion and via the underpass (subway design) described above at the L7413-0.

4.8 Boundary Fencing

Boundary fencing for the *Proposed Road Development* will be timber post and tension mesh fence complying with CC-SCD-00320[51] (as outlined indicatively in *Figure 4-8*). Where such fencing is required to be mammal proof as outlined in 9.5 of this EIAR, it shall comply with the provisions of CC-SCD-00324.

Figure 4-8: Boundary Fence



4.9 Utilities and Services

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);
- Irish Water; and
- Eircom (Telecommunications);

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.

4.10 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 advance works will commence in late 2019, with construction work commencing in 2020.

It is expected that the *Public Works Contract for the Provision of Civil Engineering Works Designed by the Employer (PW-CF3)* issued by the Department of Finance, will be the form of Contract to be used for the *Proposed Road Development*.

The construction period is anticipated to last approximately 18 months. Normal hours of work, unless specific restrictions are placed on certain activities within certain chapters of the EIAR will be:

- Monday to Friday: 08:00 to 19:00 hours;
- Saturday: 08.00 to 14:00 hours;
- Sunday: No Working.

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, consideration will be given to advance works being undertaken where appropriate.

4.10.2 Earthworks Volumes

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 leads to a deficit of fill material and the generation of soft soil material which is unsuitable for the construction of road embankments. This is mainly as a consequence of:

- The mountainous and undulating nature of the topography;
- The characteristics of the glacial till deposits which the *Proposed Road Development* intercepts, insofar as the 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 (as expanded upon in in section 4.5) and replaced with suitable fill material;

An overview of the likely earthworks volumes generated by the *Proposed Road Development* are outlined in the proceeding table.

Table 4-14: Earthworks Materials

Description	Volume (approx.)
Topsoil excavated	19,000m^3
Overall Cut (Suitable + Unsuitable)	130,000m^3
Cut acceptable material (Rock and Glacial till)	93,000m^3
Cut unacceptable material (Glacial till) – Pre treatment	37,000m^3
Cut unacceptable material (Glacial till) – Post treatment	25,000m^3
Soft unacceptable material excavated underneath embankments (Glacial till and minor alluvial deposits) – Pre treatment	40,000m^3
Soft unacceptable material excavated underneath embankments (Glacial till and minor alluvial deposits) – Post treatment	34,000m^3
Embankment fill material requirement	158,000m^3
Additional fill underneath embankments (soft ground)	40,000m^3
Acceptable fill material arising from cut sections and following treatment (incl. treated soil from soft ground)	111,000m^3
Potential for Rock material to be processed into Capping	12,000m^3
Acceptable fill material remaining from Cut sections following processing into Capping	99,000m^3
Material Importation – Pre Soil Repository/Borrow Pit (SR/BP) [Brackets] indicate post SR/BP scenario – See proceeding section for details.	99,000m^3 [40,000m^3]

4.10.2.1 Soft Soil management & additional site won material

4.10.2.1.1 *Outline of approach*

Soil Repository/Borrow Pits

The following is an outline of the characteristics pertaining to the Soil Repository/Borrow Pit (SR/BP) at *Castlegal* townland, an activity which has already been referred to in section 3.4.3.2 of this EIAR.

Although there are some prescriptive design assumptions made; these should be construed as a demonstration of how the pits could be developed and the maximum envelope available for utilisation at the site. 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 using the principles of adaptive management during the detailed design and construction stage respectively.

The Soil Repository/Borrow Pit configuration has been 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 (but which are suitable for land infilling purposes).

The associated figure relating to the following text is provided in Figures 4.10.1 of volume 3.

Soil Repository/Borrow Pit Configuration (SR/BP)

Outline

The following are outline objectives for the site configuration:

(1) The topographical slope following the landscape establishment period will resemble as close as possible its pre excavation slopes. The landscape establishment period shall be 24 months following reinstatement, or, in any event at a time when the settlement monitoring indicates that the material within the pit has fully consolidated itself and the grass sward has fully re-established itself. Should deviations be determined within this period, then an additional spread of topsoil shall be applied and seeded appropriately. 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;

(2) The topsoil quality and depth at the site shall be surveyed pre-excavation and returned to a similar state following the repository stage;

(3) The lands will be made available for return to the original agricultural use (meadow crop and grassland grazing) following completion of the landscape establishment period;

(4) The material volume characteristics of the Soil Repository/Borrow are:

  a. The extraction volume (excavation of suitable material for road construction) will be balanced by the deposition volume of soft soil arising from the site (circa 59,000m^3).

Material Extraction

The material extraction process shall generally be by machine excavation, with the potential for some blasting 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) 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;

(5) 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;

Soil 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;

(2) Specific limits in terms of Noise & Vibration, Air Quality, Hydrology and Hydrogeology will apply during the extraction process of the pit. These relate to such things as vibration limits from blasting,

dust emissions and interception of groundwater flows and are expanded upon in the various chapters of the EIAR;

(3) Land drains shall be provided as outlined in Figure 4.10.1 of Volume 3. 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;

Benefits

In addition to returning the land to its pre-excavation state; the benefits arising from this approach are a reduction to negligible quantities of material which would otherwise be required to be exported offsite and a reduction in the earthworks import requirements from circa 111,000m^3 to 40,000m^3.

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 within Section 4 of Volume 4 (Appendices). 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.

4.10.4 Construction Compounds

A Construction Compound will be required for the duration of the works. Provision has been made for this compound to the west of the proposed mainline alignment at circa Ch. 500m as outlined in Figure 4.1.1 contained within Volume 3 of this EIAR.

The activities at the compounds may include stores, offices, materials storage areas, materials processing areas, plant storage, parking of site and staff vehicles, and other ancillary facilities and activities. Controls in relation to the development and operation of the compound are described in section 5.3.5 of the Outline Erosion and Sediment Control Plan described in section 4.10.8 of this EIAR.

Following completion of the construction period, the site location of this compound, shall be returned to its pre-use (agricultural grassland) state.

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 N16:

- At the southern tie in;
- In the townland of *Drumkillsellagh* at c. Ch. 400m;
- In the townland of *Lugatober* at c. Ch. 1,120m;
- In the townland of *Lugatober* at c. Ch. 2,150m;

It is anticipated that construction traffic will also use a haul road along the road corridor itself (within the landtake area), for access. The use by construction traffic of local roads will be limited to the works which are required to construct each particular local road.

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.

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 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 diversions will be required via alternative routes on the local and regional road network.

All diversions will be planned in a manner, which will include advance notification and publicity of the diversion times and duration. The diversion routes themselves will be subject to appropriate traffic management and control which will include directional signing along the prescribed route.

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	Townland (s)	Temporary Diversion Required	Notes
L3406-0	*Doonally, Drumkilsellagh.*	No	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L3406-0, the existing N16 and the construction site.
Existing N16	*Drumkilsellagh, Drum East, Lugatober.*	No	Temporary access arrangements to be accommodated during construction (within the CPO) on or adjacent to the existing N16 and the construction site.
	Lugatober, Lugnagall.	Yes	Temporary regional diversion (on the R280, R287, R288 and the R286) will be required for a period of c. 2 weeks. This will facilitate the completion of bulk earth works between c. Ch. 2,030m and c. Ch. 2,160 and the design/construction of traffic management measures which will facilitate temporary access arrangements thereafter (within the CPO) on or adjacent to the existing N16 and the construction site.
L7415-0	*Castlegal.*	No	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L7415-0, the existing N16 and the construction site.
L7413-0	*Lugatober*	Yes	Temporary local diversion will be required for a period of c. 3 weeks. Prior to this diversion being put in place, the underpass at c. Ch. 1,300m will be open to pedestrian traffic, via a 1.2m (min width) temporary gravel access track. This will facilitate the completion of bulk earth works between c. Ch. 1,340m and c. Ch. 1,420 and the design/construction of traffic management measures which will facilitate temporary access arrangements thereafter (within the CPO) on or adjacent to the L7412-0, the existing N16 and the construction site.

Location	Townland (s)	Temporary Diversion Required	Notes
L34041-0	*Collinsford*, *Lugnagall*.	No	Temporary access arrangements to be accommodated during construction (within the CPO) either on or adjacent to the L34041-0, the existing N16 and the construction site.
L3404-0	*Lugnagall*	Yes	Temporary local diversion will be required for a period of c. 3 weeks. This will facilitate the completion of bulk earthworks/drainage along the local road and the design/construction of traffic management measures which will facilitate temporary access arrangements thereafter (within the CPO) on or adjacent to the existing N16 and the construction site.

4.10.7 Construction Works

The following outlines the likely stages of the construction works, general impacts and mitigation measures that will be employed during this stage.

4.10.7.1 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. Advance works will include diversion of services where required and vegetation clearance.

4.10.7.2 Main Earthworks Activities

4.10.7.2.1 *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 will involve earth movements, crossing services, site drainage and run off, dewatering operations, working near, or within watercourses and laying the road pavement.

4.10.7.2.2 *Fencing and Landscaping*

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.

4.10.7.2.3 *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.

4.10.7.2.4 *Blasting*

There is potential that some blasting will be required in the cut between c. Ch. 900m and c. Ch. 1,160m and within the Soil Repository/Borrow Pit in the same area.

Blasting, if carried out, shall be in accordance with the mitigation measures outlined in Chapter 7 (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.

4.10.7.3 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 EIAR will be implemented as an integral part of the *Proposed Road Development*. An Environmental Operating Plan (EOP) will be prepared by the appointed contractor in accordance with TII 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, 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 described in the Outline Erosion and Sediment Control Plan described in section 4.10.8 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.

4.10.8 **Construction Stage Water Quality Considerations**

4.10.8.1 Overview

An Outline Erosion and Sediment Control Plan (contained within volume 4 of this EIAR) 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 Tully Stream and tributaries of the Drumcliff River.

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 Biodiversity 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*;

4.10.8.2 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 **Monitoring of Environmental Commitments**

The environmental commitments outlined in this EIAR will as already discussed (section 4.10.7.3 of this Chapter) be included within the EOP to be developed by the Contractor. The Employer's Representative appointed by the Local Authority will be responsible for the auditing of this plan and for ensuring that commitments described in this EIAR are implemented by the contractor.

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.

4.12 Other Statutory Considerations

4.12.1 **Compulsory Purchase Order Considerations**

The *Proposed Road Development* by its nature will require a permanent Compulsory Purchase Order (CPO) for an area of c. 23.85 of land (including roadbed) comprising in the main agricultural lands.

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 to 2018, the Housing Acts 1966 to 2014, the Local Government Acts 1925 to 2016 and the Roads Act 1993 to 2016, 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 attenuation wetland pond facilities;
- Areas required for other drainage elements including outfalls, culverts, ditches and petrol interceptors;
- Access tracks;
- Areas for landscaping;
- Areas for construction;
- Maintenance strip;
- Acquisition of severed land plots; and
- Areas required for soil repositories/borrow pits;

In addition, further areas required under a temporary Compulsory Purchase Order include:

- 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 4.10.8 of this chapter;
- Areas required for construction of the permanent fence boundary;
- Areas required to construct retaining walls to domestic properties;
- Area required for the proposed site compound.

4.12.1.1 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 14 and 15 of this EIAR.

4.12.1.2 Access tracks:

4.12.1.2.1 *Agricultural & Domestic*

The land ownership mosaic has been used to establish access requirements and to evaluate side road and mainline realignments.

The access tracks proposed as already outlined in 4.2.2.1 will:

- Ensure landowners have access to the road network in the area;
- Eliminate direct accesses as far as it reasonably practicable onto the proposed N16;

4.12.1.2.2 *Service Tracks*

Access to drainage treatment locations as already outlined in 4.2.2.1 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.

4.12.1.3 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 14.1.1 to 14.1.2 of volume 3.

The public rights of way on local roads, will generally be within the lands to be acquired and which require extinguishment. In addition there will be extinguishments required to the national primary route at its tie in points.

The extinguishments are further described in Part 1 of the Third Schedule to the Compulsory Purchase Order described in section 4.12.1 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;

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.

4.12.2 Effects on European Sites

In relation to European sites, an Appropriate Assessment Screening Assessment and Natura Impact Statement have been prepared to provide the competent authorities with the information necessary to complete an Appropriate Assessment for the *Proposed Road Development* in compliance with Part XAB of the Planning and Development Acts 2000 to 2018 and Article 6(3) of the Habitats Directive. The Natura Impact Statement is separate to, but compliments this EIAR (and vice versa).

As outlined in section 9.4.2.2 (Biodiversity Chapter of this EIAR):

> *… This EIAR chapter and the NIS concludes that the that the Proposed Development, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site.*

4.13 Relevant Figures and Appendices

4.13.1 Figures contained in Volume 3

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

Fig. 4.1: *Proposed Road Development* Location Map: Design Overview, Plan Mainline; Key Sheets;

Fig. 4.1.1: Plan Mainline; Ch. 0m to Ch. 1,460m

Fig. 4.1.2: Plan Mainline; Ch. 1,460m to Ch. 2,540m

Fig. 4.2: *Proposed Road Development* Location Map: Design Overview, Mainline Geometrics; Key Sheets;

Fig. 4.2.1: Design Overview; Geometrics Mainline; Ch. 0m to Ch. 1,460m

Fig. 4.2.2: Design Overview; Geometrics Mainline; Ch. 1,460m to Ch. 2,540m

Fig. 4.3: *Proposed Road Development* Location Map: Design Overview, Geometrics Side Roads; Key Sheets;

4.13.2 Appendices contained in Volume 4

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 4.1: Chapter 4 (Main Report Reference); Drainage – Technical Details;

Appendix 4.2: Chapter 4 (Main Report Reference); Outline Construction and Demolition Waste Management Plan;

Appendix 4.3: Chapter 4 (Main Report References); Outline Erosion and Sediment Control Plan;

Part 2 – Impact Assessment

This section of the Environmental Impact Assessment Report (EIAR) identifies and provides an assessment of any likely significant effects from the *Proposed Road Development* to enable An Bord Pleanála to determine whether the *Proposed Road Development* would or would not be likely to have significant effects on the environment.

Throughout the preparation of this EIAR, every effort has been made to avoid, reduce or eliminate negative environmental impacts. Changes have been made to the proposed design to reduce or eliminate adverse impacts. In areas where design changes are not possible, mitigation measures have been incorporated to reduce or eliminate any adverse impacts identified.

5 Impact Assessment – Introduction, Interactions, and Cumulative Effects

5.1 General

The potential environmental impacts associated with this *Proposed Road Development* are presented in Chapters 6-15 (inclusive) under the chapter headings as already described in section 1.6.

5.1 Scope of EIAR

This EIAR has been generally prepared having regard to the following sources of information. In addition, each associated assessment chapter of the EIAR sets out further sources (legislative and guidance based) which are of a more specific nature and relevant to each particular topic.

Legislation

- Legislation as already set out in Chapter 1 of this EIAR.

EPA Guidelines

- Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2017);
- Draft Advice Notes for preparing Environmental Impact Statements, (EPA 2015).

TII/NRA Guidelines

- Project Management Guidelines (NRA, 2010);
- Project Management Guidelines (TII, PE-PMG-02041, 2017);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008).

Consultation

- Consultation with statutory and non-statutory bodies, as well as local interest groups throughout the Route Selection Stages;

5.2 Impact Assessment

5.2.1 Objectives of the Environmental Impact Assessment Report

In addition to the legislative requirements already set out, the objectives of this EIAR can be summarised as follows:

- To establish the existing environmental condition 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 EIAR addresses the 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*.

5.2.2 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.

5.2.3 Effects

Methodology

Where possible, those contributing to the EIAR use the same terminology and approach to the identification of significant effects. The following table provides an overview of the recommended description of significant effects.

Table 5-1: Description of Effects (Draft EPA Advice Notes, 2017)

Quality of Effects	**Positive Effects:** A change which improves the quality of the environment (for example, by increasing species diversity; or the improving reproductive capacity of an ecosystem, or by removing nuisances or improving amenities). **Neutral Effects:** No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error. **Negative/adverse Effects:** A change which reduces the quality of the environment (for example, lessening species diversity or diminishing the reproductive capacity of an ecosystem; or damaging health or property or by causing nuisance).
Describing the Significance of Effects	**Imperceptible:** An effect capable of measurement but without significant consequences. **Not significant:** An effect which causes noticeable changes in the character of the environment but without significant consequences. **Slight Effects:** An effect which causes noticeable changes in the character of the environment without affecting its sensitivities. **Moderate Effects:** An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends. **Significant Effects:** An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment. **Very Significant:** An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment. **Profound Effects:** An effect which obliterates sensitive characteristics
Describing the Probability of Effects	**Likely Effects:** The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented. **Unlikely Effects:** The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.

Describing the Duration and Frequency of Effects	**Momentary Effects:** Effects lasting from seconds to minutes **Brief Effects:** Effects lasting less than a day **Temporary Effects:** Effects lasting less than a year **Short-term Effects:** Effects lasting one to seven years. **Medium-term Effects:** Effects lasting seven to fifteen years. **Long-term Effects:** Effects lasting fifteen to sixty years. **Permanent Effects:** Effects lasting over sixty years **Reversible Effects:** Effects that can be undone, for example through remediation or restoration: **Frequency of Effects:** Describe how often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)

Where appropriate, mitigation measures have been proposed to reduce any significant adverse impacts. The EIAR presents the residual impacts of the *Proposed Road Development* after the proposed mitigation measures as identified in each Chapter have taken effect as planned.

5.2.4 Structure of individual Impact Assessment Chapters

Specialists have structured the relevant Chapters of the EIAR based on the EPA (2017) *Draft Guidelines on Information to be contained in Environmental Impact Assessment Reports.* In general, 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;
- **Mitigation Measures**:
  - Description of proposed mitigation measures to avoid, reduce or remedy impacts;
- **Residual Impacts**:
  - Description of any expected residual impacts after mitigation;

A summary of the environmental commitments, i.e. the mitigation measures to be undertaken is then outlined in Chapter 16 of this EIAR.

5.3 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 EIAR. This was facilitated through:

- Ongoing interaction between the design team and specialist sub consultants;
- Discussions at workshops and EIAR progress meetings; and

- Direct consultation between the various sub consultants.

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 5-2 gives an indication of the initial identification process in determining where there may have been a potential for an interrelationship to occur. Where Interrelationships have been established, they are set out accordingly, within the specific chapters.

Table 5-2: Impact Interaction identification

	Population & Human Health	Noise and Vibration	Air Quality and Climate	Biodiversity	Soils & Geology	Hydrology & Hydro-geology	Landscape and Visual	Archaeology, Architecture and Cultural Heritage	Agriculture Property	Non- Agricultural Property
Population & Human Health		•	•			•	•		•	•
Noise and Vibration	•			•	•		•	•	•	•
Air Quality and Climate	•			•	•				•	•
Biodiversity		•	•			•	•			
Soils & Geology		•	•			•				
Hydrology and Hydrogeology	•			•	•				•	•
Landscape and Visual	•	•		•				•		•
Archaeology, Architecture and Cultural Heritage		•					•			
Material Assets: Agriculture Property	•	•	•			•				•
Material Assets: Non Agricultural Property	•	•	•			•	•		•	

The following is a broad overview of the more significant inter-relationships which were identified and considered during the EIAR process.

Table 5-3: Impact Interaction overview

Inter-Relationship		Brief summary of interaction
Chapter	Chapter	
Population & Human Health	Non-Agricultural Property	Potential impacts to human beings as a result of impacts to residential properties directly/indirectly affected.
	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.

Inter-Relationship		Brief summary of interaction
Chapter	**Chapter**	
	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 be in some cases required.
	Landscape and Visual	Potential visual impacts may affect amenity values. Landscape mitigation measures is required in order to offset same.
	Agricultural Property	Social impact in terms of direct impacts on farming activities.
	Hydrology & Hydrogeology	Potential impacts to human beings in terms of water supply interruption and impact.
Material Assets: 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.
	Noise and Vibration	Potential impacts to properties in terms of noise nuisance during the construction and operational phases.
	Landscape and Visual	Potential visual impacts to human beings.
	Agricultural Property	Impacts where residential property is connected with an agricultural property.
	Hydrology and Hydrogeology	Potential impacts to properties in terms of pollution to ground and surface water.
Material Assets: 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.
	Biodiversity	Potential impacts to biodiversity 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.
	Agricultural Property	Potential impacts to properties in terms of noise nuisance during the construction and operational phases.
	Biodiversity	Potential impacts to Biodiversity sites in terms of exposure to dust, particulates and other emissions during the construction and operational phases.
Landscape and Visual	Biodiversity	Interaction required in terms of provision of mitigation to complement Biodiversity Chapter, e.g. connectivity and use of appropriate planting species.
	Archaeology, Architecture and Cultural Heritage	Potential for visual impacts and the setting of sites of Archaeology, Architecture and Cultural Heritage importance.
Agricultural Property	Hydrology and Hydrogeology	Potential impacts to properties in terms of pollution to ground and surface water.
Biodiversity	Hydrology and Hydrogeology	Potential impacts and mitigation requirements to maintain the existing hydrological and hydro-geological regime to surface and groundwater dependent ecosystems.
Soils and Geology	Noise & Vibration	Potential impacts as a result of excavation of soils and bedrock.

Inter-Relationship		Brief summary of interaction
Chapter	Chapter	
	Air Quality	Potential impacts as a result of excavation of soils and bedrock.
	Hydrology and Hydrogeology	Potential impacts as a result of interception of groundwater flows as a result of removal of geological materials;

5.4 Cumulative Impacts

The following sources of information were consulted in order to establish if there are any *...existing and/or approved projects*[61]*...* in proximity to the *Proposed Road Development*, which are likely to result in an accumulation of effects:

- Sligo County Council Planning Register;
- Sligo County Council Water Services Department;
- Sligo County Development Plan, 2017 - 2023;
- An Bord Pleanála website;
- Coillte Website;
- Eirgrid Website;

5.4.1 Roads Projects

The only approved project in proximity to the *Proposed Road Development* includes an online improvement to the existing N4/N15 in Sligo City, which occurs circa 4km to the south of the *Proposed Road Development*'s southern boundary. This project extends for approximately 670m from a point just north of Hughes Bridge, to a point just north of the junction with the R291 Rosses Point Road. The development will generally increase the traffic capacity on the N4/N15 from two lanes in each direction to three lanes (via widening), with junction improvements to those side roads intercepted by the development.

The environmental effects arising from this project are not significant considering the results of the EIA screening and Appropriate Assessment decisions, which are outlined below:

Quote 5-1: EIA Screening Decision (Sligo County Council)

> …the proposed road development would not be likely to have significant effects on the environment and the N4-N15 Sligo Urban Improvement Scheme does not require an EIA.

Quote 5-2: Appropriate Assessment Decision (An Bord Pleanála)

> …In overall conclusion, the Board was satisfied that the proposed development, by itself or in combination with other plans or projects, would not adversely affect the integrity of the European Sites in view of the sites' conservation objectives.

5.4.2 Roads Corridors

The N16 (Sligo to Northern Ireland) route forms part of the Ten-T Network, which sets out planned road, rail, air and water transport networks in the EU. The N16 Sligo to Belfast is identified as a Strategic International Access Point providing road access to and from Gateways, hubs and other areas in the vicinity of the Irish Border. The development of the N16 (Sligo to Belfast) is identified as a strategic objective in the Sligo County Council Development Plan 2017-2023, which was the subject of a Strategic Environmental Assessment (SEA).

This Project proposes to upgrade a section of the N16, between the townlands of *Drumkilsellagh* and *Lugnagall* in the north-east of Sligo. The need to upgrade this 2.54 kilometre section has been explained at

[61] Terminology used in the amended EIA Directive.

section 3.3.1.2.1 of this EIAR. This particular section of the N16 is significantly deficient and has a greater intensity of tight radii, twists and turns than any other section of the national primary network within county Sligo. This results in a poor level of service and a very low average journey speed. The rate of accidents is almost twice the national average for the years 2009 to 2014.

The Project is not dependent (whether functionally, financially, from a policy perspective, or otherwise) on an upgrade or revision to the balance of the route to Belfast.

The remaining sections of the N16 will not be developed in the short to medium term. When the time arrives for their progression; each remaining section will be the subject of further design, along with further environmental assessments, prior to any application for consent being submitted. This thereby ensures the requirements of the EIA Directive are complied with. It would be impossible to complete any useful or meaningful assessment of those hypothetical future road projects that are not yet existing and/or approved.

5.4.3 Planning Register

The online planning system for Sligo County Council, was consulted on the 01/10/2018 (covering a period of 10 years) for the proposed works area. Nine residential dwellings were identified in the townlands of *Drumkilsellagh, Castlegal, Lugatober* and *Lugnagall*;

No likely significant cumulative impact are expected as the residential developments will have a localised construction footprint with no pathway to the study area.

5.4.4 Other Projects

No other existing or approved projects, were established in proximity to the *Proposed Road Development*.

5.5 Major accidents and/or natural disasters

The assessment of the vulnerability of the *Proposed Road Development* to major accidents and natural disasters is included in this EIAR following changes to EU legislation. The revised EIA Directive 2014/52/EU states the need to assess '*the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or natural disasters which are relevant to the project concerned'*.

Considering the following, it has been established that the project is not of a nature which will result in it generating a risk of major accidents and/or disasters.

5.5.1 Seveso Sites

There are no Seveso (COMAH) sites located within County Sligo, or the adjoining County Leitrim.

5.5.2 Landslides

There have been landslides on the adjacent northern and western slopes of Cope's Mountain together with scree deposits mapped on the lower slopes. Scree is a very loose coarse gravel and boulder material which collects at the base of eroding rock slopes and is typically unstable and susceptible to instability due to further loading or extreme rainfall events. The historical rock fall location of greatest concern is located near the townland of *Lugnagall* in the Northern Section but as established at route selection stage, the *Proposed Road Development* is protected from potential run out of falling debris by the existing large quarry (Scanlon's quarry) which provides a protective depression in the land to the west of the project.

5.5.3 Figures contained in Volume 3

There are no figures associated with this chapter of the EIAR contained within Volume 3.

5.5.4 Appendices contained in Volume 4

There are no appendices associated with this chapter of the EIAR contained within Volume 4.

6 Population & Human Health

6.1 Introduction

This chapter addresses the likely significant effects on Population and Human Beings during the construction and operation phases of the *Proposed Road Development*.

The chapter initially sets out the methodology, it then describes the receiving environment and summarises the main characteristics of the *Proposed Road Development* which are of relevance for population and human health. The assessment of impacts of the *Proposed Road Development* on population and human health are described. Measures are proposed to mitigate these impacts and residual impacts are described.

6.2 Methodology

6.2.1 General

Population aspects of relevance to this assessment include journey patterns, amenity and community severance, business, tourism and employment opportunities. Other aspects relevant to the local community, and community perceptions of effects, are addressed in the specific chapters of the EIAR, namely

- Chapter 7, Noise and Vibration, to identify the predicted noise levels at properties adjacent to the *Proposed Road Development*;
- Chapter 8, Air Quality and Climate Change, to identify the predicted air quality values adjacent to the *Proposed Road Development*;
- Chapter 12, Landscape and Visual, to identify visual intrusion and landscape effects;
- Chapter 13, Archaeology, Architecture and Cultural Heritage, to identify effects on these aspects of the environment;
- Chapter 15, Material Assets and Land: Non-agriculture to assess effects on non-agricultural property.

Human health impacts are primarily considered through an assessment of the environmental pathways by which health can be affected, such as air, noise, water or soil. Therefore, the health assessment relies on these assessments and draws on the effects identified in the following chapters:

- Chapter 7, Noise and Vibration, to identify the predicted noise levels at properties adjacent to the *Proposed Road Development;*
- Chapter 8, Air Quality and Climate Change, to identify the predicted air quality values adjacent to the *Proposed Road Development*;
- Chapter 10, Soils and Geology, to identify if there are any areas of contaminated soils;
- Chapter 11, Hydrology & Hydrogeology, to identify areas with any potential impacts on surface water, areas of flood risk and groundwater

The health assessment also considers physiological effects, health improvement and improvement to services. Other aspects, such as changes in traffic flows, which are dealt with in Chapter 4, Description of the *Proposed Road Development*, have also been considered in this chapter to ensure that the effects of these issues on population and human health have been addressed.

6.2.2 Guidelines

The following guidelines were referred to while preparing and writing this chapter:

- EPA: Revised Guidelines on The Information to be Contained in Environmental Impact Statements, Draft, September 2015;
- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, draft August 2017);
- EPA: Advice Notes for Preparing Environmental Impact Statements, Draft, September 2015;

- National Roads Authority: Environmental Impact Assessment of National Road Schemes- A Practical Guide (Revision 1, November, 2008);
- Fáilte Ireland Guidelines of the Treatment of Tourism in an EIS, 2011.

The assessment of likely effects has been undertaken in line with these guidelines. The EPA Guidelines provide advice on types of effects including cumulative and in-combination effects impacts which are particularly important for Population and Human Health for instance where there is an interaction between improved accessibility economic opportunities or requests for new development.

No specific guidance on the definition for human health has been defined to date, including specific guidance on the assessment of human health in the context of EIA. The relevant guidance that has been considered here includes also:

- European Commission (EC) Guidance (EC 2003) *Implementation of Directive 2001/42 on the assessment of the effects of certain plans and programmes on the environment;*
- The World Health Organization WHO Environmental Noise Guidelines for the European Region 2018;
- The World Health Organisation (WHO) *Night time Noise Guidelines for Europe* (WHO 2018);
- Health Impact Assessment Resource and Tool Compilation (US EPA 2016);
- WHO *Guidelines for Community Noise* (WHO 1999);
- Health in Environmental Impact Assessment - A Primer for a Proportionate Approach (IEMA 2017);
- Health Impact Assessment (Institute of Public Health Ireland 2009).

6.2.3 Impact Categories and their Assessment

6.2.3.1 Overview

The purpose of the Population and Human Health impact assessment is to identify the likely significant effects as they might affect users of the *Proposed Road Development* and local people, including sensitive receptors such as homes, hospitals, hotels and other accommodation, schools, tourism and recreation facilities and visitor attractions.

6.2.3.2 Data Sources

An assessment of Population and Human Health requires that an understanding of the baseline environment and local community is acquired through background research, site visits, and conversations with local people and community representatives. Specifically, data has been collected by means of:

- Primary data sources (e.g. demographic data from Census 2016 and Census 2011 produced by the Central Statistics Office);
- Design drawings of the *Proposed Road Development*;
- Maps of the surrounding area, including Ordnance Survey 1:50,000 map;
- Other relevant environmental data considered during the environmental assessment, most especially traffic volumes, air quality, noise, landscape and visual, agriculture and property;
- A review of relevant planning documents including the Sligo County Development Plan 2017-2023, the Consultation Paper pertaining to the Sligo & Environs Local Area Plan 2018-2024 and the North Fringe Local Area Plan (LAP) 2010-2016.
- Observation of local settlement and travel patterns and identification of community facilities;
- Conversations with local people;
- Review of consultations undertaken by Sligo TII Project Office, including submissions made during earlier N16 Route Options public consultations held in January/February 2016 and July/August/September 2016;

- A literature review on the scientific evidence of the potential impacts of roads on human health;
- Collation of the results of the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water, soils and traffic volumes, based on reference to accepted standards/guidelines/limits for the protection of human health.

6.2.4 Impact Assessment Methodology

Effects can result from direct, indirect, secondary and cumulative effects on environmental conditions. They can be positive, neutral or negative. The significance of an effect is based on objective evidence and subjective concerns and may be described as *Not significant*, *Imperceptible, Slight, Moderate, Significant, Very Significant* or a *Profound* impact. Significance depends, among other considerations, on the nature of the environmental effect, the timing and duration of an effect, and the probability of the occurrence of an effect. Receptor extent qualifies the assessment of significance by identifying the number of receptor types likely to be affected as an approximate proportion of the local population or road users and is assessed qualitatively as: few; medium; many; or very many. For instance, an effect may be significant for a particular population subset, but the number of people impacted could be few in number.

6.2.4.1 Methodology for assessing population effects in EIA

The assessment of population generally addresses effects at a community level, rather than for individuals or identifiable properties, although effects for individual businesses are discussed where these are located beside the road or are very dependent on road traffic or accessibility. Effects on individual properties are addressed separately in Chapters 14 and 15 which deal with Agricultural Property and Non-Agricultural Property. There are interactions with other environmental assessments, particularly with possible effects identified in Chapter 7 (Noise and Vibration), Chapter 8 (Air Quality), and Chapter 13 (Cultural Heritage).

The rationale for applying a particular level of significance to an effect as it would affect the worst hit subset of the population is outlined below in Table 6-1 to Table 6-5**.**

Journey patterns

Effects on journey time and journey patterns may arise during the construction phase due to construction traffic movements that are additional to normal traffic volumes on the existing road network or due to temporary road diversions or signalling as these affect traffic movement. Operational effects will arise from changes in journey time or patterns due to the *Proposed Road Development*. Average walking speed for pedestrians is taken to be 5 km/h. Average cycle speed is assumed at 20 km/hr.

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 length or duration.
Slight	Slight improvement in journeys where impact is positive. Some inconvenience where impact is negative. Some likelihood of changes in journey habits.
Moderate	Moderate reduction in journeys where impact is positive, moderate increase where impact is negative. Greater likelihood of changes in journey habits.
Significant	Much shorter journey times where impact is positive, much longer journeys where impact is negative. High likelihood of changes in journey habits.
Very Significant	Considerably shorter journey times where impact is positive, considerably longer journeys where impact is negative. Very high likelihood of changes in journey habits.
Profound	An approximate doubling (or halving) in typical journey length or duration sufficient to cause marked change in behaviour of a sizeable proportion of population.

Amenity

Journey amenity effects arise from the proximity to construction as it affects the pleasantness and perceived safety of the environment for walking, cycling or driving. The level of traffic on a road, the proximity and separation of footpaths and cycle-paths, the nature of any crossings/junctions to be negotiated, the legibility of a journey (including signage), visual intrusion (including sightlines) and safety for equestrians, are amongst the factors relevant to the assessment of amenity. The principal concern is with pedestrians or cyclists, but journey amenity impacts also apply to drivers, for example due to safety anxiety associated with the crossings of major roads. General amenity effects can arise due to any effect that the *Proposed Road Development* may have on residential quality of life, amenity or recreation due to environmental effects such as noise or visual intrusion, for which specific significance levels are identified in the respective chapters of the EIAR. There are also links here to tourism.

Table 6-2: Criteria used in the assessment of Amenity effects

Impact Level	Significance Criteria
Imperceptible	No significant amenity impacts are apparent.
Slight	A small impact on community wellbeing or an amenity can be attributed to the proposed development.
Moderate	A moderate impact on community wellbeing or an amenity can be attributed to the proposed development.
Significant	A proposed development has the potential to impact on community wellbeing or an amenity such as to significantly affect many people's behaviour and quality of life or the functioning of the amenity.
Very Significant	A proposed development has the potential to substantially impact on community wellbeing or an amenity such as to affect most people's behaviour and quality of life or the viability of the amenity.
Profound	Effects of a scale to significantly impact on community wellbeing to an extent that people's behaviour or quality of life is substantially changed; for example, where significant health issues arise or where people may wish to relocate.

Accessibility and community severance

Accessibility or community severance refers to people's access to one another, work places or community facilities, particularly as it affects facilities used by older people, children or other vulnerable groups such as those with limited mobility and/or disabilities. This can take the form of new severance, where a *Proposed Road Development* creates a barrier to access. Alternatively, there can be relief from severance due to improvements to road design or sightlines, or from the introduction of crossing facilities, underpasses or bridges. Social severance can occur too due to changes in accessibility, but also where communities become identified by their containment within road boundaries. The degree of new severance, or relief from severance, depends on the context in which this change occurs including the existing volume of road traffic, the speed of traffic, sightlines and the number of crossings by pedestrians, cyclists or others.

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 with some hindrance to movement.
Moderate	Some residents, including children and elderly people, are likely to encounter severance. For others, journeys will be longer or less attractive.
Significant	Many residents, including children and elderly people, are likely to encounter significant severance which could dissuade them from making particular journeys.
Very Significant	Most residents, including children and elderly people, are likely to encounter very significant severance which will be sufficient to induce a reorganisation of their activities, to cause them to make less frequent trips to nearby neighbourhoods or to make less use of particular community facilities.
Profound	People are likely to be deterred from making trips to an extent that includes permanent loss of access or a change in the location of centres of activity.

Table 6-4: Criteria used in the assessment of Relief from Severance

Impact Level	Significance Criteria
Imperceptible	Journey patterns maintained
Slight	Present journey patterns likely to be maintained, but with reduction in hindrance to movement (e.g. 10-30% reduction in traffic levels (AADT))
Moderate	Journeys will be shorter or more attractive sufficient to permit some more frequent or new journeys by foot or bicycle (e.g. 31-50% reduction in traffic levels (AADT)
Significant	Journeys will be significantly shorter or more attractive sufficient to encourage more frequent or new journeys to particular community facilities by foot or bicycle (e.g. 51-70% reduction in traffic levels (AADT)
Very Significant	Very significant reduction in severance sufficient to ensure that all residents can make more frequent journeys to particular community facilities by foot or bicycle (e.g. 71-90% reduction in traffic levels (AADT)
Profound	A reduction in severance of such significance as to provide new access to community facilities or to cause a very significant increase in pedestrian or cycle journeys (e.g. more than 90% reduction in traffic levels (AADT)

Business, tourism and employment

Economic effects can arise during construction from local employment opportunities and purchasing of local inputs, or from the impact of construction works on local economic activity or businesses.

During operation, significant effects (positive or negative) can arise due to changes in the local environment due to the displacement of existing economic activity, from accessibility effects on local business or employment opportunities, or from development opportunities for the local economy. There are also potential interactions with other economic activities in the local area as well as with regard to settlement patterns, population change and tourism.

Table 6-5: Criteria used in the assessment of Economic effects

Impact level	Significance criteria
Imperceptible	No significant economic impacts are apparent
Slight	A small effect on the business environment can be attributed to the proposed development
Moderate	A moderate effect on the business environment can be identified.
Significant	An effect that has the potential to impact on business performance or to influence the location decisions of new business.
Very significant	An effect that has the potential to substantially impact on business performance or to influence the location decisions of new business.
Profound	Effects of a scale to substantially impact on the performance of a major business or several businesses. Where these businesses are important local employers there is the possibility of major impacts for the general prosperity of the local area or region.

The assessed population effects relating to journey patterns, amenity, community severance and economic are summarised in Table 6-22 and Table 6-23:

- nature of an effect;
- location and population subgroup affected;
- current character of the local environment;
- sensitivity of local receptors and their capacity to absorb change;
- duration and frequency of an effect;
- extent of the effect in terms of area or population affected;
- Proposed mitigation; and
- Residual effect.

6.2.4.2 Methodology and specific guidance for assessing Human Health in EIA

This section sets out the methodology that was used in order to assess the impact of the *Proposed Road Development* on health. The recitals to the 1985 and 2011 EIA Directives refer to "human health" and include "Human Beings" as the corresponding environmental factor. The 2014 EIA Directive (2014/52/EU) changes this factor to "Population and Human Health". However, no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU. In addition, no specific guidance on the assessment of human health in the context of EIA has been issued to date.

The 2017 draft EPA guidelines on the information to be contained in Environmental Impact Assessment Reports note that "*while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in the SEA Directive (2001/42/EC)*". The Commission's SEA Implementation Guidance (section 5.26) states "*The notion of human health should be considered in the context of the other issues mentioned in paragraph (f) and thus environmentally related health issues such as exposure to traffic noise or air pollutants are obvious aspects to study*". (Paragraph (f) (of Annex I of the SEA Directive) lists the environmental factors including soils, water, landscape, air etc.).

The 2017 draft EPA guidelines note that the above health assessment approach is consistent with the approach set out in the 2002 EPA Guidelines where health was considered through assessment of the environmental pathways through which it could be affected, such as air, water or soil, *viz*:

"*The evaluation of effects on these pathways is carried out by reference to accepted standards (usually international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon limits, doses and thresholds for environmental pathways, such as air, water or soil, provides robust and reliable health protectors [protection criteria] for analysis relating to the environment*".

The 2017 draft EPA guidelines also note that in an EIA Report, "*the assessment of impacts on population & human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in the EIAR e.g. under the environmental factors of air, water, soil etc and that "assessment of other health & safety issues are carried out under other EU Directives, as relevant. These may include reports prepared under the Integrated Pollution Prevention and Control, Industrial Emissions, Waste Framework, Landfill, Strategic Environmental Assessment, Seveso III, Floods or Nuclear Safety Directives. In keeping with the requirement of the amended Directive, an EIAR should take account of the results of such assessments without duplicating them*".

The Institute for Environmental Management and Assessment (IEMA) in the UK issued a discussion document in 2017 *Health in Environmental Impact Assessment - A Primer for a Proportionate Approach*, which it describes as a primer for discussion on what a proportionate assessment of the impacts on health should be in EIA and is a useful document when considering what can and should be assessed in the context of EIA. Regard has been had to the general approach advocated in this document when compiling this chapter.

One of the messages in the IEMA document in terms of assessing health in EIA, is that there should be a greater emphasis on health outcomes, (that is the potential effects on human health), rather than simply the health determinants, (that is the agents or emissions which could have the potential to have health effects). The IEMA document noted that in EIA, there has previously been a strong focus on just the agents or emission levels (e.g. dust) rather than focussing on the effects of these agents/emission levels on human health. This change in emphasis does not mean a complete change in practice. For example, measurement and modelling of dust levels continues to be an essential part of the health assessment.

The IEMA document notes that "*public health is defined as the science and art of promoting and protecting health and well-being, preventing ill-health and prolonging life through the organised efforts of society and has three domains of practice: health protection, health improvement and improving services*". The IEMA document suggests that these three domains should be considered in the assessment of health in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles, inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies.

The World Health Organization (WHO) defined health in its broader sense in its 1948 constitution as "*a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity*". Therefore, whilst the EPA guidance is useful in terms of health protection, for a more holistic assessment as per the IEMA document, it is also worthwhile to look at broader health effects in terms of opportunities for improvement of health and for improvement of access to services. While it is important to do this, it is also important not to attribute every conceivable event as being a health effect. To further rely on the WHO definition, a health effect would be something that would have a material impact on somebody's physical mental and social well-being be that positive or negative.

Therefore, *health protection, health improvement and improving services* are all considered in this chapter of the EIA Report.

6.2.4.2.1 *Health Impact Assessment and Environmental Impact Assessment*

The IEMA document notes that Health Impact Assessment (HIA) and EIA are separate processes and that whilst a HIA can inform EIA practice in relation to human health, a HIA alone will not necessarily meet the EIA human health requirement. HIA is not routinely carried out for road projects in Ireland.

Guidance for performing Health Impact Assessment (HIA)'s was issued by the Institute of Public Health in Ireland in 2009. There are however considerable difficulties in performing a HIA as outlined by the Institute of Public Health for a project such as a road development. Not least of these is the difficulty of getting baseline health data. It is quite difficult due to patient confidentiality and other reasons to accurately determine levels of even relatively common medical conditions in a relatively defined population that might be affected by a road project. Qualitative and quantitative baseline health data is a vitally important part of the appraisal section of the HIA. In the absence of an accurate baseline it is very difficult to assess qualitative and quantitative changes that might occur. One could use more generalised data that might exist for larger areas such as a city or county but these would be at most an estimate of the local baseline and not accurate enough to allow for meaningful interpretation.

The IEMA document notes that the WHO provides an overview of health in different types of impact assessment[62] and presents the WHO perspective on the relationship of HIA to other types of impact assessment as follows:

"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Given the value of impact assessments from a societal perspective, this is a risk not to be taken lightly ... The need … and justification for separate HIA cannot automatically be derived from the universally accepted significance of health; rather, it should be demonstrated whether and how HIA offers a comparative advantage in terms of societal benefits …

Health issues can, and need to, be included [in impact assessment] irrespective of levels of integration. At the same time, from a civic society perspective, it would be unacceptable for HIA to weaken other impact assessments. A prudent attitude suggests optimizing the coverage of health along all three avenues:

- *better consideration of health in existing impact assessments other than HIA;*
- *dedicated HIA; and*
- *integrated forms of impact assessment*

It is clear therefore that even the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over the EIA Report. It is for these reasons that this health assessment is part of the EIA Report and there is no stand-alone HIA.

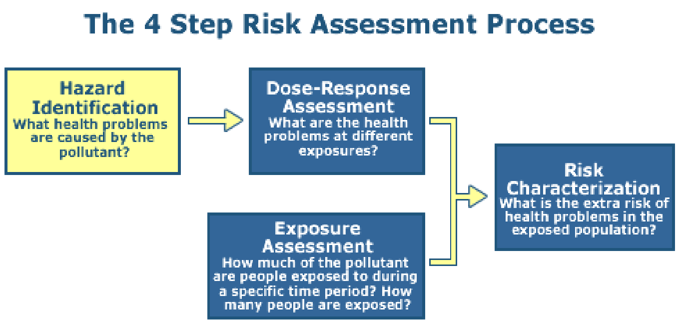
[62] World Health Organization Regional Office for Europe. Health in impact assessments: opportunities not to be missed. 2014

It is therefore important to note that this assessment on human health is part of an overall EIA Report rather than a stand-alone HIA. The HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population, whilst the health assessment in the context of EIA focuses the attention of the assessment on likely significant effects, i.e. on effects that are deemed likely to occur and, if they were to occur, would be expected to be significant (as per the requirements of the EIA Directive). Conducting an HIA will not necessarily meet the EIA population and human health requirement.

Health Protection

The assessment of human health for the *Proposed Road Development*, in terms of health protection, follows the approach set out in the EPA guidelines and in the Commissions SEA Implementation Guidance. It is also similar in nature to the US EPA guidance. Human Health protection is considered through the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water and soils. The US EPA guidance includes a four step approach which is represented graphically in Figure 6-1 below.

Figure 6-1: Human Risk Assessment



The potential noise, air, soils and water impacts which could affect human health were identified (Hazard Identification), the scale of these potential impacts (Dose-Response Assessment) and their duration (Exposure Assessment) were assessed and the significance of the potential impact on human health determined (Risk Characterization).

When using a recognised Health Based Standard, the dose-response assessment is actually included in the standard. In other words, the authorities or expert committees which recommended the level of the standard will have taken into account the health problems at the different exposure levels and set the level within the standard to prevent these problems from occurring.

Health Improvement

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, could contribute to improving the health and wellbeing of socio-economically deprived communities.

The assessment of human health for the *Proposed Road Development*, in terms of health improvement, includes an assessment on how the *Proposed Road Development* would impact on the socio-economics of the community.

Improvement of access to services

Improving access to services such as hospitals or recreational facilities will have an impact on the health of a community. Therefore, the assessment of human health for the *Proposed Road Development* includes an assessment on whether or not the *Proposed Road Development* will improve accesses to these services.

Literature Review

A literature review on the potential impacts of roads on human health has been carried out. This section presents the results of that literature review.

One of the first areas in the literature review to consider is the health determinants relevant to the *Proposed Road Development* – that is the agents or emissions which could have the potential to have health effects. Health outcomes – that is the potential effects on human health arising from those health determinants are then considered.

The environmental factors (pathways) through which health could be affected by a road development both during construction and operational phases include:

- Noise and Vibration– for example potential exposure of people to noise emissions from vehicles and construction activities;
- Air - for example potential exposure of people to dust and air emissions from vehicles and construction activities;
- Water – for example potential exposure of people to changes in water quality (surface and ground water) or changes in water flows – flood risk;
- Impacts of improved transport on health Outcomes;
- Soils – for example potential exposure of people to contaminated land;

The health outcomes arising from such emissions are discussed further below.

In addition, the impacts of the *Proposed Road Development* on psychological health and also health improvements and improvements to services have been included in the literature review below. These topics also fall under the area of "Wellness".

The last fifteen years in Ireland has seen the development of the modern motorway and other major road network between the major urban centres as well as relief roads in urban areas. The literature review included a review of any published data of reported health effects from either the construction or operation of these roads. Using a "PubMed[63]" search, key words such as "Health Effects Roads Ireland" found that there were no published studies in peer reviewed literature. There was however a significant tranche of literature from outside Ireland and in particular in relation to emissions to air and noise. The vast majority of the studies deal with potential emissions from operational roads with a particular emphasis on Noise, Particulate Matter (including PM_{10} and $PM_{2.5}$) as well as other air pollutants such as NO_2 and SO_2 amongst others. The literature is clear that these are the major hazards with the potential for human health effects. The literature is also strongly consistent with a Dose response effect as presented below with regard to noise and air emissions - the lower the dose the lower the effect. Health Based Standards[64] such as WHO and EU standards incorporate literature evidence in the setting of these standards. In essence there is little evidence of significant health effects from air and noise emissions when these standards are not exceeded. It is important to note that these standards are set to protect vulnerable subsections of the population including its most vulnerable members which include children and persons with disabilities and, accordingly, will necessarily protect the more robust subsections. Other emissions such as water and soil can be an issue if there is potential contamination to water or soil or an enhanced flood risk. Again, there is little evidence of significant health effects from water and soil emissions when these standards are not exceeded.

These assessments use standards (such as air quality standards) in order to identify whether significant impacts will arise or not. It is important to point out that health standards such as those set by the WHO are primarily intended to protect the vulnerable subsections of the population and, accordingly, will necessarily protect the more robust subsections. This includes the vulnerable in society who form part of every

[63] PubMed is a search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics.

[64] The term standards in this instance covers guidelines for example noise guidelines as such standard are not currently available.

population. The standards are set at levels for which there will be no significant health effects, but do not exclude each and every effect, i.e. slight or moderate health effects are possible even below the levels at which health based standards would apply.

These health based standards are discussed further below in relation to the various environmental pathways but it is also appropriate to understand the principle behind the setting of such standards.

Noise

Noise is measured using the standard decibel scale (dBA). The "A" represents a weighting that mimics human hearing. It is important to note that because the decibel is a log scale, the figure can be somewhat confusing. In energy terms an increase by 3 dB means a doubling of the sound intensity.

The TII Guidelines state that "*depending upon the circumstances and characteristics of the sound in question, a change in level of 3dB is just perceptible, whereas an increase of 10dB is perceived as a subjective doubling of loudness*". Very few noise sources are constant. A series of noise events can be averaged over any given period of time using the equivalent continuous sound level (L_{eq}). L_{eq} is the method of averaging recommended in industry and environmental assessments and in guidelines issued by, for example, the World Health Organization. This Leq average can be further refined in relation to time of the day. For example L_{DEN} is an Leq which takes into account a weighting system for Day, Evening and Night. Similarly the L_{night} is an Leq which considers nigh time exposure only.

It is normally assumed that noise inside a building with the windows open, will be at least an estimated 15dB less than that outside. With windows closed, noise levels are reduced further inside, up to in excess of 35dB, depending on the building fabric. The actual attenuation varies depending on the type of building, size of the windows and other factors.

It should be noted that the assessment for this EIA Report relates to environmental exposure to noise. Undoubtedly those with the highest noise exposure will be those working on the construction of the *Proposed Road Development*. Legislation is in place for control of work place noise and is policed by the Health and Safety Authority.

A Europe-wide study by Fritschi (2011), and another paper by Hellmuth, published by WHO demonstrate a significant burden of adverse health impacts associated with environmental noise exposure, drawing from earlier WHO publications summarising health evidence and recommending guidelines for community noise exposure. A review of noise exposure across Europe in 2014 by the European Environment Agency (EEA) likewise recommends and applies metrics for various health outcomes. In general terms increasing noise in communities is associated with adverse health outcomes and vice versa. The nature and the severity of these outcomes is further discussed below.

The potential health impacts due to noise include:

- Noise-Induced Hearing Impairment;
- Interference with Speech Communication;
- Disturbance at schools;
- Sleep Disturbance;
- Hypertension and Cardiovascular Disease.

Noise-Induced Hearing Impairment

Hearing impairment is typically defined as an increase in the threshold of hearing. It is assessed by threshold audiometry. It only occurs however above a certain noise level. Data from the International Standards Organisation (ISO) and WHO states that Noise Induced Hearing Loss will not occur at noise levels below 70dB no matter how long the exposure continues.

Interference with Speech Communication

Noise interference can interfere with speech comprehension. These may include problems with concentration, fatigue, uncertainty and lack of self-confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of stress reactions.

Particularly vulnerable to these types of effects are the hearing impaired, the elderly, children in the process of learning, and individuals who are not familiar with the spoken language. Sensitive communication takes place indoors for the majority of the time and as noted above, the average noise attenuation of being inside a building with the windows open is conservatively estimated to be 15 dB.

Disturbance at schools

There are several studies on the effect of environmental noise on education. However most of these relate to airport noise and to a lesser extent traffic noise. From the literature review undertaken, school learning may be the factor most affected by environmental noise.

The RANCH study was one of the largest studies performed on this matter in Europe and was published in the Lancet in 2005. While showing little new data, it suggests a small effect on reading comprehension in 9 to 10 year old primary school children. It also stated "Neither aircraft noise nor traffic noise affected sustained attention, self-reported health, or overall mental health." It was surprising that the study suggested significantly improved memory function in children exposed to high levels of traffic noise. This appears intuitively difficult to understand, but certainly does not suggest that there is the opposite effect. Based on this, disturbance at schools will not be an issue.

Sleep Disturbance

Sleep disturbance is considered to be a major environmental noise effect on human health. It is however estimated that 80-90% of the reported cases of sleep disturbance in noisy environments are for reasons other than noise originating outdoors. Understanding of the impact of noise exposure on sleep, stems mainly from experimental research in controlled environments.

Field studies conducted with people in their normal living situations are scarce. However most of the more recent field research on sleep disturbance has been conducted for aircraft noise.

Sensitive groups include the elderly, shift workers, persons especially vulnerable to physical or mental disorders and other individuals with sleeping difficulties.

There is evidence that habituation to night-time noise events occurs, and that noise-induced awakening decreases with increasing number of sound exposures per night. Studies have also shown that the frequency of noise-induced awakenings decreases for at least the first eight consecutive nights with people becoming accustomed to the noise thereafter (Journal Behavioural Sleep Medicine, 2007). In summary people get used to the noise and the potential for interference with sleep diminishes.

As stated above most of the published research is related to aircraft noise but in a published study (Babish, 2006) which studied some 23,000 people, the authors concluded that at the same average night time noise-exposure level, aircraft noise is associated with more self-reported sleep disturbance than road traffic, and road traffic noise is associated with more sleep disturbance than railways.

People also sleep during the daytime, for example shift workers, but ambient noise levels are much greater during the day and therefore it is less likely that an additional noise source will have a significant effect to those who try to sleep during day time.

Hypertension and Cardiovascular Disease

A number of studies have postulated a link between environmental noise and hypertension and also cardiovascular disease. There is somewhat more evidence in relation to airport noise rather than noise due to road traffic. Some of the studies, particularly in relation to noise due to road traffic, have problems in that there are potential confounders[65]. One of the issues was trying to differentiate whether effects may be due to air pollution rather than noise. Some more recent studies have suggested that noise may have an independent effect. The extent of the effect is difficult to determine but it is clear that it is only at higher levels of environmental noise than any measurable effect is likely to occur.

Regarding road noise specifically, several meta-analyses of cardiovascular disease have been published by W. Babisch. These date from 2006 to 2014 and show evidence to provide a risk ratio for all ischaemic heart disease (IHD), also known as coronary heart disease (CHD) risk. A meta-analysis published by Vienneau in 2015, used many of the same studies to establish an IHD risk ratio that was used in the 2014 European Environment Agency quantification of noise health impacts across Europe. A limited number of studies of stroke risk associated with environmental noise exposure have also been published by Houthuijis.

These postulated links have been considered by expert bodies such as the WHO when they set their noise guidelines and in particular the Environmental Noise Guidelines 2018. These are an update from those issued in 2009, the WHO Night Noise Guidelines for Europe. It stated that in the two European countries studied (Switzerland and The Netherlands) that almost 50% of the population are exposed to night time noise in excess of 45dB L_{night}.

These new guidelines quote some health effects at quite low night time levels and proposed an ideal noise level of 45dB L_{night} outside residences, measured at the nearest fascade. It is important to realise that these are population or public health purposes. It is not stipulate, nor could it for each and every residence but rather for the population as a whole

The WHO night noise guidelines refer to L_{night} parameter which relates specifically to noise levels over the night-time period. The NRA Guidelines on the Treatment of Noise and Vibration sets a design goal in terms of a composite 24 hour parameter, the L_{den}. Whilst the L_{den} includes for night-time noise, direct comparison of the two parameters is not possible as they relate to different averaging time periods. The results of the noise assessment are discussed by the author of the Noise chapter and an understanding of the difference in units and its implications for the results were obtained.

It is important to note that whilst the WHO Guidelines are used in assessing potential health impacts, they can at times be misinterpreted. They are not, and were never intended to be, considered as a threshold. For example, the difference between a property experiencing a night time noise level of 44 dB and another property experiencing a night time noise level of 45.1 dB would be imperceptible for individuals living there and differences in health status would also be imperceptible. There are always other factors when one looks at an individual residence. An example might be that the nearest facade may be a gable end with no windows, the residence may be well insulated and the noise in the house or more particularly in the bedroom may be well below what one might otherwise expect given the noise levels outside.

In 2018 the WHO issued updated guidelines Environmental Noise Guidelines for the European Region. They issued specific guidelines for road noise. They can be summarised as follows:

- For average noise exposure, they recommend reducing noise levels produced by road traffic below 53 decibels (dB) Lden, as road traffic noise above this level is associated with adverse health effects;
- For night noise exposure, they recommended reducing noise levels produced by road traffic during night time below 45 dB Lnight, as night-time road traffic noise above this level is associated with adverse effects on sleep;
- They specifically recommend "To reduce health effects," the GDG (Guideline Development Group) strongly recommends that policymakers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night

[65] In statistics, a confounder (also confounding variable or confounding factor) is a variable that influences both the dependent variable and independent variable causing a spurious association.

noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure.

One might ask how one can reconcile these guidelines with road traffic anywhere? The fact is that these guidelines are for populations. The WHO absolutely realise that every individual residence will not be below 45dB Lnight. However, the question in relation to the assessment of the impact on health will be determined by the overall impact on the population.

The WHO Guidelines therefore are guidelines for protection of health in communities. In terms of potential impacts on health, night time noise is far less important and does not merit being considered in the same way as other factors such as diet, exercise, cigarette smoking and genetics. The slight increase or decrease in night-time noise that might occur on individual residences would be so small as to be unmeasurable in terms of health effects. Therefore, in assessing night time noise in the context of the WHO Guidelines, it should only be in the context of overall noise levels in the community rather than the increase or decrease at an individual residences or clusters of residences. Whilst noise levels are often quoted with respect to potential effects on health and they are used in the significance assessment, it should be noted that the differences in significance between the different levels are relative rather than absolute.

Summary Noise

In terms of the health effects of environmental noise there is some limited evidence of effects on blood pressure, cardiovascular risk, school performance and in relation to sleep disturbance. Any effects demonstrated are more likely at higher noise levels. Many effects are only demonstrated with ambient noise in excess of 70 dB.

<u>Vibration</u>

Vibration has the potential to have health effects when perceptible. These could include for example sleep disturbance. Another issue which is sometimes described is infrasound. The latter is sound but at a frequency so low that it is not audible to the human ear. If at high levels it may be perceived as vibration. These effects, in relation to vibration and infrasound, however only occur when the levels are high and perceptible to human beings for example an underground train. Therefore for this assessment vibration is essentially scoped out.

<u>Air Quality</u>

Vehicles with internal combustion engines emit air pollutions, including particular matter, carbon monoxide, nitrogen oxides and a variety of hydrocarbons. Previously, lead compounds were added to petrol and lead emissions were a major issue but the sale of leaded petrol has been banned for many years. In the last few years in Ireland, partly because of tax driven reasons, there has been a switch in the type of internal combustion engines in cars from primarily petrol to primarily diesel cars in newer vehicles. Emissions would be broadly similar. However, there are some differences and in particular there is a higher level of particulate emissions from diesel cars. Nitrogen oxides and hydrocarbons can oxidise oxygen in the air to ozone if exposed to high levels of sunlight. While this is problematic in some countries, it is less likely to be an issue in the Sligo area for reasons outlined further given the excellent baseline air quality.

The following components of air emissions of motor vehicles were considered for the health assessment:

- Carbon monoxide;
- Other products of combustion;
- Fine particulates

Carbon Monoxide

Carbon monoxide is formed by incomplete combustion of fuels such as petrol and diesel. It can be absorbed into the blood stream and reduce the oxygen carrying capacity of blood. It is present in all forms of combustion and for example is a particular issue with regard to cigarette smoking and air levels of carbon monoxide is one way of monitoring people's smoking habits. High levels are associated with increased hospital admissions, cardiovascular disease and mortality after high exposure.

Products of combustion

Nitrogen Dioxide, and oxides of Nitrogen in general, directly affects the lungs. It is also gas produced during fuel combustion and impairs the lungs immune defence mechanism. When contacted with water which would line the lungs, it forms an acid to essentially burn the airways. There can be an increased severity of asthmatic attacks, etc.

Fine particles

Fine particles include PM_{10}, i.e. particulate matter less than 10 micrograms in diameter but also in more recent time, more emphasis has been made on small particles, again including $PM_{2.5}$, i.e. less than 2.5 microns, PM_1 and even nanoparticles which are smaller particles again. These have been known to exacerbate respiratory conditions such as bronchitis and pneumonia and there is increased mortality with higher levels.

Particulate emissions have received attention in recent years given increasing evidence of their health effects. Indeed, there have been calls to ban diesel vehicles in larger cities because of potential adverse effects. However, when assessing the human health impacts of the *Proposed Road Development*, one must consider the Do-Nothing scenario would lead to those vehicles continuing along the old route with diesel emissions continuing or increasing with traffic increases with those living along the route being exposed. Overall therefore the *Proposed Road Development* may have potential benefits regarding particles than the Do-Nothing scenario.

Appropriate Standards

The starting point in selecting the appropriate standard to apply is EU directives which had been set down. In Ireland, these are monitored by the EPA. The current applicable directive is the Clean Air for Europe (CAFÉ) Directive.

The following tables show the limit or target values specified by the five published directives that set down limits for specific air pollutants. The directives cover:

- Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM_{10} and $PM_{2.5}$) and lead;
- Carbon monoxide and benzene;
- Ozone;
- Arsenic, Cadmium, Nickel and Benzo(a)pyrene

Table 6-6: Limit values of CAFÉ Directive 2008/50/EC

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m3	Limit Value ppb	Basis of Application of the Limit Value	Limit Value Attainment Date
SO2	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1 Jan 2005
SO2	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1 Jan 2005
NO2	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1 Jan 2010
NO2	Protection of human health	calendar year	40	21	Annual mean	1 Jan 2010
PM10	Protection of human health	24 hours	50		Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM10	Protection of human health	calendar year	40		Annual mean	1 Jan 2005
PM2.5 - Stage 1	Protection of human health	calendar year	25		Annual mean	1 Jan 2015
PM2.5 - Stage 2	Protection of human health	calendar year	20		Annual mean	1 Jan 2020
Lead	Protection of human health	calendar year	0.5		Annual mean	1 Jan 2005
Carbon Monoxide	Protection of human health	8 hours	10,000	8620	Not to be exceeded	1 Jan 2005
Benzene	Protection of human health	calendar year	5	1.5	Annual mean	1 Jan 2010

As discussed previously, air quality standards are set to protect the vulnerable such as those with respiratory illnesses, the old and infirm. Slightly higher levels of oxides of nitrogen above the standards may have no effect on the vast majority of the population but may be significant for the vulnerable. Hence the human health impact assessment has relied on compliance with the Air Quality Standards to determine whether significant impacts will arise on human health or not. The standards used include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directive 2008/50/EC* which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO. The C*ouncil Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. These are clearly appropriate and robust standards. The table above shows that the levels set primarily for the protection of human health. Therefore, provided these levels are not exceeded one can be confident that there will be no adverse effect on human health due to air emissions.

Potential Health Impacts from Air

In 2010, the Health Effect Institute (HEI) Panel in the US, in a study partially funded by the US EPA on the Effects of Traffic-Related Air Pollution, concluded that exposure to air pollutants specifically from roads is likely to be associated with all-cause mortality[66], cardiovascular disease incidence and mortality, and reduced lung function, albeit with weaker evidence (due to fewer and smaller studies) than the wider air pollution health evidence base.

The WHO published a review in 2005 of the health effects of transport-related air pollution which concluded that health effects include increased cardiopulmonary mortality risk and respiratory morbidity risk.

Since 2013, the International Agency for Research on Cancer (IARC) defines diesel engine exhaust as carcinogenic to humans. Petrol engine exhaust is classified by IARC as possibly carcinogenic, as there is inadequate evidence to form a firmer conclusion

A relatively recent article by Chen et Al published in the Lancet in early 2017 showed a small (7%) increase in the incidence of dementia in those living less than 50 meters from major roads but no increase in the incidence of Multiple Sclerosis or Parkinsons disease. The authors postulated that increased levels of $PM_{2.5}$ and NO_2 may be associated factors. Notably - this is not a major road project and AADT values are quite low.

However, there were important limitations on the study as the study was based in Ontaria, Canada where major roads would include some of the busiest highways and trunk roads in the world. Perhaps the most significant criticism of the study was that the authors could not control adequately for socio-economic effects. Socio-economic effects are related to the incidence of dementia. If the individuals living within 50 metres of major roads in Ontario were of lower socio-economic status than those living further away this might explain the relatively small effect. Overall while further studies are recommended one can draw relatively little from this one study.

While there are some difficulties making comparisons between the impact of road building in say China, far more relevant information can be gleaned with similar projects within Ireland while being conscious of international published data. This is due to the fact that the baseline environment in densely populated counties such as China, which currently includes polluted air quality in its baseline, is not comparable to that of Ireland and in particular Sligo.

The 2014 publication from the OECD The Cost of Air Pollution, The Health Impacts of Road Transports points out that while the health impacts of air pollution in western countries is decreasing, that it is increasing in countries like China and India. It is more important for us in Ireland to consider the data from this country and similar countries.

While it is now 13 years old, an important document in Ireland was the Health Impacts of Transport, a Review published in March, 2005 by the Institute of Public Health in Ireland. This remains the most recent publication from this body on this subject.

The document reviews the elements of health impacts of transport. It originated as part of the transport HIA in Ballyfermot organised by the Eastern Regional Health Authority and proceeds from the Institute's strategic objective to strengthen the capacity of those working for public health.

In the Executive Summary they stated:

"the effect of air quality on human health has been extensively researched and expert opinion is available in this area. Currently, evidence is strongest for air pollution as a cause for short-term health problems in certain groups such as the elderly and those with underlying health problems such as heart or lung disease. Longer term health impacts are suspected to result from certain components of air pollution. However, it has been difficult to ascribe a cause and effect with certainly. Traffic is a leading source of air pollution and any issues which would reduce traffic volume can have potential benefits to health by improving air quality. Vehicle

[66] This is mortality from all causes e.g. cancer, heart, lung etc.

speeds is also a factor warranting consideration. Low average speeds such as those on congested routes are less efficient in the use of fuel and result in greater pollution emissions."

It can be concluded that the principal of moving traffic to a road with higher average speeds has actually a potential benefit on health.

Water

Accessibility to high quality clean water is obviously very important contributor to human health. In Ireland these are regulated by the European Union (drinking water) Regulations 2014. These regulations impose duties on Irish Water and local authorities in relation to the sampling and recording of water quality. There are strict standards in relation to the quality of water in relation to its chemical content as well as microbiological aspects. Provided the standards are observed one can be confident that there will be no adverse effect on human health due to effects on water quality.

Flooding also has potential for human health effects. Apart from the economic impacts of flooding, particularly of repeated flooding in certain areas, individuals who have their homes and residences flooded can be subject to very significant psychological impacts. Financial loss can occur particularly in areas which previously experienced flooding and were no longer insured. This loss can relate to the actual damage to the properties caused by the flooding will also to potential loss in value of the property. These can be associated with increased levels of anxiety and even depression. Flooding can also potentially be to spread of disease. This made the spread by vermin or alternatively flooding the sewers and septic tanks. When considering the potential health effects of the *Proposed Road Development* in relation to flooding, it is important to consider if the risk of flooding is increased or decreased or indeed unaffected by the *Proposed Road Development*.

Soils

Contamination of Land

If a project has the capacity to contaminate land this is also the potential for human health effects. This contamination could for example arise if previously buried contaminated material is unearthed during the construction process. Examples of this might include an unidentified landfill, previous industrial contamination or indeed naturally occurring sources of contamination. Contaminated land could in turn affect health either by direct contact, either people living and working on the land itself or for example children playing on the land. Some contaminants may be concentrated in food grown in the land and this is another manner in which contaminated land could have a health effect.

Radon

Radon is a naturally occurring radioactive gas that originates from the decay of uranium in rocks and soils. It is colourless, odourless and tasteless and can only be measured using special equipment. When radon surfaces in the open air, it is quickly diluted to harmless concentrations, but when it enters an enclosed space, such as a house or other building, it can sometimes accumulate to unacceptably high concentrations. Radon decays to form tiny radioactive particles, some of which remain suspended in the air. When inhaled into the lungs these particles give a radiation dose that may damage cells in the lung and eventually lead to lung cancer.

It is only when radon has potential to build up in buildings that are inhabited by human beings that the health risk occurs. Indeed, these buildings due to heating or otherwise can in certain areas draw in radon from the ground as warm air rises within the buildings. If radon is found at high levels in buildings one of the most effective remedies is to create a sump which creates its own negative pressure and draws the radon away from entering the building. More information on this can be found on the EPA website[67].

[67] http://www.epa.ie/radon/getinformed/

Psychological

In the planning process, potential adverse effects on psychological health are often mentioned, for example, anxiety and stress experienced by those whose homes are to be unfortunately compulsory acquired or those whom will experience a change in the environment in which they live.

The community will also experience annoyance from the temporary impacts of traffic management and other effects during the construction phase. As against this there is the potential reduction in annoyance amongst road users in the operational phase where there are reduced journey times. Annoyance however, is not in itself ill health.

For virtually every proposal for any road development there are concerns about potential adverse effects on a person's overall psychological well-being. This is a somewhat more difficult matter to assess as there are no direct measurements one can use. While one can give great detail in predicting for example noise emissions, one cannot use the same scientific certainty in predicting psychological impacts. It is not possible to use a standards-based approach for example.

There are various degrees of psychological impact and these can be both positive and negative. There can be a positive impact, whereby people may look forward to better transport. There can also be adverse effects of varying degrees. At the lower end of this impact might be annoyance where somebody is annoyed by for example, outside noise, dust depositing or temporary traffic delays associated with construction of the roads. This is not a medical impact as such. If someone develops a psychological illness such as anxiety or depression this would be a medical impact.

Construction by its very nature is transient but it is expected that construction activities will cause some annoyance such as from road diversions and temporary road closures. The potential effects are minimised by use of appropriate traffic management as outlined in 4.10.6 of the EIAR. There has been a considerable amount of road construction in Ireland over the last few decades. However, there is no documented evidence from these projects to link adverse outcomes with psychological health in Ireland.

Health improvements

The *Proposed Road Development* has the potential to provide opportunities for health improvements.

Employment and income are among the most significant determinants of long-term health, influencing a range of factors including the quality of housing, education, diet, lifestyle, coping skills, access to services and social networks. Many epidemiological studies consistently show better health outcomes are associated with higher socio-economic status.

Consequently, poor economic circumstances can influence health throughout life, where communities subject to socio-economic deprivation are more likely to suffer from morbidity, injury, mental anxiety, depression and tend to suffer from higher rates of premature death than those less deprived. One of the most reliable methods to improve health within a community is to raise its socio-economic status.

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstance, could contribute to improving the health and wellbeing of socio-economically deprived communities.

In social health terms, economic development also brings the opportunity for reducing inequities in society. Long-term unemployment for example is detrimental to the individual, family and society. It has potential to transfer across generations so that families where the head of household is long term unemployed are themselves far more likely to become or stay unemployed. This has potential to create and sustain social inequities.

Improvement of Access to Services

Studies show that recreational activities can have a positive impact on a person's wellbeing and their health.

One of the advantages of improved road infrastructure is that it allows traffic to travel more safely at increased average speeds and with fewer delays. Whilst this is obviously of benefit to all road users it is particularly of benefit for emergency services where time can make the difference between life-and-death. A much-quoted article by Lyon et al from 2004 showed a much improved survival rate from out-of-hospital cardiac arrests was strongly influenced by reduced response times for emergency services. The ability for emergency services such as ambulances to rapidly access emergency situations therefore has the ability to save lives.

Improving access to cinemas, parks, retail and other recreational activities will therefore make it easier for people to undertake recreational activities. Improved access to medical services will also have added benefits to a person's health as will access to education facilities as outlined above in the Health Improvement section.

6.2.4.2.2 *Assessment of Human Health Effects*

There is a difficulty in assigning levels of significance to human health impacts. In medicine, as in all science, the concept of statistical significance is used. This involves attaching a value to significance, often expressed as a percentage level of confidence in the data. Confidence measures of 95% or even 99% are often used to measure levels of certainty or changes that are not due to chance alone.

This is a valid approach for the study of the impacts on a *population*, but does not absolutely exclude a response on an *individual*. However, it is difficult to assign levels of significance to individual human health impacts without detailed information about that individual. Thus, the significance of health effects are assessed on a group or community basis rather than on an individual basis. There is such a variability in human response that one could never identify all possible individual effects and so, in accordance with the guidance referred to above, it is considered to be more appropriate to assess the significance of health effects at a population level.

Table 6-7: Criteria Used in the Assessment of Community Human Health Protection Impacts

Impact Level	Significance Criteria
Imperceptible	No significant human health impacts are apparent
Slight	A small impact on individual reported symptoms but no change in health status can be attributed to the *Proposed Road Development*
Moderate	A moderate impact on health status of an individual but no change in morbidity or mortality can be attributed to the *Proposed Road Development*
Significant	The *Proposed Road Development* has the potential to impact on individual health status with an associated change in morbidity
Very Significant	The *Proposed Road Development* has the potential to impact on the health status of groups of people
Profound	The *Proposed Road Development* has the potential to impact on the health status of communities

Asthma can be used as an example when using these criteria:

- An Imperceptible impact would be one with no measurable effect on asthma;
- A Slight impact might be a temporary increase in symptoms in an individual but no change in the severity of the underlying condition or treatment required;
- A Moderate impact might be an individual increasing their use of inhalers attributable to the *Proposed Road Development* but no change in underlying condition and no effect on the vast majority of asthmatics;
- A Significant effect might be an individual becoming asthmatic or an individual's asthma becoming measurably more severe as a result of the *Proposed Road Development*;
- A Very significant effect might be a group of individuals becoming asthmatic or their asthma becoming measurably more severe as a result of the *Proposed Road Development*;

- A Profound effect might be a measurable increase in the incidence or severity of asthma in a community as a result of the *Proposed Road Development*

6.3 Description of the Existing Environment and Constraints

6.3.1 Context

The *Proposed Road Development* falls within the Electoral Division (EDs) of Glencar and Drumcliff East in County Sligo. Glencar ED has a total population of 236 and Drumcliff East a population of 724. These two EDs represent the study area as they crossed by the *Proposed Road Development*, although there are a further 12 EDs on or beside the N16 to the north as far as the Northern Ireland border and 2 Eds to the south before the city of Sligo. The *Proposed Road Development* crosses into the townland of *Lugatober* from *Castlegal* and *Drumkilsellagh* to the south.

At a county level, Table 6-8 shows a small increase in the population of County Sligo between 2011 and 2016, but a decrease of 0.1% in the city area itself. The small town of Manorhamilton in north County Leitrim experienced a significant increase in population in both the previous inter-Censal periods.

Table 6-8: : County Sligo and urban population change

Year and % change	County Sligo	Sligo (settlement)	Manorhamilton	Blacklion	Enniskillen
2016	65535	19199	1466	194	n/a
2011	65393	19452	1336	229	13823
2006	60894	19402	1158	174	13592
% change 2011-2016	0.2%	-0.1%	9.7%	-15.3%	-
% change 2006-2011	7.4%	0.3%	15.4%	3.2%	1.7%

Of the EDs, Table 6-9 shows an increase in the population of Glencar ED of 9.8% to 236 following a small decease in the previous inter-Censal period of 2006 to 2011. By comparison, there has been a small decline of -1.6% in the population of Drumcliff East to 724, albeit following a significant increase its population between 2006 and 2011, and a more significant decline in the population of the ED of Calry to the south on the N16. Population density in Glencar is light at 16.9 persons per km^2 compared with 45.9 for the Sligo Rural Area overall or approximately 35.6 once the main settlements are excluded. Drumcliff East includes sections of the N15 Sligo to Donegal primary road and numerous settlement clusters between the N16 and N15. Its population density is higher at 51.8 persons per km^2. EDs to the east along the N16 fall into County Leitrim. With the exception of Manorhamilton, populations are small and have had mixed fortunes in recent years with modest increases in the ED of Glenade and corresponding falls in the EDs of Glenfarn, Kiltyclogher and Munakill.

Table 6-9: Local Population – Electoral Divisions

Year and % change	2016	2011	2006	% change 2011-16	% change 2006-11
Glencar (Co Sligo)	236	215	222	9.8%	-3.2%
Co Sligo to south					
Drumcliff East	724	736	417	-1.6%	76.5%
Calry	1702	1806	1808	-5.8%	-0.1%

Year and % change	2016	2011	2006	% change 2011-16	% change 2006-11
Co. Leitrim					
Glencar (Co Leitrim)	256	250	248	2.4%	0.8%
Glenade	172	154	248	11.7%	-37.9%
Sramore	390	370	307	5.4%	20.5%
Lurganboy	415	388	385	7.0%	0.8%
Manorhamilton	1892	1782	1655	6.2%	7.7%
Kiltyclogher	207	233	254	-11.2%	-8.3%
Glenaboy	239	238	244	0.4%	-2.5%
Glenfarn	132	147	131	-10.2%	12.2%
Munakill	169	196	213	-13.8%	-8.0%
Coonclare	178	189	193	-5.8%	-2.1%
Co. Cavan					
Eskey	319	342	283	-6.7%	20.8%
Tuam (includes Blacklion)	331	388	349	-14.7%	11.2%

There is no core settlement in the EDs of Glencar and Drumcliff East with most properties being individual houses or farms located along the L-3404 between the N16 and Glencar Lough, on the local road between Drumcliff and Glencar Lough, or in small clusters on cul-de-sac roads off the N16.

Table 6-10: shows age distribution for the two EDs which show a relatively high proportion of young people. In Drumcliff ED, there is a slightly lower relative age-related dependency relative to the county as a whole given the low proportion of the population over 65 years, but this latter category form a higher proportion of the population in Drumcliff East.

Table 6-10: Age distribution

ED	0-16	17-24	25-34	35-44	45-54	55-64	65+
Glencar	62	27	18	29	39	37	24
% Glencar	26.3%	11.4%	7.6%	12.3%	16.5%	15.7%	10.2%
Drumcliff E	130	53	62	83	91	111	195
% Druncliff E	18.0%	7.3%	8.6%	11.5%	12.6%	15.3%	26.8%
% Co Sligo	*22.9%*	*9.6%*	*11.4%*	*14.1%*	*13.3%*	*12.4%*	*16.2%*

Table 6-11 shows that the number of households has increased slightly in both EDs, despite the small population fall in the Drumcliff East. Table 6-12 reveals a relatively low proportion of two person households and a relatively high proportion of households with children (all ages) in Glencar ED. This could be regarded as being a positive situation for a rural area and indicates a lower risk of single-person household isolation than would apply to some nearby areas such as north Leitrim. The situation in Drumcliff East ED is closer to the average for County Sligo (including the city of Sligo). In both EDs there is a lower proportion of one person households than for the county as a whole.

Table 6-11: Private households

ED	2016	2011
Glencar	83	76
Drumcliff East	285	278

Table 6-12: Household composition

ED	One person	Couple	Couple with children	Couple with children &/or others	Parent with children	Parent with children & others	Two or more family units	Non-family households
Glencar	19	19	34	1	9	0	1	0
% Glencar	22.9%	9.6%	41.0%	1.2%	10.8%	0%	1.2%	0%
Drumcliff E	64	67	97	4	24	0	4	5
% Drumcliff	22.5%	23.5%	34.0%	0.2%	8.4%	0%	1.4%	1.8%
% Co Sligo	*29.8%*	*21.5%*	*34.2%*	*1.9%*	*11.1%*	*0.9%*	*0.5%*	*0.1%*

Of these households, Table 6-13 reveals that a high proportion of properties in Glencar ED were built in the 1980s compared with the existing housing stock, while the 1970s witnessed the greatest household growth in Drumcliff East ED. Since this time there a steady supply of new properties has continued to be built with a relative reduction in recent years, due in part to the national economic recession. Table 6-14 shows that most of these properties are owner occupied (with or without mortgage), although a modest proportion are also privately rented. Most of these properties were occupied on Census night as shown in Table 6-15 with only a handful being recorded as holiday homes, but with a rather large proportion in Drumcliff East being vacant properties. Table 6-16 shows that only six properties in Glencar, typically those along the roads, are connected to a public mains water supply, but most source their water from private wells with others being connected to public or private group water schemes.

Table 6-13: Households year built

ED	Pre 1971	1971-80	1981-90	1991-2000	2001-2010	2011 or later	Not stated
Glencar	19	12	23	10	10	2	6
Drumcliff E	73	65	55	39	35	11	7

Table 6-14: Type of occupancy

ED	Owner-occupied	Private rental	Rented from local authority	Occupied free of rent	Not stated
Glencar	61	11	2	2	6
Drumcliff E	258	19	2	4	2

Table 6-15: Occupancy on Census night

ED	Occupied	Temporary absent	Holiday home	Other vacant	Not stated
Glencar	82	6	2	5	0
Drumcliff E	286	9	3	24	0

Table 6-16: Household water supply

ED	Public main	Public group scheme	Private group scheme	Private source	None	Not stated
Glencar	6	7	11	50	1	7
Drumcliff E	37	89	90	59	1	9

Table 6-17 shows that most residents are in work, but that there is also a high proportion of students in Glencar ED, most probably young people in school or college in Sligo or elsewhere. There is also a rather high proportion of retired people in Drumcliff East ED. Of people in employment in the Glencar ED, 11 work in agriculture, 21 in commerce and trade, and 29 professional services, whereas the respective proportions in Drumcliff East are 19, 52 and 103. The proportion of people who are unemployed or looking for their first job is relatively low compared with figures for County Sligo as a whole.

Table 6-17: Individual economic status

ED	At work	Not employed	student	Home maker	retired	Unable to work
Glencar	93	4	37	12	33	2
% Glencar	51.4%	2.2%	20.4%	6.6%	18.2%	1.1%
Drumcliff E	288	26	66	43	17	12
% Drumcliff E	47.0%	4.2%	10.8%	7.0%	28.9%	2.0%
% Co. Sligo	*50.0%*	*8.2%*	*12.2%*	*6.9%*	*17.8%*	*4.9%*

Table 6-18 shows that, when compared with the county as a whole, the Glencar ED and Drumcliff EDs both contain relatively high proportions of people aligning with the professional, managerial or technical social classes as defined by the CSO, relative to non-manual or manual occupations.

The EDs are not characterised by higher levels of social disadvantage. The Pobal HP Deprivation Index is calculated to show trends over time and comparisons within an individual Census related to the dimensions of demographic profile, social class composition and the labour market situation[68]. On this index, Glencar scored 7.7 in 2016. Although this is a decline on the baseline score of 9.8 in 2006, it indicates a slight recovery from 7.6 in 2011 and compares with a 2006-2016 decline from 2.3 to -2.2 for the Sligo Rural Area and from 0 to -4.2 nationally. In relative terms, based on the 2016 Census data only, Glencar is the least deprived ED in the Sligo Rural Area with a score of 11.7 compared with 1.6.

The respective figures for Drumcliff East ED show slightly higher social disadvantage at 1.9, again a decline on the baseline score of 2.4, but also with a partial recovery since 2011. In relative terms, Drumcliff East has a score of 5.2.

In terms of health, 19 (8.1%) people in Glencar ED report having some form of disability, but everybody[69] perceives themselves to be in "fair" or better health. In Drumcliff ED, the relative figure for disability is 95 (13.1%) and four persons report their health to be "bad".

[68] Haase and Pratschke (2017). Index based on data including population change, age dependency, education, household rooms, socio-economic status, single parents and unemployment.

[69] Although 8 persons did not state their perception of personal health.

Table 6-18: Social Class

ED	professional	Managerial or technical	Non-manual	Skilled or Semi-skilled Manual	Unskilled	Others gainfully occupied
Glencar	31	97	40	44	2	22
% Glencar	13.1%	41.1%	16.9%	18.6%	0.1%	9.3%
Drumcliff E	103	280	106	162	14	59
% Drumcliff E	14.2%	38.7%	14.6%	22.4%	1.9%	8.2%
% Co. Sligo	7.9%	26.7%	18.1%	25.1%	3.1%	19.0%

Given the rural nature of the study area, most people travel to work, school or college by private vehicle (either as driver or passenger when compared with figures for the county as a whole (Table 6-19). A high proportion also travel by public transport (mainly bus). This figure likely includes school or college students. Table 6-20: shows that most people in Glencar ED have a journey of under half an hour, while in Drumcliff East, which is closer to the city of Sligo, most people have a journey of 15 minutes or less. Some of the longer journeys could be by students using school buses. A high proportion of households have two cars, for which rurality, employment and social class are likely to be relevant factors. A high proportion also have one car with only three people having no access to a car.

Table 6-19: Means of travel to work, school, or college

ED	Foot	Bicycle	Public transport	Vehicle	Work mainly at home	Not stated
Glencar	5	2	33	119	4	4
% Glencar	3.0%	1.2%	19.8%	71.3%	2.4%	2.4%
Drumcliff E	19	3	24	352	13	15
% Drumcliff E	4.5%	0.7%	5.6%	82.6%	3.1%	3.5%
Co Sligo	*12.1%*	*1.2%*	*8.0%*	*70.9%*	*3.6%*	*4.2%*

Table 6-20:: Journey time to work, school or college

ED	Under 15 mins	¼ hour – ½ hour	½ - ¾ hour	¾ hour – 1 hour	> 1 hour	Not stated
Glencar	55	63	22	1	9	14
% Glencar	38.2%	43.8%	15.3%	0.7%	6.3%	9.7%
Drumcliff E	239	109	24	8	12	21
% Drumcliff E	57.9%	26.4%	5.8%	1.9%	2.9%	5.1%
Co Sligo	*41.1%*	*31.4%*	*13.0%*	*3.1%*	*4.0%*	*7.4%*

Table 6-21: Car ownership

ED	No car	One car	Two cars	Three cars	Four or more cars	Not stated
Glencar	3	25	39	8	2	5
% Glencar	3.7%	30.5%	47.6%	9.8%	2.4%	6.1%
Drumcliff E	16	92	140	20	9	8

ED	No car	One car	Two cars	Three cars	Four or more cars	Not stated
% Drumcliff E	5.6%	32.3%	49.1%	7.0%	3.2%	2.8%
% Co Sligo	*14.7%*	*41.6%*	*34.8%*	*5.1%*	*1.4%*	*2.4%*

6.3.2 Character and significance

The N16 provides an important connection between Sligo, Leitrim and Northern Ireland (Enniskillen) and currently carries circa 3,500 AADT per year. At present, it is characterised by numerous bends and poor sightlines, making for very limited overtaking opportunities. There is a mix of regional traffic, including lorries (6%) and a regional Bus Éireann service, but also local traffic that includes commuters and slower-moving farm vehicles. There is also school traffic and school buses that must cross the N16 at *Doonally* Bridge on route to Calry National School (St Patrick's) which is located 5km to the south-east.

Junctions have been the location of two vehicle accidents in the past, some of which have been of a serious nature. Safety is compromised by traffic speed and limited sightlines for vehicles turning right from the N16 onto the L-3406-0 (southbound), the L-7415-0 (northbound), the L-7413-0 (southbound) and the L-3404-0 (southbound) as well as at residential, farm and field entrances at 5 locations. Southbound vehicles from the direction of Manorhamilton can access the area of Glencar Lough using another road to the east, but vehicles exiting the L-3404 on to the N16 are faced with very limited sightlines to the right. Traffic volumes, together with vehicle speeds up to and often exceeding the 100km limit, also prevent casual vehicle stops along the road and greatly limit its use for cycling. As only small numbers of properties are located on the N16 itself, there is little reason for walking along the road, but any walking is extremely hazardous given the current traffic conditions.

6.3.3 Sensitivity

The landscape along the N16 is of value for tourism and amenity. The road climbs along the western slopes of Cope's Mountain and provides views across to the coast, King's Mountain and Glencar Lough. Glencar Lough is an important tourist destination that includes access to waterfalls and the King's Mountain plateau. The area is well visited by local people and tourists, both domestic and international, for casual visits, cycling and walking, and pictures of the area regularly feature in promotional literature for County Sligo. Walkers and hill-walkers ascend the scenic escarpment behind (north) Glencar Lough with small numbers also ascending the massif of Copes Mountain. A lay-by on the N16 at Gortnagrelly provides views across to Glencar and King's Mountain. Consequently, the landscape, and the minimisation of visual impacts is an important consideration in the route selection process.

Seven occupied properties, and one unoccupied property, are located alongside the existing N16 in the study area with a few others located within a 100-200 metres. Of the aforementioned minor roads joining the N16, each are also lined by moderate numbers of single properties or clusters of private houses, especially the L-3406 Drum Road, the L-7415-0 and the L-3404-0. These roads would therefore be the source of commuting or local journeys, including by a proportion of more elderly residents (noting the figures given in Section 6.3.1). Although the N16 is used for cycling, including by a few local residents, the road and traffic conditions do present a road safety hazard and cyclist numbers are fewer than could be expected given the connectivity provided by the road relative to minor roads. As only small numbers of properties are located on the N16 itself, it can be expected that there would not be much walking along the road for purposes of community interaction or for amenity, but any walking is extremely hazardous given the absence of a roadside footpath, the discontinuous grass verge and the current traffic conditions.

There are no community facilities in the study area itself. Calry National School is located 5km from the study area. Sligo Tennis Club in located nearby in the vicinity of Shannon Oughter near the N15. There is also an Alzheimer's daycare facility at *Doonally*. As well as private dairy, cattle and sheep farms, a couple of non-farm businesses are located within the study area, namely a guest house and a shot blasting business. On the

N16 between *Lugatober* and the city boundary for Sligo, there is also a haulage business and the Regional Veterinary Laboratory at *Doonally*. The AbbVie international pharmaceutical company occupies a large site accessible from a roundabout junction with the N16.

Large scale residential development commences at Rathbraghan and The Gateway area on the edge of the City of Sligo. This area also includes the Clarion Hotel and Sligo Institute of Technology and student residences, Bellanode Community College, Sligo College of Further Education, and HSE Mental Health Inpatient Facilities, Resource and Training Centres. Closer towards the N15, the suburb of Ballytivnan includes St. Edwards National School, St. Joseph's Special School, St. Joseph's Parish Church and the Mowlam Nursing Home. Sligo University Hospital and Sligo Grammar School are located south of the N16 Ash Lane, the former with an entrance off this road. A Traveller halting site is also located here.

6.4 Assessment of effects

6.4.1 Assessment of the Do-Nothing and Do-Minimum Impact

6.4.1.1 Population

In the event that the *Proposed Road Development* is not built, traffic volumes can be expected to increase in line with existing trends by 2.5% by 2020, 16% by 2036 and 23% by 2051. At present, the N16 is characterised by severe bends and a poor alignment with very limited overtaking opportunities. This means that the road safety hazard will increase along with the increase in traffic volumes under a Do-Nothing scenario. A Do-Minimum scenario might involve some local improvements in road alignment, but would have only a slight overall effect on reducing this road safety hazard. Journey times and journey amenity will continue to deteriorate. The continued poor quality of the road would contrast with, and reduce the positive cumulative effect, of recent improvements to sections of the N16 in County Leitrim. This would mean that the national route would fail to provide the quality of connectivity between the North-West and Northern Ireland that is needed to secure North-South interaction and economic growth.

6.4.1.2 Human Health

Traffic demands in Sligo and its environs will continue to grow whether the *Proposed Road Development* proceeds or not. The number of people living in Sligo and its environs has increased and is predicted to continue do so.

Negative impacts (dust, noise, nuisance, etc.) currently experienced by people from traffic congestion on existing routes will continue and potentially increase as traffic increases.

6.4.2 Construction Impacts

6.4.2.1 Population

The *Proposed Road Development* will cross an entirely rural area. It will relocate the N16 away from five occupied properties, although the new alignment will pass within 200 metres of at least five other properties with works also affecting additional properties along local roads intercepted by the *Proposed Road Development*. Altogether, the development will involve the permanent acquisition of approximately 0.43ha from 15 non-agricultural properties (see Chapter 15: Material Assets – Non-Agricultural). Construction is expected to take 18 months.

The *Proposed Road Development* will include the construction of a roundabout junction with the L-3406-0 Drum Road. This is located close to a small cluster of private houses on the Drum Road and within 100 metres of the first of these properties and a farm off the N16. There is likely to be a temporary *slight-moderate negative* effect on these two properties while the roundabout and road are under construction due mainly to noise and visual intrusion (see Chapter 7: Noise and Chapter 12: Landscape and Visual).

The *Proposed Road Development* passes close to *Castlegal* House, a property of heritage interest (see Chapter 13: Archaeology, Architecture and Cultural Heritage). Although understood to have been recently purchased, the property is currently unoccupied. This property, and two others to the north-west on the far side of the *Proposed Road Development* where it enters a cutting, are those which are identified in Chapter 7: Noise as being those most likely to experience effects of residential amenity due to higher noise levels from rock breaking and HGV movement. One of these properties operates as the guest house. An effect on residential amenity will be realised by a property at the start of the L-7413-0 which is located within 50 metres of the works at a point where the road moves from an embankment to a cutting. A steepened side slope will be constructed between the road and the house and is specifically addressed in Chapter 4: Description of the *Proposed Road Development*. Construction works here will also similarly affect noise levels (see Chapter 7: Noise) and also visual amenity (see Chapter 12: Landscape and Visual). Works will also require the temporary diversion of the minor road for a period of approximately three weeks. As members of the same family live on the same minor road on each side of the works, an underpass will be provided for vulnerable road users (via temporary provision) to mitigate the severance effect.

Works in the vicinity of the L7413-0 would involve a diversion for a period of around 3 weeks of 4km for the worst affected properties to the L3406-0 Drum Road to the south and up to 4.8km to the north to the L3404 Glencar Road. In addition, the L3404-0 will also require a temporary diversion for around 4 weeks of around 8km for the worst affected properties to reach the L3406-0 or destinations in the direction of Manorhamilton. These diversions are of significant length, but would affect a small number of journeys for short periods of time. By comparison, traffic on the national primary route will be required to divert to the regional road network for a period of around 2 weeks while earthworks are undertaken between Ch. 2,000 and 2,300. The likely diversion routes for this period, will be via the R286/R288/R287 for northbound traffic and via the R286/R287 for southbound traffic ; these routes can be supported if required via alternative diversions on the R287 between Dromahair and Carraroe if required. This will place additional traffic on these roads which are rather narrow in places, although the standard volume of N16 traffic will be split between them and with other regional roads. There will result in some additional traffic through Dromahair, and on the R278/R286, sections of which would not be suitable for prolonged use by increased volumes of traffic or HGVs. However, total additional volumes are likely to be modest and the diversions expected to last no more than 2 weeks.

Road construction traffic is expected to use the new alignment where possible, but crossings of the existing road by construction vehicles will be needed in *Lugatober*. This will require flag men or signalling and is expected to have a *slight negative* effect of journey time. HGVs carrying aggregates and other materials will also need to use the existing N16 to access the study area. The *Proposed Road Development* includes significant embankments and cuttings, but it is proposed that excavated materials will be reused where possible such that HGV traffic will have a *slight negative* effect on the residential amenity of properties beside the N16 and on the journey amenity of drivers and cyclists using the existing road. The latter effect arises from the difficulty of overtaking slow-moving vehicles and the narrowness of parts of the existing N16.

6.4.2.2 Human health

This section addresses health impacts under three main headings as per the methodology discussed above, that is, Health Protection, Health Improvements and Improving services. Health Protection covers the health effects of the *Proposed Road Development* arising from noise, vibration, air emissions, water and soil contamination and psychological issues. These are all discussed further below.

6.4.2.2.1 *Health Protection*

Noise

It is noted that despite the extents of the *Proposed Road Development* and the overall construction period, the potential noise impact on any individual receptor during construction will be limited as the activity in any one location will be limited in scale and time. Thus, the potential for human health effects will be similarly limited.

The potential noise impacts are assessed in Chapter 7, Noise and Vibration in accordance with the relevant NRA Guidelines. The results of the baseline noise monitoring and potential impacts which are described in full in Chapter 7 Noise and Vibration have been compared against the reliable noise guidelines to determine if any human health effect is likely.

As discussed previously, the potential health effects of noise can include

- Noise-Induced Hearing Impairment;
- Interference with Speech Communication;
- Disturbance at schools;
- Sleep Disturbance;
- Hypertension and Cardiovascular Disease

As noted above, any effects demonstrated are more likely at higher noise levels. Many effects are only demonstrated with ambient noise in excess of 70dB. The results of the noise assessment detailed in Chapter 7, Noise and Vibration indicate that there is no receptor which will receive this volume of noise for any sustained period therefore health effects of noise from the *Proposed Road Development* will not be significant. This is discussed further below.

The noise assessment detailed in Chapter 7, Noise and Vibration identified that during the construction phase of the *Proposed Road Development* there is potential for some temporary moderate to significant impacts on nearby residential and business properties due to noise emissions from certain construction activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that potential noise impacts are kept to a minimum. As detailed in Chapter 7, Noise and Vibration the contract documents will clearly specify the construction noise criteria which the construction works must operate within. The Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001 and the NRA *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* 2013. Therefore, significant noise impacts during construction will not arise and no adverse health effects are predicted during construction.

Vibration

The potential vibration impacts as a result of the *Proposed Road Development* both during construction and operation have been assessed in Chapter 7, Noise and Vibration. Overall the predicted impact from vibration is very low and characterised as not significant. While there may be some degree of local vibration transmitted during some aspects of construction, such as blasting or drilling, these will typically be of short duration and very localised and occur only during construction hours. Given the short duration it will not have any negative health impacts.

Air Quality

As discussed previously, provided the air quality standards are not exceeded one can be confident that there will be no adverse effect on human health due to air emissions. This is discussed further below.

It is important in these areas to consider the baseline environment. The EPA Air Quality Index shows that the air quality in both Sligo City and County is very good. There are multiple reasons for this. One is Sligo's geographical location on the edge of the Atlantic Ocean exposed to prevailing winds which predominantly blow air pollutions away from the centres population. There have also been very good controls with regard to potential sources of pollution in the Sligo area. This was further supported by the site specific air quality monitoring undertaken for the *Proposed Road Development*.

There is no history of heavy industry emitting high levels of pollutions for example. The major sources of industry currently operating in Sligo include pharmaceutical companies with very low emissions. It is against this background air quality that any emission would occur.

As detailed in Chapter 8, Air Quality and Climate, certain sensitive receptors have been identified in the study area for the *Proposed Road Development* and dusts that are likely to be generated during the construction phase are normally heavier and larger particles. As these are heavier, they tend to fall rapidly to the ground and have a very limited level outside the actual construction site. There are potential occupational health issues for the works which would require for example the use of respiratory protection equipment in certain phases. However, as also pointed out in Chapter 8, Air Quality and Climate, in the event of such large dust leaving the site, by nature of its' relatively large size, that is greater than 10 microns, it is not respirable and will not have significant human health effects.

It is also noted that despite the extents of the *Proposed Road Development*, the potential air quality impact on any individual receptor will be limited as the activity in any one location will be limited in scale and time. Thus, the potential for human health effect will be similarly limited.

Water

As is identified in Chapter 11, Hydrology & Hydrogeology no negative impact from either surface water, or groundwater is anticipated. In this regard human health effects will not occur.

Given that all residual water supplies will comply with water quality standards the potential impacts on human health are assessed as Imperceptible.

In addition, in the broader context, the flood risk assessment has demonstrated that there is no significant flooding impact arising from the *Proposed Road Development* and hence no potential impact on human health.

Water quality

As detailed in Chapter 11, Hydrology & Hydrogeology, there has been considerable attention given to ensuring that there will be no adverse effect on water quality. Where necessary mitigation measures are put in place to ensure continued supply of high quality and safe drinking water.

No adverse effect on water quality is predicted and therefore there will be no health effect.

Soils

Soil Contamination

As detailed in Chapter 10, Soils and Geology there are no known areas of contaminated lands crossed by the *Proposed Road Development*. While it is not anticipated that any of the construction or operational works would lead to soil contamination the contractor will be obliged to monitor the construction at all stages. In the event that any source of contamination is identified, in excavation or other means, this would have to be addressed at that time in consultation with statutory bodies such as the EPA. This will ensure that even in the unlikely event a source of contamination is discovered that appropriate mitigation measures will be put in place to ensure no adverse effect on human health.

Psychological

As set out in Chapter 15, Material Assets Non-Agriculture, the *Proposed Road Development* has been designed to avoid as many properties as possible. A number of alternatives have been considered as detailed in Chapter 3, Alternatives Considered, however the conclusion of the consideration of the alternatives is that the *Proposed Road Development* represents the optimum transport solution and has avoided the greatest number of known and immovable constraints and is the option that overall has the least environmental impact taking all other potential environmental impacts into account. The people living in affected residences have genuine concerns that their lives will be adversely affected. Many have lived in the area many years or indeed all of their lives.

The community will also experience annoyance from the temporary impacts of traffic management and other effects during the construction phase. As against this there is the potential reduction in annoyance amongst road users in the operational phase where there are reduced journey times.

Whilst individual annoyance cannot be discounted, annoyance in itself is not ill health. There is no evidence that there are any significant effects on human health from simply transient levels of annoyance. In these circumstances the negative impact is assessed at Slight. In addition, while there may be positive impacts of reduced annoyance for those not stuck in traffic there is little evidence of positive impacts on human health and the positive impact is assessed also as Slight.

6.4.3 **Operational Phase**

6.4.3.1 Population

The *Proposed Road Development* will involve improved alignment within the study area, providing a *slight positive* effect on journey times and journey amenity on the N16 section in County Sligo. These effects will together allow for improved accessibility to employment, retail, social and health services in Sligo. This improved accessibility applies also to emergency vehicles. The road development will also enhance safety on this section of the N16 as it will bypass the current lengthy 180 degree bend at *Lugatober* and improve junction sightlines between the new section of road and the L-3406, the L-7415-0, the L-7413-0 and the L-3404-0, particularly for right-turning vehicles. The *Proposed Road Development* will also improve the safety of farm and residential access from the L-34041-0 and from at least five other access points. Of these minor roads, the L-3406-0 currently carries the most traffic (740 AADT), followed by the L3404-0 (337 AADT). Lighting will be provided at the roundabout junction with the L-3406-0. This will support driver, cyclist and pedestrian safety and is specifically addressed in Chapter 4: Description of the *Proposed Road Development*. The absence of sharp bends relative to the existing alignment will also provide improved journey amenity by providing more opportunity to appreciate the scenic landscape. Consequently, the overall effect on journey amenity is qualified as a *significant positive* effect.

The inclusion of a two-way cycle lane in the *Proposed Road Development* will greatly improve journey amenity for local and leisure cyclists on the N16. A cycle lane connection is also provided to the L7415-0 via an uncontrolled crossing point of the realigned N16 with good sightlines, and to the severed section of the existing N16 at *Lugatober* via a combined cycle/VRU underpass at the L7413-0. The roundabout junction between the N16 and L-3406-0 includes an uncontrolled crossing point with the alignment of the road here providing for good visibility. The cycle lane will also be available for use by pedestrians, although numbers are likely to be very few. This *significant positive* effect only applies in the study area as a proportion of cyclists would still choose to re-join the N16, including sections to the south that continue be characterised by narrow width and poor sightlines. Leisure cyclists may choose to continue down to Glencar Lough in the north of the study area and could be encouraged to use the L-3406-0 Drum Road to connect with the North West Cycle Trail to the west which continues directly into the city of Sligo. Indeed, the proposed cycle lane has been designed to connect with the L-3406-0. Overall, the net effect on both journey amenity and health is expected to be *slight-moderate* positive.

The *Proposed Road Development* will have a moderate *psychological* or *neighbourhood severance* effect on a farm family living on the L-7413-0 at *Lugatober*, although this is eliminated at a physical level by the inclusion of a cycle and VRU underpass (see also Chapter 14: Material Assets: Agricultural and Chapter 15: Material Assets: Non-Agricultural). Properties here are also among those likely to experience the higher visual effects on residential amenity (see Chapter 12, Landscape and Visual). Some community severance will also be introduced by the closure of the existing N16 at the northern cut-off. Although the majority of journeys to the south will be unaffected, any journey to the north, including to Glencar Lough, will require up to an 800 metre detour, but for a very small number of householders.

The *Proposed Road Development* will have a *moderate negative* economic effect on the Glenview Guest House located on a severed section of the existing N16 parallel with Ch. 1,000 and a *slight negative* effect on a shot-blasting business just to the south. The effect on the former can be reduced through signage and other measures proposed as mitigation below. Continued use and maintenance of this section of the old road will be assured by cycle use connecting with the proposed cycle lane on the *Proposed Road Development*.

There is potential for further sensitive tourism development in the area, particularly at Glencar. This opportunity will benefit from the positive effect of the *Proposed Road Development* on journey amenity and the inclusion of the cycle lane.

6.4.3.2 Human health

6.4.3.2.1 *Health Protection*

Noise

The noise assessment for the operational phase of the *Proposed Road Development* indicates that noise mitigation measures are confined to the road surfacing material used and that all receptors in proximity to the *Proposed Road Development* comply with the requirements of the TII Noise Thresholds.

Many properties along the existing roads that currently experience high levels of traffic will experience a notable reduction in noise levels depending on the distance from the road, traffic volume changes and speed reductions.

Baseline noise levels are important to consider when assessing human health impacts. Human perceptions of volume are such that changes of less than 3dB are usually not perceived. If noise levels do not increase by at least 3 dB there will be no adverse outcome over than experienced prior to the change. In this regard a threshold of 3 dB is appropriate to identify a change in noise levels which can be reliably perceived by humans.

As mentioned above the WHO Environmental Noise Guidelines are for communities rather than individual residences and in addition it is important to remember that the levels are not thresholds. Nevertheless, individuals will always be concerned with the potential effects on them and therefore, it is useful to use these levels in attempting to attribute significance to changes in noise levels. The overall noise impact of the proposed road is positive. Far more residence will experience a significant reduction in noise levels than will experience an increase. This is very much in keeping with the WHO Guidance in terms of Noise reduction for populations which recommended:

to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure.

Site Specific Operational Noise Impacts

Overall the human health impact from a community or population perspective the impact of the proposed road is positive as traffic will be moved away from residences along the current route. Individual residences may experience increases but from a health impact the overall assessment is somewhat positive.

Vibration

The potential vibration impact during the operational phase as assessed in Chapter 7, Noise and Vibration is predicted as being not significant. Therefore, there will be no negative health impacts.

Using the criteria for the significance of human health impact detailed in section 6.2.4.2.2 above the potential impact caused by vibration is assessed as Imperceptible.

Air Quality

The potential air quality impacts are assessed in Chapter 8, Air Quality and Climate in accordance with the relevant TII Guidelines. The results of the baseline air quality monitoring and potential impacts which are described in full in Chapter 8, Air Quality and Climate have been compared against the reliable air quality standards both during the construction and operational phases to determine if any health effect is likely.

The *Proposed Road Development* is predicted to have a negligible impact on air quality, as defined in Chapter 8, Air Quality and Climate[70], across the study area during the construction phases and as such an imperceptible impact on human health. Whilst some areas of the study area will experience a slight negative impact on air quality during the operational phase all air quality levels will remain well within air quality standards and as such there will be an imperceptible impact on human health. Site specific impacts during operation are further detailed below.

Water

Water quality

No adverse effect on water quality is predicted and therefore there will be no health effect.

6.4.3.2.2 *Health Improvement*

As detailed above, the *Proposed Road Development* has the potential to bring with it, significant socio-economic benefits. It will facilitate transport of goods and people in a timely, reliable and efficient manner. The full economic benefit will be realised once the *Proposed Road Development* is completed.

The inclusion of a cycle lane in the *Proposed Road Development* will provide health benefits in that regular cycling is recognised as an activity that can make a significant contribution to physical and mental health and well-being. Regular exercise is a well-recognised means of reducing risk in terms of obesity, diabetes, hypertension, cardiovascular disease and osteoporosis amongst other conditions. There are also significant psychological benefits and studies have consistently shown self-reported well-being is significantly higher in those who frequently exercise. Increased opportunities for exercise (adjacent cycle tracks) also has the potential to bring benefits.

One of the problems associated with the route as set out in Chapter 2.4, The Need for the *Proposed Road Development* is safety. The *Proposed Road Development* is designed to optimal safety levels. It is well established that roads which are designed to safe standards are associated with reduced accident levels.

The *Proposed Road Development* would further improve access to health care through enhanced public and private transport connectivity, and may facilitate faster and safer emergency response through improved road capacity and resilience. The previously quoted study by Lyon reinforces this point with improved survival rate with out-of-hospital cardiac arrests with more rapid response times. This improvement is equally important in relation to the heading below under improving services.

6.4.3.2.3 *Improvement of Access to Services*

Many of the potential impacts have already been extensively assessed above. For vehicle drivers the ability to access services will be improved by the *Proposed Road Development*.

It is clear therefore that with regards to access to services the *Proposed Road Development* impact is overwhelmingly positive. That being said, certain individuals albeit very few, who are living or accessing areas in the immediate vicinity of the *Proposed Road Development*, would for reasons of severance or road closures

[70] Where the impact magnitude of the changes in concertation of PM_{10} is imperceptible, then the impact description is negligible.

have to detour somewhat from their current routes. Once they do access the transport links, however, they too will benefit from improved access to services.

6.4.3.2.4 *Summary*

In summary therefore, the impacts of the *Proposed Road Development* in the operational phase will be largely positive with opportunities for health improvements. These include, but are not limited, to improved access to services including emergency services, the potential for socio-economic development with the associated health improvements.

6.4.4 Interactions and cumulative effects

There are important interactions between the Population and Human Health assessment and those for Design (Traffic), Agricultural and Non-Agricultural Property, Noise and Vibration, and Landscape and Visual during both the construction and operational phases. There are interactions between Human Health, Noise & Vibration and Air Quality in the construction phase. In addition, there are minor interactions with the Cultural Heritage assessment.

At a strategic level there are interactions between the assessment of effects in this chapter and non-transport policies including spatial development, regional economic development, North-South links, social inclusion, health and tourism.

There will a significant positive cumulative effect on *journey times, journey patterns* and *journey amenity* together with recent improvements to sections of the N16 in County Leitrim by improving connectivity with Northern Ireland and the potential social and economic gains that greater interaction will bring. Similarly, there are potential positive cumulative effects on accessibility and connectivity with *Proposed Road Development*s in and around the city of Sligo including the proposed Eastern River Crossing of the Garvogue River. Tourism too will benefit from improvements to accessibility and connectivity, together with enhanced journey amenity arising a greater opportunity for road users to enjoy views of the scenic landscape. These positive effects can combine with the impact of recent tourism promotion and investments in the North-West. Other positive cumulative effects are associated with health policy and encouragement of cycling by adding a new cycle lane within an existing cycle infrastructure of the North West Cycle Trail.

It is not considered that there will be any negative cumulative effects on human health. The distances between the projects noted above and the *Proposed Road Development* result in no cumulative noise or air quality impacts. There is potential that reduced journey times and fewer unforeseen delays could have a potential benefit on psychological health. Any projects which make roads safer and reduce the probability of road accidents and fatalities can only be seen in positive terms from a human health perspective.

6.4.5 Assessment of worst case scenario

The *Proposed Road Development* can be expected to have a positive residual effect under all scenarios even if aspects such as increased cycling uptake or the opportunity to increase national and regional social and economic links are not fully realised. The worst-case scenario would be represented by a Do-Nothing scenario or, elsewise, by a Do-Minimum scenario that fails to implement road improvements in full.

6.5 Mitigation

6.5.1 Population

The following mitigation measures have now been included in the road development or are proposed:

- Provide for community interaction and pedestrian movement with informal pedestrian and cyclist crossing facilities at the roundabout junction with the L-3406-0.

- Provide pedestrian underpass access during construction from a severed farmhouse at the start of the L-7413-0 to permit crossing of the road to family members located on the other side.
- Include good and continuous signage for all diversions using minor roads.
- Include good and continuous signage for diversions using regional roads, including ensuring warning signage for potentially hazardous or more populated sections unfamiliar to diverted motorists and HGV drivers. Avoid school term.
- Consider facilities to enhance the tourism attraction of the proposed cycleway, for example, erection of information boards at natural viewpoints such as that at *Lugatober*.
- Provide road marking **t**o facilitate southbound cyclists to cross the L3404-0 to join the proposed cycleway.
- Include uncontrolled crossing point for southbound cyclists between Ch. 0 to Ch. 350.

6.5.2 Human Health

Mitigation measures proposed for the potential air quality, noise, water and soils are specified in Chapter 7 (Noise and Vibration), Chapter 8, (Air Quality and Climate) Chapter 10 (Soils and Geology), and Chapter 11, (Hydrology & Hydrogeology). The key mitigation measures which apply to human health are detailed in full in the respective chapters listed above. The implementation of these mitigation measures, emissions, including air and noise will be adequately controlled to ensure no adverse effect on human health.

6.6 Residual effects

6.6.1 Population

Following mitigation, the *Proposed Road Development* will have a *significant positive* effect on journey amenity including road safety. There can be expected to be a *slight positive* effect on accessibility and journey times to Sligo and the east which will benefit people living in the local community. Journey amenity for visitors will be improved by the proposed viewing facility providing a positive interaction with policy with regard to tourism. Journey amenity and tourism potential will also be significantly improved by the inclusion of the cycle lane. The positive residual effect will be strengthened by a moderation of the severance effect on households beside the existing road due to both the effect of crossing facilities and the presence of the cycle lane. The positive regional economic effect will also be enhanced by applying the proposed mitigation to minimise any local economic effects on small businesses. In addition, the *Proposed Road Development* will provide regional economic benefits to cross-border trade and interaction.

6.6.2 Human Health

6.6.2.1 Health Protection

From a community perspective overall, there are potential benefits in terms of human health protection. These arise from overall reductions in noise levels and improvements in air quality in these areas. Unfortunately, there are individuals who have slight negative impacts because of their proximity to the *Proposed Road Development*. The implementation of the mitigation measures will result in a residual slightly positive impact.

Similarly, from a psychological health point of view overall from community perspective the impacts of the *Proposed Road Development* are assessed as being positive. Again, there are individuals who may be adversely affected and principal among these are likely to be those whose homes are to be compulsorily acquired. The residual impact will be positive.

6.6.2.2 Health Improvements

There is the potential for a very significant opportunity for health improvements associated with the *Proposed Road Development*. These include the potential for economic development as well as tourism which in itself is associated with an improvement in health status. There is the potential for improvements in social health with a reduction in unemployment and particularly long-term unemployment. Such a potential if realised will bring with it benefits including reduced inequality in society. There is the potential for reduced traffic accidents with a corresponding reduction in mortality and morbidity. Ease of access and egress has the potential to improve social interaction. It also will allow quicker and more reliable access for emergency services such as ambulances. The residual impact will be positive.

6.6.2.3 Improvement of access to services

There is potential for significant improvement in access to services. The benefits of this apply to both the residents of Sligo and beyond. Easier access to national road network will allow greater availability of national services such as major hospitals and others. The residual impact will be positive.

Table 6-22: Summary Table of Effects (Construction)

Nature of Effect	Location / Sub-Group	Current situation	Construction Effect	Significance	Duration & frequency	Extent	Proposed Mitigation	Residual Effect
Journey time	N16 *Lugatober*	n/a	Construction vehicle crossings of N16	Moderate negative	Short-term (at times up to 12 months)	High	Flagman or signalling	Slight negative
Journey time	L7413 *Lugatober*	n/a	Diversion of up to 4km south or 4.8km north	Significant negative	Short-term (c3 weeks)	Low	Good diversionary signage. Minimise duration	Significant negative
Journey time	L3404 Glencar	n/a	Diversion of up to 8km south or north	Significant negative	Short-term (c2 weeks)	Low	Good diversionary signage. Minimise duration	Significant negative
Journey time and Residential amenity	R280/R287 or R286/R288	n/a	Diversions of up to 2 weeks. Split between two or more routes.	Significant negative	Short term (c2 weeks)	High	Good diversionary and hazard signage. Avoid school terms.	Moderate negative
Journey amenity	N16	HGV traffic around 6%	Construction vehicle use of N16	Slight negative	Short term (at times up to 12 months)	High	Reuse materials on site where possible.	Imperceptible to Slight negative
Residential amenity	Junction between N16 and L-3406-0	Two properties located close to or beside N16.	Construction works on roundabout junction	Slight to moderate negative	Short-term (at times up to 12 months)	Low	See Chapter 7 Noise and Chapter 12 L&V.	Slight negative
Neighbourhood severance	One property (directly) at start of L-7413-0	n/a	Neighbourhood severance introduced by construction works	Significant negative	Short-term (see also Operational	Low	Facilitate prior pedestrian access arrangements by opening pedestrian/cyclist subway.	Slight negative (psychological severance only)

Table 6-23: Summary Table of Effects (Operation)

Nature of Effect	Location / Sub-Group	Current situation	Operational Effect	Significance	Duration	Scale	Proposed Mitigation	Residual Effect
Journey times	N16	Journey times reduced by limited poor sightlines and overtaking opportunities	Improved sightlines	Slight positive	Permanent	High	-	Slight positive

Nature of Effect	Location / Sub-Group	Current situation	Operational Effect	Significance	Duration	Scale	Proposed Mitigation	Residual Effect
Journey amenity, safety and tourism.	N16	Road hazard introduced by poor sightlines and connections with local roads.	Improved sightlines and connections with local roads. Enhanced opportunity to view landscape.	Significant positive	Permanent	High	-	Significant positive
Journey amenity, tourism (cycling)	N16	Poor cycling amenity due to proximity to traffic	Inclusion of cycle lane. Health and tourism benefits.	Moderate-positive	Permanent	Medium		Significant positive.
Severance	One property (directly) at start of L-7413-0	n/a	Psychological severance introduced at L-7413-0, but proposed subway eliminates physical severance.	Slight negative	Permanent	Low	Underpass included for physical connectivity. Provide ramp access.	Slight negative
Neighbourhood severance	Three properties on N16 north	Existing pedestrian severance due to absence of roadside footpath and fast traffic.	Physical severance of N16 in north of study area	Slight – moderate negative	Permanent	Low		Slight negative
Economic	Guest House	Business beside N16, but not well signposted.	Severance of this section of N16	Moderate negative	Permanent	Low		Moderate negative
Economic	Shot-blasting business	Business beside N16, but not well signposted.	Severance of this section of N16	Slight negative	Permanent	Low		Slight negative
Economic	Regional	Principal road connection between Sligo and Enniskillen, but sections remain in poor condition.	Improvement to one section of the N16	Slight positive, but significant at cumulative level.	Permanent	High		Slight-significant positive.

7 Noise & Vibration

7.1 Introduction

This Noise and Vibration Impact Assessment evaluates the potential noise and vibration impacts for the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*.

The Noise and Vibration Impact Assessment initially sets out the methodology to be used for the assessment (Section 7.2), then describes the existing environment (Section 7.3), sets out the predicted impacts of the *Proposed Road Development* (Section 7.4), describes the mitigation measures to be incorporated in the *Proposed Road Development* (Section 7.5) and details any residual impacts (Section 7.6). The Noise and Vibration Impact Assessment also described any difficulties encountered in compiling the information (Section 7.7).

During the construction phase for the *Proposed Road Development*, noise and vibration will potentially be generated by site preparation works, excavation and infilling works. During the operation phase of the *Proposed Road Development*, noise and vibration will potentially be generated by vehicular engine and tyre noise on the road. Therefore, the potential noise and vibration impacts on noise sensitive receiver properties have been considered for both the construction and the operational phases of the project.

7.2 Methodology

7.2.1 Relevant Guidance

This Noise and Vibration Impact Assessment is prepared in accordance with the requirements of Section (50) of the Roads Act 1993 (as amended), and having regard to the following guidance documents:

- *TII Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (2014)*
- *TII Guidelines for the Treatment of Noise and Vibration in National Road Schemes. National Roads Authority (2004)*
- *TII Environmental Impact Assessment of National Road Schemes – A Practical Guide (2008)*
- *EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports Draft (August 2017)*
- *ISO 1996-1: 2016 Description and Measurement of Environmental Noise*
- *World Health Organisation Noise Guidelines for the European Region* (2018)
- *BS 5228-1:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites. Noise*
- *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Vibration*
- *BS 6472 -1:2008 Guide to Evaluation of Human Exposure to Vibration in Buildings*
- *BS 7385-2: 1993 Evaluation and measurement of vibration in buildings - Guide to damage levels from ground-borne vibrations*

- The Guidelines for Noise Impact Assessment (October 2014) produced by the Institute of Environmental Management and Assessment (IEMA) *HMSO (1988) Department of Transport Welsh Office, Calculation of Road Traffic Noise (CRTN)*
- *UK DMRB (1993) Design Manual for Roads and Bridges, Volume 11 Consolidated Edition*
- Sligo County Council Noise Action Plan for Sligo County and City, 2018 – 2022.
- *Environmental Noise Regulations (2006) (S.I. No. 140 of 2006)*
- *European Union (Environmental Noise) Directive 2002/49/EC of the European Parliament and of the Council of 25th June 2002 relating to the Assessment and Management of Environmental Noise.*

7.2.2 Baseline Noise Surveys

A baseline environmental noise survey was undertaken at 6 No. representative noise sensitive locations (N1-N6) in proximity to the *Proposed Road Development* in accordance with the methodology outlined in Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (2014) and ISO 1996 *Description and Measurement of Environmental Noise*. This baseline environmental noise survey provides a description of the environmental noise character of the area. The baseline noise surveys were undertaken at sites representative of noise sensitive locations and to establish the maximum and minimum noise levels and the “worst-case” situations along the existing and the *Proposed Road Development* alignment. Due to the relatively short and close to online alignment of the *Proposed Road Development* a 6 No. attended short period (15 minute) and 2 No. unattended 24-hour (daytime and night-time) baseline noise monitoring surveys were carried out. The baseline noise measurements were carried out on the 4th and 5th April 2018 at a sufficient number of properties to establish a representation of the existing noise climate in the vicinity of the *Proposed Road Development*.

All noise measurements were taken in appropriate weather conditions, i.e. in the absence of wind and precipitation and in conditions of standard temperature and pressure. Clearly, these ideal conditions very rarely apply throughout a full 24-hour monitoring period. However, potential variations in measurements are small if reasonable care is taken to avoid the worst excesses of the elements, as was ensured during the survey period. The sound level meters were fitted with a windshield under all circumstances. Care was taken to ensure average wind speeds of less than 5m/sec occurred when all noise measurements were taken. Wind speeds were monitored using a *Logic Energy* telemetry system and rainfall was measured using a tipping bucket rain gauge. Wind speed and rainfall was averaged over synchronised 1-hour intervals. No 1-hour average wind speeds of more than 3m/sec or any rainfall was recorded during the survey period.

The measurement parameters recorded during the baseline survey are defined as follows:

- L_{Aeq}: is the equivalent continuous A-weighted sound level – the sound pressure level of a steady sound having the same energy as a fluctuating sound over a specified measuring period. It can be considered similar to an average level.
- L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.
- L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period and is used to quantify background noise in the absence of the main noise source.

Using the methodology presented in the *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (2004) the relevant L_{den} noise level at the 24-hour monitoring location has been calculated directly from the measured $L_{Aeq\ 1hr}$ values and the relevant L_{den} noise level at each short-term monitoring location has been calculated from the L_{A10} noise level. This methodology allows for a determination of the nature of the existing noise environment at noise sensitive properties adjacent to the proposed development. The details of the sound level meters used during the surveys, calibration certificates and the results of the baseline monitoring survey are presented in Appendix 7.1 conatined within Volume 4 og this EIAR.

7.2.3 Construction Phase Noise & Vibration Impact Assessment

The ground works associated with the construction of the *Proposed Road Development* will include excavations, embankments and fill sections, road paving and installation of signage and services etc. along the proposed development alignment. Equipment and noise sources, such as rock breakers, excavators, generators, dump trucks and road rollers, etc. will be the main noise sources associated with the construction phase of the *Proposed Road Development*. Where required drilling and blasting equipment will be used.

The assessment of construction noise impact was undertaken in accordance with the methodologies outlined in the TII Guidelines and *BS 5228-1:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites. Noise.* The assessment of construction related vibration impacts was undertaken in accordance with the TII Guidelines and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Vibration.*

A significant cutting of up to 13m depth (measured along the design centreline) and an adjacent Soil Repository/Borrow Pit which will require the extraction of glacial till soils and limestone bedrock occurs between c. Ch. 900m and c. Ch. 1,160m along the route, other minor cut areas also occur elsewhere of lesser depth below 5m. It is anticipated that excavation is likely to be carried out using rock ripping with some potential for blasting. All properties within 500m of the proposed cutting at *Castlegal* where there is the potential for blasting works have been identified and assessed for vibration related impacts.

7.2.4 Operation Phase Noise & Vibration Impact Assessment

Vehicles travelling on the *Proposed Road Development* have the potential to generate a negative impact due to traffic noise at nearby receiver locations. This traffic noise impact assessment applies to the component of traffic which is associated with traffic travelling along the existing and proposed alignment and associated link roads.

In accordance with the TII Guidelines all receivers within 300m of the proposed alignment were identified and assessed for operational phase noise related impacts. A receiver height of 1.5m is representative of a bungalow property and a receiver height of 4m is representative of a two-storey property. As the requirement for mitigation measures is influenced by the height at which the receiver is located in relation to the road traffic noise source, a worst-case assessment for each receiver was undertaken where each property was assessed at a receiver height of 4m to represent a two-storey property, irrespective of whether the property was a bungalow property. On the basis of these worst-case assessment, any properties determined to potentially require noise mitigation measure design were specifically assessed as either a bungalow or two-storey property.

Road traffic noise impact predictions were conducted using the CadnaA noise modelling software (Version 4.3), which generated predicted noise levels for the noise sensitive receivers located within 300m of the *Proposed Road Development*.

This noise prediction model incorporates the calculation methodologies outlined in the Calculation of Road Traffic Noise (CRTN) produced by the UK Department of Transport (Welsh Office) and the methodology outlined within Method A of the TII Guidelines. The CadnaA computational model develops a visual and mathematical representation of the existing and predicted noise environment in the vicinity of the *Proposed Road Development*. Existing and future predicted traffic data, horizontal and vertical alignments of the project and existing and proposed local topography were used to predict the traffic noise impact at the nearby sensitive locations due to the *Proposed Road Development*.

The existing N16 alignment and the proposed alignment were digitised within the CadnaA noise model. The projected traffic flows associated with the *Proposed Road Development* for the base year (2018), the year of opening (2021) and the design year (2036) were input into separate models. The CadnaA noise prediction software allows for a prediction of noise levels at a number of receiver points which may be affected by the *Proposed Road Development*. Noise levels resulting from the introduction of the new alignment have been predicted to assess the change in the noise climate in the vicinity of these receivers. The predicted noise levels have been compared to the design goal criteria as stipulated in the TII Guidelines to determine if mitigation is required. Predicted noise levels are quoted as free-field L_{den} noise levels.

Traffic flow data used in the noise prediction modelling was based on the traffic flows on the existing N16 and proposed traffic flows on the proposed N16 alignment. All traffic flows were supplied as 24-hour AADT (Annual Average Daily Traffic) flows and these flows were converted to hourly flows according to specific diurnal profiles for Non-Heavy Commercial Vehicles (HCV) and HCV traffic for each road segment outlined in the 2004 Guidelines. Specific Heavy Goods Vehicle (HGV) percentages on each road segment were provided. The relevant traffic volumes on each road segment were provided by Sligo County Council.

Traffic speeds on the existing N16 and the proposed N16 alignment were modelled at the speeds in km/hour as provided by Sligo County Council. The existing N16 was modelled at a speed of 67 Kph and the proposed N16 alignment was modelled at a speed of 96 Kph.

The screening effects of topographical undulations, walls, embankments, bunds and cuttings which have the potential to provide natural noise attenuation have been incorporated into the noise prediction model using 1m interval ground contour data and elevation details for the existing N16 and the proposed N16 alignment as provided by Sligo County Council.

The CadnaA noise model has been used to predict noise levels at noise sensitive receivers for the base year (2018), the year of opening (2021) and the design year (2036), the “Do-Nothing” and “Do-Something” scenarios have been modelled (Refer to Section 7.4).

The likely future perceived impact of change in traffic noise levels at the noise sensitive properties adjacent to the *Proposed Road Development* has also been determined. In addition to the assessment of noise impact in accordance with the TII Guidelines, the perceived impact of change in traffic noise level has also been reported for the noise sensitive receivers in the Year of Opening (2021) and the Design Year (2036).

The perceived impact rating and the subjective response to changes in noise levels as outlined in this study have been determined based on the subjective assessment of changes in noise levels, in terms of perceived change and loudness outlined in Table 7-1 to Table 7-2. The Guidelines for Noise Impact Assessment (October 2014) produced by the Institute of Environmental Management and Assessment (IEMA) address the key principles of noise impact assessment and are applicable to all development proposals where noise effects are likely to occur. The guidelines state that the noise level threshold and significance should be determined, based upon the specific evidence and likely subjective response to noise. The criteria above reflect the key benchmarks that relate to human perception of sound. A change of 3 dB(A) is generally considered to be the smallest change in environmental noise that is perceptible to the human ear under most normal conditions. A 10 dB(A) change in noise represents a doubling or halving of the noise level. The difference between the minimum perceptible change and the doubling or halving of the noise level is split to provide greater definition to the assessment of changes in noise level. An impact scale offered by the IEMA guidelines is shown in Table 7-1.

Table 7-1: IEMA Impact from the Change in Sound Levels

Long-term impact classification	Short-term impact classification		Sound Level Change L_{pAeqT} (positive or negative) T = either 16hr day or 8hr night	
Negligible	2	Negligible	3	>0 dB and <1 dB
	4	Minor	5	>1 dB and <3 dB
Minor	6	Moderate	7	>3 dB and <5 dB

Long-term impact classification	Short-term impact classification	Sound Level Change L_{pAeqT} (positive or negative) T = either 16hr day or 8hr night
Moderate	8 Major	9 ≥5 dB and <10 dB
Major		10 ≥10 dB

To determine the overall noise impact, the magnitude and sensitivity to changes in noise levels, the Noise Effects Descriptors presented in Table 7-2 are offered by the IEMA guidelines.

Table 7-2: Noise Effects Descriptors (IEMA)

Very Substantial	Greater than 10 dB L_{Aeq} change in sound level perceived at a receptor of great sensitivity to noise
Substantial	11 Greater than 5 dB L_{Aeq} change in sound level at a noise sensitive receptor, or a 5 to 9.9 dB L_{Aeq} change in sound level at a receptor of great sensitivity to noise
Moderate	12 A 3 to 4.9 dB L_{Aeq} change in a sound level at a sensitive or highly sensitive noise receptor, or a greater than 5 dB L_{Aeq} change in sound level at a receptor of some sensitivity
Slight	13 A 3 to 2.9 dB L_{Aeq} change in a sound level at a receptor of some sensitivity
None/not significant	14 Less than 2.9 dB L_{Aeq} change in sound level and/or all receptors of negligible sensitivity to noise or marginal to the zone of the influence of the proposed development

Table 7-3: Relationship between Noise Impact, Effect and Significance (IEMA)

Magnitude (Nature of Impact)		Description of Effect (on a specific sensitive receptor)	Significance
	Substantial	Receptor Perception = Marked Change Causes a material change in behaviour and/ or attitude, e.g. individuals begin to engage in activities previously avoided due to preceding environmental noise conditions. Quality of life enhanced due to change in character of the area.	More Likely to be Significant (Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a non-significant effect)
	Moderate	Receptor Perception = Noticeable Improvement Improved noise climate resulting in small change in behaviour and/or attitude, e.g. turning down volume of television; speaking more quietly; opening windows. Affects the character of the area such that there is a perceived change in the quality of life.	
Beneficial	Slight	Receptor Perception = Just Noticeable Improvement Noise impact can be heard, but does not result in any change in behaviour or attitude. Can slightly affect character of the area but not such that there is a perceived change in quality of life.	(Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a significant effect) Less Likely to be Significant
-	Negligible	N/A = no discernible effect on receptor	Not Significant
	Slight	Receptor Perception = Non-intrusive Noise impact can be heard, but does not cause change in behaviour or attitude, e.g. turning up volume of television, speaking more loudly; closing windows. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.	Less Likely to be Significant Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a significant effect)
	Moderate	Receptor Perception = Intrusive Noise impact can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows. Potential for non-awaking sleep disturbance. Affects the character of area such that there is a perceived change in the quality of life.	
	Substantial	Receptor perception = Disruptive Causes material change in behaviour and /or attitude, e.g. avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in getting to sleep, premature awakening, and difficulty in getting back to sleep. Quality of life diminished due to change in character of area.	Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a non-significant effect) More Likely to be Significant
Adverse	Severe	Receptor Perception = Physically Harmful Significant Changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or psychological effects, e.g. regular sleep deprivation / awakening ; loss of appetite, significant , medically definable harm, e.g. auditory and non-auditory.	Significant

In 1999 and 2009, the World Health Organisation (WHO) published guidelines to protect human health, specifically from community noise and night noise exposure. In recent years, there has been a substantial increase in the number and quality of studies on environmental noise exposure and health impacts. Also, newer studies included noise from sources such as railways and wind turbines. In light of this new evidence, the WHO Environmental Noise Guidelines for the European Region have been developed and published in October 2018.

The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. Leisure noise in this context refers to all noise sources that people are exposed to due to leisure activities, such as attending nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and listening to loud music through personal listening devices.

WHO has conducted surveys on noise annoyance. According to these large-scale surveys, road traffic noise is the most important source of annoyance, generally followed closely by neighbour noise. Aircraft noise can also be a substantial source of annoyance. Railway noise and industrial noise are enumerated less frequently.

WHO has published the following 'strong' recommendations in relation to noise levels produced by road traffic. *For average noise exposure, the Guideline Development Group (GDG) strongly recommends reducing noise levels produced by road traffic below 53 dB L_{den}, as road traffic noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic during night time below 45 dB L_{night}, as night-time road traffic noise above this level is associated with adverse effects on sleep. To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure*.

7.2.5 Operation Phase Vibration Impact Assessment

As stated in the TII Guidelines "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. This aspect does not require further consideration unless there are unusual circumstances under which higher than normal traffic vibration levels may be expected".

7.2.6 Operation Phase Noise Mitigation Measure Design Criteria

The TII Guidelines outline that road traffic noise impact criteria in Ireland is based on the L_{den} noise parameter. The results of the noise prediction modelling are presented as the L_{den} noise level, which is a composite of long term L_{Aeq} values for day, evening and night (termed L_{day}, $L_{evening}$ and L_{night}). The TII has stipulated that all national road schemes should be designed, where feasible, to meet the 60dB L_{den} design goal as specified in the TII Guidelines. Mitigation measures are deemed necessary when the following three conditions are satisfied at sensitive receptors:

(a) the combined expected maximum traffic noise level, i.e. the relevant noise level from the *Proposed Road Development* together with other traffic in the vicinity is greater than the 60dB L_{den} design goal.

(b) the relevant noise level is at least 1dB more than the expected traffic noise level without the *Proposed Road Development* in place.

(c) the contribution to the increase in the relevant noise level from the *Proposed Road Development* is at least 1dB.

These conditions ensure that mitigation measures arising out of this process are based upon the impact of the *Proposed Road Development* under consideration only. Mitigation measures are considered when the *Proposed Road Development* has a net negative impact, i.e. the predicted traffic noise level is greater than 60dB L_{den}, the predicted noise level due to *Proposed Road Development* traffic and induced traffic is at least 1 dB more than the 'Do- nothing' noise level and the contribution from the *Proposed Road Development* traffic only is at least 1dB more than the 'Do-nothing' noise level.

This design goal noise level of 60dB L_{den} has been selected to protect people from being annoyed from a relatively steady and continuous noise source such as the *Proposed Road Development*. However, it is noted that the TII Guidelines state that "*the Authority accepts that it may not always be sustainable to provide adequate mitigation in order to achieve the design goal. Therefore, a structured approach should be taken in order to ameliorate as far as practicable road traffic noise through the consideration of measures such as alignment changes, barrier type (e.g. earth mounds), low noise road surfaces* etc." and the design goal of

60dB L_{den} is not a statutory requirement. Accordingly, if major works are required to bring a noise level from a predicted noise level of approximately 61dB L_{den} to 60dB L_{den} for example, these works would not necessarily be carried out. When determining the requirement for mitigation measures, it is important to consider any potential design difficulties and cost, based on the relative impact of the *Proposed Road Development* on a receiver property in comparison to the currently experienced noise level at such properties.

7.3 Existing Environment

7.3.1 Baseline Noise Monitoring

The existing noise environment in the vicinity of the noise sensitive receivers nearest to the existing and the *Proposed Road Development* was established though a baseline noise monitoring survey undertaken at 6 No. attended short period (15 minute) and 2 No. unattended 24-hour (daytime and night-time) baseline noise monitoring locations (N1 – N6), as described in Section 7.2. The baseline noise monitoring locations are shown in Figures 7.1.1 and 7.1.2 contained within Volume 3 of this EIAR; the baseline noise monitoring results are provided in Table 7-4. Due to the relatively short and online nature of the *Proposed Road Development* 6 No. residential receptors were selected. No noise mitigation measures are in place along the alignment of the existing N16.

Table 7-4: Results of the Baseline Noise Monitoring.

Noise Monitoring Location	24 Hour Monitoring – 1-Hour L_{Aeq} noise levels converted to L_{den} (dB)	Short term CRTN monitoring – 15-minute L_{A10} noise levels converted to L_{den} (dB)
NML 1 (24 Hour Location)	60.3	-
NML 2 (24 Hour Location)	53.9	-
NML 3	-	58
NML 4	-	55
NML 5	-	65
NML 6	-	55

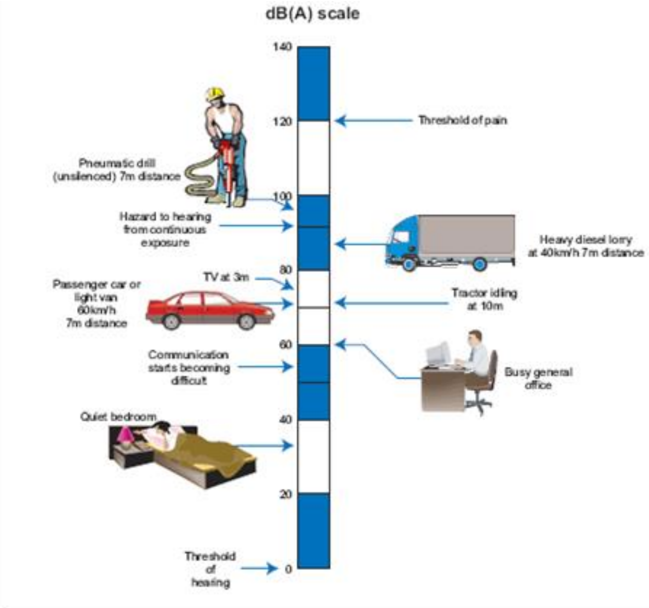
The existing ambient noise environment in the study area is dominated by the existing traffic noise from the N16. Noise levels were also influenced by a combination of other noise sources such as birdsong, dogs barking and agricultural practises.

The L_{Aeq} sound levels recorded during the baseline noise survey indicate that at the residential properties in very close proximity to the existing N16 there is an exceedance of the WHO published guidelines to protect human health. The WHO Environmental Noise Guidelines for the European Region published in October 2018 and the 60dB L_{den} design goal as specified in the TII Guidelines are exceeded at the residential properties that are in close proximity to the existing N16. At the monitoring locations at residential properties that are located further from the existing N16 there is no exceedance of the WHO published guidelines.

The calculated L_{den} sound level at the 24-hour monitoring locations at NML 1 and NML 2 are both in compliance with the 60dB L_{den} design goal as specified in the TII Guidelines. The noise prediction model validation process has been primarily based on these two 24-hour monitoring locations.

The measured noise levels are consistent with the subjective commentary during the baseline noise survey. Traffic noise from the existing N16 dominates the noise climate in the area. Figure 7-4 indicates a typical comparison level of common sound levels on the dB(A) Scale for reference against the measured sound levels at the residential properties in proximity to the existing N16.

Figure 7-1: The Typical Level of Common Sounds on the dB(A) Scale [Source: UK Design Manual for Roads and Bridges, Volume 11 Consolidated Edition 1993].



7.3.2 Baseline Vibration Monitoring

Ground vibration levels in areas such as along the existing N16 alignment are likely to be extremely low at any potentially sensitive locations as there were no significant sources of vibration noted in the study area other than road traffic. As stated above, ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Therefore, no baseline vibration monitoring was carried out in the vicinity of the proposed alignment.

7.4 Impact Assessment

There are two phases of the *Proposed Road Development* that may impact on the existing noise and vibration environment in the area. These are:

- Construction phase, and
- Operational phase - Noise modelling has been used to predict noise impacts at noise sensitive receivers for the Year of Opening (2021) and Design Year (2036), and in each case, the 'Do-Nothing' and 'Do-Something' scenarios have been modelled and compared.

7.4.1 Construction Noise & Vibration Impact Assessment

It is anticipated that the associated earthworks and construction operations will extend over a period of 12 – 18 months. The majority of the works associated with the construction of the *Proposed Road Development* will be ground works that are required in order to excavate the cut sections and to form the embankments along the alignment of the *Proposed Road Development*. It is anticipated that varying degrees of overburden and bedrock removal and infilling will be required in a number of cut and fill sections along the *Proposed Road Development*.

Construction works will also include road paving and installation of services, etc. along the *Proposed Road Development*. Equipment and noise sources, such as rock breakers, excavators, dump trucks, rollers, generators, etc. will be the main noise sources associated with the construction phase of the project. Where required drilling and blasting equipment will be used. Due to the linear nature of road construction projects the noise sources will move along the proposed alignment throughout the construction phase.

7.4.1.1 Construction Noise Guidelines

The TII Guidelines outlines construction noise limits as detailed in Table 7-5.

Table 7-5: Maximum Permissible Noise Levels at the Façade of Dwellings During Construction (Source: TII Guidelines).

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{AMax} dB
Monday to Friday - 07.00 to 19.00	70	80*
Monday to Friday - 19.00 to 22.00	60*	65*
Saturday - 08.00 to 16.30	65	75
Sundays and Bank Holidays - 08.00 to 16.30	60*	65*

* Construction activity at these times, other than that required in respect of emergency works, will normally require the explicit permission of the relevant local authority.

7.4.1.2 Construction Vibration Guidelines

The relevant vibration standards can be divided into two categories, those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. In the case of continuous sources of vibration, such as traffic, vibration is perceptible at around 0.5mm/s and may become disturbing or annoying at higher magnitudes. However, higher levels of vibration are typically tolerated for single events or events of short duration. For example, blasting (an instantaneous activity) and piling (a repetitive/continuous activity), two of the primary sources of vibration during road construction projects, are typically tolerated at vibration levels up to 12mm/s and 2.5mm/s, respectively.

The TII Guidelines identify 2.5mm/s as the vibration level that may be considered tolerable during piling works. This limit provides for protection against the vibration nuisance and is comfortably within the limit for potential cosmetic damage. The potential vibration levels that could be generated by rock breaking works, as required, would be expected to be comparable to the level of vibration that may be generated by piling works. The TII limits for protection against cosmetic damage are given as a function of vibration frequency, and are:

- 8 mm/s (vibration frequency <10Hz);
- 12.5 mm/s (vibration frequency 10 to 50Hz);
- 20 mm/s (vibration frequency >50 Hz).

7.4.1.3 Construction Vibration Impact

A significant cutting of up to 13m depth (measured along the design centreline) and an adjacent Soil Repository/Borrow Pit which will require the extraction of glacial till soils and limestone bedrock occurs between c. Ch. 900m and c. Ch. 1,160m along the route, other minor cut areas of lesser depth also occur elsewhere below 5m. It is anticipated that excavation will involve rock ripping with some potential for blasting.

The closest receiver properties to the rock cut area at *Castlegal* are property No.'s 116, 117 & 118. Property No.'s 116 and 117 are approximately 100m from the rock that will be required to be excavated in the cutting at *Castlegal*. Property No.'s 116 and 117 are modern properties. Property No. 118 (*Castlegal* House) is approximately 100m from the rock cut area at *Castlegal* and is identified in the Cultural Heritage chapter as a residential property with outlying buildings built c. 1820 . The residential property was extended or rebuilt in the mid-nineteenth century. Therefore, this property is unlikely to conform to modern building standards.

At *Lugatober*, Property No.'s 125 and 126 are approximately 50m and 20m respectively from a proposed 4m deep cutting which will have steepened earth slopes on the eastern side. At this location there is some potential for minor volumes of rock to be encountered at a depth of 3m. Therefore, in this localised area, excavation of the rock in close proximity to the nearby properties will be undertaken using a process of rock splitting rather than rock breaking. This method is significantly quieter and produces significantly less vibration.

To avoid the risk of cosmetic damage to sensitive older buildings and those in close proximity to rock excavation works, the TII Guidelines suggest that vibration levels should be limited to 8mm/s at frequencies of less than 10Hz, to 12.5mm/s for frequencies of 10 to 50Hz, and to 20mm/s at frequencies of 50Hz and above. Appropriate mitigation measures are outlined in Section 7.5.

The majority of properties in the vicinity of the *Proposed Road Development* will comply with modern building regulation standards and in this regard the vibration limit levels outlined above are representative of levels that would be expected to be tolerable by these properties, without undue concern. In addition, it should be noted that there is a significant safety margin accounted for within the TII limits, and properties with slight deviations from modern building regulation standards should not be at significantly increased risk of cosmetic damage. Property condition surveys will be offered for all buildings within 50m of the development boundary. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as the follows:

- the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to project commencement;
- the second stage shall consist of post-construction condition surveys which shall include photographic records.

7.4.1.4 Blasting Noise & Vibration Impacts

At the proposed cutting and Soil Repository/Borrow Pit at *Castlegal* (between c. Ch. 900m and c. Ch. 1,160m), it likely that a certain amount of blasting may be required. At properties where there is a potential impact due to blasting, i.e. properties within approximately 500m of the proposed cutting at *Castlegal*, the impact could be of significance, in the event that the noise and/or vibration impact exceeded the TII limits. In such circumstances, mitigation would be required as outlined in Section 7.5.

Blasting may generate ground vibration, but it is generally the airborne vibration or air overpressure generated by the blast that is of most significance to the residential receiver. Noise from blasting operations can give rise to concern or alarm to persons. The effect of blasting operations in terms of both ground borne and airborne vibration depends on factors such as the distance to the receptor, the prevailing geology, the meteorological conditions, the explosive charge weight and the depth of charge. The magnitude of vibration is expressed in terms of Peak Particle Velocity (PPV) in millimetres per second (mm/s).

Guidance relevant to acceptable vibration at the foundation of buildings is contained within BS 7385 (1993): Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground-borne vibration. This guidance states that there should typically be no cosmetic damage to buildings if transient vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz and above. These guidelines refer to relatively modern buildings. Therefore, the guideline values should be reduced to 50% or less for more critical buildings. Critical buildings would include premises that are highly sensitive to vibration or historic buildings that may be in poor repair. Such buildings will be identified during building condition surveys, which, subject to landowner consent, will be carried out for all buildings within 500m of the proposed cutting at *Castlegal* if blasting was to be undertaken along the *Proposed Road Development*. As stated above, to avoid the risk of cosmetic damage to sensitive older buildings and those in close proximity to rock excavation works, the TII Guidelines suggest appropriate and conservative vibration limits. Blasting impacts can be closely monitored in close proximity to the nearest streams, rivers and lakes to the proposed blasting areas. Blasting has the potential to damage a fish swim bladder and may also kill or damage fish eggs or larvae. The swim bladder is a gas-filled organ that permits fish to maintain neutral buoyancy. Fish and aquatic habitats will be protected during blasting. A review of relevant reference material from Canadian and New Zealand government departments has allowed for a determination of maximum vibration levels that should be permitted in spawning bed areas of rivers to protect fish eggs. In summary, if levels of vibration in a river can be maintained below 13 mm/s PPV there will be no impacts on the spawning beds of fish eggs. In comparison to the TII vibration limits to ensure that there will be no potential for damage to buildings during construction, the recommended vibration limits in the nearest streams, rivers and lakes during blasting should be easily achievable by the Blasting Contractor. The nearest stream at *Castlegal* Bridge is approximately 250m from the rock cut area at *Castlegal*.

Vibration limits during the construction phase of the project will be limited to the guideline limit values specified in the TII Guidelines for the Treatment of Noise and Vibration in National Road Schemes. These have been set in order to protect against any cosmetic or structural damage being experienced during the construction phase.

7.4.1.5 Construction Noise & Vibration Impacts

Table 7-6 outlines the noise levels from typical road construction noise sources during different phases of the construction process as referenced from *BS 5228-1:2009+A1:2014*.

Table 7-6: Typical noise levels during different construction processes as referenced from BS 5228-1:2009+A1:2014

Ref No.	Equipment	A-weighted sound pressure level, L_{Aeq}, dB @ 10m
Table C.2 Sound level data on site preparation		
Clearing Site & Ground excavation/earthworks		
1	Dozer ж (142 kW, 20T)	75 ж
3	Tracked excavator (102 kW, 22T)	78
12	Dozer (142 kW, 20T)	80
14	Tracked excavator (226 kW, 40T)	79
Loading lorries		
27	Wheeled loader (493 kW)	80
Distribution of material		
30	Dump truck (tipping fill) (306 kW, 29T)	79
31	Dump truck (empty) (306 kW, 29T)	87
Rolling and compaction		
37	Roller (rolling fill) ж	79 ж
Table C.4 Sound level data on general site activities		
Distribution of materials		
1	Articulated dump truck ж	81 ж
Mixing & Pumping concrete		
20	Concrete mixer truck	80
Trenching		
63	Tracked excavator	77
Power for site cabins		
84	Diesel generator	74
Pumping water		
88	Water pump (diesel) (10 kW, 100Kg)	68
Sweeping and dust suppression		
90	Road sweeper (70 kW)	76
91	Dust suppression unit trailer	78
Table C.5 Sound level data on road construction works		
Breaking road surface & concrete		
1	Backhoe mounted hydraulic breaker	88
6	Hand-held pneumatic breaker	95
Road planing		
7	Road planer (185 kW, 17T)	82
Earthworks		
14	Bulldozer ж (250 kW, 35T)	86 ж
16	Articulated dump truck ж (194 kW, 24T)	81
Rolling and compaction		
19	Road Roller ж (95 kW, 22T)	80 ж
21	Vibratory Roller ж (95 kW, 12T)	80 ж
29	Vibratory compacter (asphalt)	82
Paving		

Ref No.	Equipment	A-weighted sound pressure level, L_{Aeq}, dB @ 10m
Table C.2 Sound level data on site preparation		
Clearing Site & Ground excavation/earthworks		
33	Asphalt paver (+ tipper lorry) ж	84 ж
Table C.9 Sound level data on hard rock quarries		
Breaking boulders/oversized material		
11	Excavator mounted rock breaker	93
15	Tracked semi-mobile crusher	96

ж Drive-by maximum sound pressure level in L_{Amax} (overall level)

As stated, a combination of blasting and rock breaking will be used to excavate the rock cutting at *Castlegal*. The rock from the cutting at *Castlegal* will be reused as general fill and capping material along the proposed alignment. It is also proposed that there will be a Soil Repository/Borrow Pit constructed adjacent to the rock cutting at *Castlegal*. This site to the east of the alignment will provide suitable fill/capping material for use elsewhere along the proposed alignment and also accept unsuitable glacial till material in the repository stage. The construction of the Soil Repository/Borrow Pit is likely to be via machine excavation (rock rippng) with potential for some blasting.

Typical noise levels during different construction processes as referenced from BS 5228-1:2009+A1:2014 are outlined in Table 7-6 above, rock breaking will result in a noise level of approximately 93 - 96 dB $L_{Aeq,1hour}$ at 10m. Noise from rock breaking will occur over short term intervals and will be during daytime periods only. The nearest residential properties will be informed of the timing and duration of the rock breaking. The potential construction noise impact from rock breaking and associated transport due to the creation of the cutting and the Soil Repository/Borrow Pit at *Castlegal* has been assessed. Realistically, it is most likely that the rock breaker activity in the proposed cutting and Soil Repository/Borrow Pit at *Castlegal* will occur separately over the course of the construction phase. Construction noise levels have been predicted at the nearest residential properties due to simultaneous rock breaker activity and the operation of an adjacent tracked excavator which will load 15 dump trucks per hour. The dump trucks will travel either north or south in the direction of where the fill/capping material is required as part of the construction project. For the purposes of the noise impact assessment it has been assumed that there will be 6 dump truck movements to the north and 6 dump truck movements to the south during a worst-case 1 hour period. This is a worst-case construction noise impact assessment. Table 7-7 outlines the Sound Power Levels for various plant and equipment associated with the construction noise impact assessment. The predicted construction noise levels are based on the likely operations that will occur on site during each phase of activity. The construction noise models are based on importing AutoCad drawings into the CadnaA noise prediction software. The location of the relevant noise sources within the rock breaking areas, excavation areas and the haul roads have been represented accordingly. *Table 7-8* outlines the predicted noise levels due to rock breaker, tracked excavator and dump truck movements in proximity to the proposed cutting and Soil Repository/Borrow Pit at *Castlegal* during the construction phase.

Table 7-7: Sound Power Levels for plant and equipment, e.g. rock breaker, tracked excavator and dump truck movements in proximity to the proposed cutting and borrow pit at Castlegal during the construction phase.

Likely Plant & Equipment for use at proposed cutting and borrow pit at Castlegal	L_W used in Noise Model (dB)
Overburden Removal, e.g. Dozer and/or Volvo / Doosan / Komatsu Excavator loading HGV	110 dB (Point Source) = 82 dB(A) @10m from source
Excavation, e.g. Volvo / Doosan / Komatsu Excavator loading HGV	108 dB (Point Source) = 80 dB(A) @10m from source
Haul Road HGV movements (assuming 15 per hour @ 20 Kph)	105 dB (Line Source) with associated number of movements per hour along the line source.
Rock Breaker	123 dB (Point Source) = 95 dB(A) @10m from source

Table 7-8: Predicted noise levels due to rock breaker, tracked excavator and dump truck movements in proximity to the proposed cutting and Soil Repository/Borrow Pit at Castlegal during the construction phase.

Property Number	Predicted $L_{Aeq,1hour}$ at nearest Receiver Location dB(A)	
	Due to rock breaking and HGV movements for the creation of the cutting at *Castlegal*	Due to rock breaking and HGV movements for the creation of the borrow pit at *Castlegal*
114	50.6	50
115	54.4	53
116	60.7	55.3
117	56.2	49.1
118	54.6	51.5
119	46.9	42.4
120	44.2	39.7
121	46.8	45.1
122	46.2	45
123	42.2	39.8
124	39.5	38.3
125	53.7	53.5
126	53.7	53.5
127	48.4	48
128	45.4	44.5
TII Construction Noise Limit	70 dB $L_{Aeq,1hour}$	

7.4.2 Operational Noise & Vibration Impact Assessment

7.4.2.1 Operation Noise Impacts

This section of the assessment identifies the potential impacts on the environment associated with the *Proposed Road Development* in operation.

Noise Model Validation:

In relation to the calibration and validation of the noise model, the TII Guidelines states that "*whilst there is no need for further validation of the established CRTN prediction methodology, the Authority considers that the noise models themselves should be validated in order to ensure that the roads, topography and other critical features have been correctly represented and incorporated into the model. This could be done in a number of ways, for example, the survey results could be compared with the predicted results obtained using traffic data that are representative of the conditions during the period when the survey was conducted. The exact method of validation is left to the discretion of the Acoustic Engineer*".

The TII Guidelines state that "*depending upon the circumstances and characteristics of the sound in question, a change in level of 3dB is just perceptible, whereas an increase of 10dB is perceived as a subjective doubling of loudness*". Therefore, where a monitored and modelled noise level is within approximately +/- 3dB, the location can be deemed to be well validated in relation to monitored and modelled noise levels (i.e. a "Good" Level of Validation). Where a monitored and modelled noise level is within approximately +/- 5dB, the location can be deemed to be moderately validated in relation to monitored and modelled noise levels (i.e. a "Moderate" Level of Validation). Where a monitored and modelled noise level is >5dB, the location can be deemed to be poorly validated in relation to monitored and modelled noise levels (i.e. a "Poor" Level of Validation). It is important to note that the modelled noise levels are entirely due to traffic noise, whereas the monitored noise levels may be prone to impact from other noise sources such as birdsong, children playing, dogs barking, agricultural or commercial activities in the area, etc. The noise model has been validated primarily on the basis of noise levels recorded at two 24-hour monitoring locations that are in close proximity to the existing and proposed development alignment (Table 7-8). This is due to the fact that the dominant noise source in these areas is the existing consistent traffic flow. Traffic flow data for the existing alignment has been input into the noise validation model. The results of the validation show that a good level of validation was achieved at the noise monitoring locations.

*Table 7-9**:** Monitored noise levels versus predicted noise levels 'Base Year 2018 Calibration Model' at noise monitoring locations along the existing N16 alignment.*

Receiver Locations	Monitoring Results converted to L_{den}	Existing Model Noise Levels L_{den} dB(A)	Difference between monitored & modelled noise levels	Difference; <3dB(A), 3-5dB(A), >5dB(A)	Level of Validation
NML 1 (24-Hr Location)	60.3	58.2 (NSR 104)	2.1	<3 dB(A)	Good
NML 2 (24-Hr Location)	53.9	53.8 (NSR 132)	0.1	<3 dB(A)	Good
NML 3	58	61.9 (near NSR 104)	3.9	3-5 dB(A)	Moderate
NML 4	55	53.3 (near NSR 118)	1.7	<3 dB(A)	Good
NML 5	65	67.1 (near NSR 116/117)	2.1	<3 dB(A)	Good
NML 6	55	55.8 (NSR 126)	0.8	<3 dB(A)	Good

Noise Impact Prediction

There are 46 residential properties (noise sensitive receivers) located within 300m of the *Proposed Road Development*. A significant majority of these noise sensitive receivers are located in in excess of 100m and / or in a 'sheltered location' away from the direct impact of traffic noise sources due to being located behind significant topographical undulations.

It is proposed that in order to allow for a reduction in road traffic noise levels, a Stone Mastic Asphalt road surface, i.e. a Low Noise Surface, will be used in the *Proposed Road Development*. This has been reflected in the choice of a 'pervious road surface' in the noise prediction model which allows for 3.5 dB(A) reduction in predicted noise level.

The results of the predicted noise levels from the CadnaA noise modelling software at the selected 46 receivers located in closest proximity to the *Proposed Road Development* from the noise model in the Year of Opening 2021 and the Design Year 2036 are presented in Table 7-9.

As the requirement for mitigation measures is influenced by the height at which the receiver is located in relation to the road traffic noise source, the predicted noise levels in Table 7-9 are presented for all noise sensitive receiver locations at a receiver height of 4m, i.e. receiver height for a two-storey building.

On the basis of perceived change and loudness as outlined in Table 7-1 to Table 7-2, Table 7-9 also outlines the subjective change in noise level at each individual noise sensitive property. Table 7-9 outlines a summary of the overall perceived impact of change in traffic noise level at the noise sensitive properties in the Design Year (2036).

The majority of residential properties in close proximity to the existing N16 will remain in similar proximity to the alignment of the *Proposed Road Development* and therefore, on account of no predicted increase in traffic volume due to the *Proposed Road Development* there will be no significant change in noise levels at these properties as a result of the new alignment.

The operational noise impacts for the various scenarios in 2036 are presented in Figures 7.2.1 to 7.4.2 contained within Volume 3 of this EIAR.

Table 7-9: Predicted noise levels at receivers located within 300m of the proposed N16 alignment.

Receptor Number	Base Year 2018	Year of Opening 2021					Design Year 2036					Subjective Response	Mitigation Required
		Do Nothing - Modelled Noise Levels L_{den} dB(A)	Do Something -Modelled Noise Levels L_{den} dB(A)	Do Something - Modelled Noise Levels - Scheme Only L_{den} dB(A)	Difference between Do Nothing & Do Something dB(A)	Difference between Do Nothing & Do Something Scheme Only dB(A)	Do Nothing - Modelled Noise Levels L_{den} dB(A)	Do Something -Modelled Noise Levels L_{den} dB(A)	Do Something - Modelled Noise Levels - Scheme Only L_{den} dB(A)	Difference between Do Nothing & Do Something dB(A)	Difference between Do Nothing & Do Something Scheme Only dB(A)		
100	62.2	62.3	62.1	27	-0.2	-35.3	62.8	62.7	27.4	-0.1	-35.4	No Change	No
101	63.7	63.8	63.4	28.7	-0.4	-35.1	64.4	64	29.1	-0.4	-35.3	No Change	No
102	62.7	62.9	62.6	30	-0.3	-32.9	63.4	63.1	30.5	-0.3	-32.9	No Change	No
103	60.2	60.3	60.2	31.7	-0.1	-28.6	60.8	60.7	32.2	-0.1	-28.6	No Change	No
104	58.2	58.4	55.3	55.1	-3.1	-3.3	58.9	55.8	55.6	-3.1	-3.3	Noticeable +ve	No
105	57.9	57.9	55.2	54.4	-2.7	-3.5	58.5	55.7	54.9	-2.8	-3.6	Noticeable +ve	No
106	58.4	58.4	55.9	54.5	-2.5	-3.9	59	56.5	55	-2.5	-4.0	Noticeable +ve	No
107	57.9	57.9	57.1	51.7	-0.8	-6.2	58.5	57.7	52.2	-0.8	-6.3	Negligible +ve	No
108	52	52.1	49.9	47.5	-2.2	-4.6	52.7	50.5	48.1	-2.2	-4.6	Negligible +ve	No
109	50.9	50.9	50.2	43.3	-0.7	-7.6	51.5	50.8	43.8	-0.7	-7.7	Negligible +ve	No
110	54.5	54.5	54.4	39.7	-0.1	-14.8	55.1	54.9	40.2	-0.2	-14.9	No Change	No
111	54	54.1	54	39	-0.1	-15.1	54.6	54.6	39.5	0.0	-15.1	No Change	No
112	54	54	54	38.6	0.0	-15.4	54.6	54.5	39.1	-0.1	-15.5	No Change	No
113	56.5	56.6	56.5	39	-0.1	-17.6	57.1	57.1	39.4	0.0	-17.7	No Change	No
114	56.8	57	50.3	50.2	-6.7	-6.8	57.5	50.7	50.6	-6.8	-6.9	Clearly Noticeable +ve	No
115	68.3	68.4	52.7	52.7	-15.7	-15.7	69	53.1	53.1	-15.9	-15.9	Very Substantial +ve	No
116	65	65.1	50.8	50.7	-14.3	-14.4	65.7	51.2	51.2	-14.5	-14.5	Very Substantial +ve	No
117	60.6	60.7	48.1	48	-12.6	-12.7	61.3	48.4	48.3	-12.9	-13.0	Substantial +ve	No
118	50.8	50.9	52.8	52.8	1.9	1.9	51.4	53.3	53.2	1.9	1.8	Negligible -ve	No
119	40.2	40.3	39.5	35.6	-0.8	-4.7	40.8	39.9	36	-0.9	-4.8	Negligible +ve	No
120	46.6	46.6	46.4	38.5	-0.2	-8.1	47.1	46.9	38.9	-0.2	-8.2	No Change	No
121	49.5	49.6	48.4	46.3	-1.2	-3.3	50.7	49.3	46.9	-1.4	-3.8	Negligible +ve	No
122	51.1	51.1	50.2	46.7	-0.9	-4.4	52.3	51.4	47.4	-0.9	-4.9	Negligible +ve	No
123	51	51	50.7	41.3	-0.3	-9.7	52.4	52.1	41.7	-0.3	-10.7	No Change	No
124	49.9	50	49.8	41.1	-0.2	-8.9	51.4	51.2	41.5	-0.2	-9.9	No Change	No
125	52.1	52.2	56.1	56.1	3.9	3.9	53	56.3	56.3	3.3	3.3	Noticeable -ve	No

Table 7-9 (Continued): Predicted noise levels at receivers located within 300m of the proposed N16 alignment.

Receptor Number	Base Year 2018	Year of Opening 2021					Design Year 2036					Subjective Response	Mitigation Required
		Do Nothing - Modelled Noise Levels L_{den} dB(A)	Do Something -Modelled Noise Levels L_{den} dB(A)	Do Something - Modelled Noise Levels - Scheme Only L_{den} dB(A)	Difference between Do Nothing & Do Something dB(A)	Difference between Do Nothing & Do Something Scheme Only dB(A)	Do Nothing - Modelled Noise Levels L_{den} dB(A)	Do Something -Modelled Noise Levels L_{den} dB(A)	Do Something - Modelled Noise Levels - Scheme Only L_{den} dB(A)	Difference between Do Nothing & Do Something dB(A)	Difference between Do Nothing & Do Something Scheme Only dB(A)		
126	56.1	56.2	56.2	56.5	0.0	0.3	56.8	55.7	55.7	-1.1	-1.1	Negligible +ve	No
127	65.3	65.5	53.1	53.1	-12.4	-12.4	66	53.4	53.4	-12.6	-12.6	Substantial +ve	No
128	54.7	54.8	50.5	50.2	-4.3	-4.6	55.3	50.9	50.5	-4.4	-4.8	Noticeable +ve	No
129	69.4	69.6	56.6	56.6	-13.0	-13.0	70.1	57.1	57	-13.0	-13.1	Substantial +ve	No
130	47.4	47.5	48.4	48.3	0.9	0.8	48.1	48.8	48.8	0.7	0.7	Negligible -ve	No
131	55	55.2	53.8	53.8	-1.4	-1.4	55.7	54.2	54.2	-1.5	-1.5	Negligible +ve	No
132	53.8	53.9	51.1	50.8	-2.8	-3.1	54.4	51.6	51.3	-2.8	-3.1	Noticeable +ve	No
133	54.2	54.3	52.3	49.3	-2.0	-5.0	54.9	52.9	49.9	-2.0	-5.0	Negligible +ve	No
134	52.1	52.1	51.3	42.1	-0.8	-10.0	52.6	51.8	42.7	-0.8	-9.9	Negligible +ve	No
135	48.5	48.5	47.6	40.9	-0.9	-7.6	49.1	48.2	41.4	-0.9	-7.7	Negligible +ve	No
136	46.4	46.4	45.2	40.4	-1.2	-6.0	47	45.8	40.9	-1.2	-6.1	Negligible +ve	No
137	51	51.1	49.8	43.1	-1.3	-8.0	51.6	50.3	43.7	-1.3	-7.9	Negligible +ve	No
138	50.2	50.2	49.2	42	-1.0	-8.2	50.8	49.8	42.6	-1.0	-8.2	Negligible +ve	No
139	57.1	57.1	57	41.2	-0.1	-15.9	57.6	57.4	41.7	-0.2	-15.9	No Change	No
140	52.6	52.6	52.3	40.5	-0.3	-12.1	53.1	52.8	41.1	-0.3	-12.0	No Change	No
141	49.6	49.6	49.1	39	-0.5	-10.6	50.1	49.6	39.6	-0.5	-10.5	No Change	No
142	50.1	50.2	49.4	40.9	-0.8	-9.3	50.8	50.1	41.5	-0.7	-9.3	Negligible +ve	No
143	45.3	45.3	45.2	28.7	-0.1	-16.6	45.9	45.8	29.2	-0.1	-16.7	No Change	No
144	50.2	50.2	50.1	34.1	-0.1	-16.1	50.7	50.6	34.6	-0.1	-16.1	No Change	No
145	56.9	56.9	56.8	37.8	-0.1	-19.1	57.3	57.2	38.3	-0.1	-19.0	No Change	No

Table 7-10: Summary of Subjective Change in Noise Levels, at the Noise Sensitive Properties in the Design Year (2036).

Impact	No Change	Negligible	Noticeable	Clearly Noticeable	Substantial	Very Substantial
Negative	17	2	1	0	0	0
Positive		15	5	1	3	2

There will be either a 'No Change' or a 'Negligible' increase or decrease in traffic noise levels at 34 of 46 noise sensitive receiver locations assessed in proximity to the *Proposed Road Development*.

The main changes in noise levels are a noticeable to very substantial positive change in noise levels at 11 properties, numbered as 106, 105, 132, 104, 128, 114, 127, 129, 116 and 115. There is predicted significant improvement in noise levels at these properties as the *Proposed Road Development* will move these properties further from the national primary route and there will also be a benefit from the use of a low noise surface. Properties 114, 115, 116 and 117 are located to the west of the existing N16 alignment between c Ch. 850m – 1,050m. Properties 127, 128 and 129 are located to the east of the existing N16 alignment between c. Ch. 1,550m – 1,700m.

There will be a 'noticeable' increase in noise levels of approximately 3 dB(A) and hence, a negative impact in noise levels at property 125. This property is located approximately 140m from the existing N16 alignment and will be approximately 60m from the centreline of the new N16 alignment. However, there will be no mitigation required at this location as the predicted noise level is well below the 60 dB L_{den} design goal as specified in the TII Guidelines.

Currently, there are 25 properties within 300m of the N16 that are in excess of the 53 dB(A) L_{den} WHO (2018) guideline value and 8 properties that are in excess of the 60 dB(A) L_{den} TII design goal. With the *Proposed Road Development* there will 18 properties within 300m of the N16 that are in excess of the 53 dB(A) L_{den} WHO (2018) guideline value and 3 properties that are in excess of the 60 dB(A) L_{den} TII design goal. Therefore, the *Proposed Road Development* will have a positive impact in terms of future predicted noise levels.

7.5 Mitigation

Noise and vibration mitigation measures for the two phases of the *Proposed Road Development* that may impact on the existing noise climate in the area are outlined below. These are:

- Construction Phase Mitigation Measures, and
- Operational Phase Mitigation Measures.

7.5.1 Construction Phase Noise Mitigation Measures

In order to ensure that the noise limit of 70 dB(A) $L_{\mathbf{Aeq,\ 1\ hour}}$ will be achieved, noise emissions at the construction phase will be managed in accordance with the mitigation measures outlined below, which are consistent with the recommendations contained within BS 5228 *"Noise control on open and construction sites"*.

- No plant used on site will be permitted to cause an ongoing public nuisance due to noise.
- To ensure that where rock blasting / breaking is required, the noise limits outlined in Table 7-5 are not exceeded at 1m from the façade of the nearest noise sensitive properties, noise

monitoring will be carried out at the nearest noise sensitive properties (i.e. within approximately 100m of the construction works) during these works.

- If the noise limits outlined in Table 7-5 are exceeded at 1m from the façade of the nearest noise sensitive properties, temporary noise screens will be erected in close proximity to the noise source such as rock breakers, etc. to ensure that a noise level of less than 70 dB(A) $L_{Aeq\ 1\ hour}$ is achieved at the nearest noise sensitive properties.

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 ensure that:

- The best means practical, 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 of the "sound reduced" 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.
- Machines which are used intermittently will be shut down or throttled back to a minimum during those periods when they are not in use.
- Any plant such as generators or pumps which are required to work outside of normal working hours will be surrounded by an acoustic enclosure.
- Throughout the contract the supervision of the works will include ensuring compliance with the limits using the methods set out in BS 5228.

Works other than the pumping out of excavations, security and emergency works will not be undertaken outside the working hours outlined in Table 7-5 without the written permission of Sligo County Council. Works other than pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of Sligo County Council. When overtime and shift working, outside normal working hours, is permitted, the maximum permissible noise limits outlined in Table 7-5 will apply, subject to confirmation of operating hours and noise levels with Sligo County Council.

7.5.2 Construction Phase Vibration Mitigation Measures

If utilised by the contractor, blasting works may generate a potential vibration impact associated with the construction works that would be of sufficient magnitude to generate noticeable ground vibration.

The design, execution and completion of any blasting within 150 metres of any existing structure shall require special considerations. In such cases, the following recommended mitigation measures are proposed;

- Blasting trials will be carried out in order to monitor vibration patterns and provide an independent field assessment of full scale blasting,
- The blasting design, execution and completion of the rock excavation works shall limit the weight of explosive charges in each delay in order to: reduce vibration to a minimum, minimise overbreak, minimise induced instability in the rock mass, minimise fracturing of the rock in the rock slope as a result of the method of excavation and also prevent undercutting of embankment or cutting slopes, structure foundations and buried services and the like,
- The Design shall ensure that in a rock cutting containing intermediate benches, the drill holes and depths of sub-drill at each blast level shall be designed, executed and completed to minimise damage and instability at the edges of the bench,
- The Contractor shall liaise with land and property owners adjacent to the area of blasting and minimise disturbance or intrusion to the general public and prevent surprise or alarm being caused to the public and livestock during the execution and completion of the blasting,
- Prior to any rock blasting, the Contractor shall be responsible for notifying the public of any proposed blasting activities no later than 14 days in advance of the commencement of the blasting activities and shall publicise the work with an advisory notice which shall be published in the local press and be posted at public buildings and offices and other locations. Written notification and public notices shall as a minimum include all the following:
  - project details and name of Contractor,
  - location of proposed blasting activities,
  - precise dates and times of blasts,
  - the name, address and telephone number of a contact within the Contractors organisation who shall deal with queries from members of the public,
  - the period over which the blasting shall be undertaken or likely to undertaken and,
  - details of audible and visual warnings that shall be provided prior to all individual blasts.
- Where possible, blasting shall be carried out at the same time or times on each date,
- Carriageways shall be protected from fly rock or other debris, and there shall be no damage to adjacent property or infrastructure during the execution and completion of the blasting works,
- The potential for flyrock during blasting will be controlled by the blasting contractor. The blasting contractor will be required to take precautions for the protection of persons and property, including proper loading and stemming of holes and the use of blasting mats or other effective means of controlling the blast or resultant flying material. The blasting contractor will ensure that the danger area is clear of workers and residents and is kept clear during the blasting period.

- As and if deemed necessary during the construction phase, vibration monitoring will be carried out at affected properties (if any) during critical stages of the rock blasting and rock breaking/piling works (subject to property owner consent),
- The TII vibration limits will be complied with during rock blasting and rock breaking/piling works, and
- Property condition surveys will be offered for all buildings within 50m of the development boundary and those within 500m of proposed blasting works along the *Proposed Road Development*. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as follows:
  - the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to project commencement,
  - the second stage shall consist of post-construction condition surveys which shall include photographic records.

As stated, the main rock cut area along the proposed N16 alignment is at *Castlegal* (approximate chainage 900 – 1,160). The cutting required in this area will be approximately 13m deep at the deepest section (measured along the road centreline). A combination of rock breaking and blasting will also be undertaken to allow for the excavation of the Soil Repository/Borrow Pit, east of the proposed alignment at *Castlegal*.

7.5.3 Operation Phase Noise Mitigation Measures

The requirement for noise mitigation measures at the noise sensitive receiver locations has been examined based on a review of the three conditions which are required to be satisfied in order for mitigation measures to be deemed necessary as stipulated in the TII Guidelines.

Of the 46 No. receiver locations assessed, no receivers were deemed to require mitigation measures in the Year of Opening (2021) or the Design Year (2036) as the predicted traffic noise levels at noise sensitive receiver locations comply with the TII design goal criteria. Therefore, other than the Low Noise Surface already described, no noise mitigation measures need to be incorporated into the design of the proposed N16 road development.

7.5.4 Operation Phase Vibration Mitigation Measures

No vibration related mitigation measures are required in respect of the operational phase of the proposed N16 road development.

7.6 Residual Impacts

7.6.1 Construction Phase

Residual impacts refer to the prevailing noise climate after the *Proposed Road Development* and appropriate mitigation measures have taken effect as planned. Therefore, as the construction phase and its associated potential noise and vibration impacts are short term and temporary there will be no residual construction noise and vibration impacts.

7.6.2 Operation Phase

There will be either 'No Change' or a 'Negligible' increase or decrease in traffic noise levels at 34 of 46 noise sensitive receiver locations assessed in proximity to the *Proposed Road Development*. No receivers were deemed to require mitigation measures in the Year of Opening (2021) or the Design Year (2036) as the predicted traffic noise levels at noise sensitive receiver locations comply with the TII design goal criteria. It is proposed that in order to allow for a reduction in road traffic noise levels, a Stone Mastic Asphalt road surface, i.e. a Low Noise Surface, will be used in the *Proposed Road Development*.

The main changes in noise levels are a noticeable to very substantial positive change in noise levels at 11 properties, numbered as 106, 105, 132, 104, 128, 114, 127, 129, 116 and 115. There is predicted significant improvement in noise levels at these properties as the *Proposed Road Development* will move these properties further from the national primary route and there will also be a benefit from the use of the low noise surface. There will be a 'noticeable' increase in noise levels of approximately 3 dB(A) and hence, a negative impact in noise levels at property 125. This property is located approximately 140m from the existing N16 alignment and will be approximately 60m from the centreline of the new N16 alignment. However, there will be no mitigation required at this location as the predicted noise level is well below the 60 dB L_{den} design goal as specified in the TII Guidelines.

7.7 Difficulties Encountered in Compiling Information

No difficulties were encountered in compiling this noise and vibration impact assessment.

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 this Chapter and are contained within Volume 3 of the EIAR:

Fig. 7.1.1: Noise & Vibration Impact Assessment, Sheet 1 of 2;

Fig. 7.1.2: Noise & Vibration Impact Assessment, Sheet 2 of 2;

Fig. 7.2.1: Operational Phase Noise Contours, 2036, Do-Nothing, Sheet 1 of 2;

Fig. 7.2.2: Operational Phase Noise Contours, 2036, Do-Nothing, Sheet 2 of 2;

Fig. 7.3.1: Operational Phase Noise Contours, 2036, With Scheme, Sheet 1 of 2;

Fig. 7.3.2: Operational Phase Noise Contours, 2036, With Scheme, Sheet 2 of 2;

Fig. 7.4.1: Operational Phase Noise Contours, 2036, Scheme Only, Sheet 1 of 2;

Fig. 7.4.2: Operational Phase Noise Contours, 2036, Scheme Only, Sheet 2 of 2;

7.8.2 **Appendices contained in Volume 4**

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 7.1: Chapter 7 (Main Report Reference), Noise Methodology & Calculations;

8 Air Quality and Climate Change

8.1 Introduction

This Air Quality and Climate Impact Assessment evaluates the potential Air Quality and Climate impacts for the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*.

The Air Quality and Climate Impact Assessment initially sets out the methodology to be used for the assessment (Section 8.2), then describes the existing environment (Section 8.3), sets out the predicted impacts of the *Proposed Road Development* (Section 8.4), describes the mitigation measures to be incorporated in the *Proposed Road Development* (Section 8.5) and details any residual impacts (Section 8.6). The Air Quality and Climate Impact Assessment also described any difficulties encountered in compiling the information (Section 8.7).

During the construction phase for the *Proposed Road Development*, Air Quality and Climate impacts will potentially be generated by site preparation works, excavation and infilling works. During the operational phase for the *Proposed Road Development*, Air Quality and Climate impacts will result from vehicular emissions. Therefore, the potential Air Quality and Climate impacts on nitrogen oxides (NOx), nitrogen dioxide (NO_2) and particulates (PM_{10}) at sensitive receiver properties have been considered for both the construction and the operational phases of the *Proposed Road Development*.

The European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 came into effect on 1st September 2018. The Regulations transpose EIA Directive 2014/52/EU and give further effect to the 2011 Directive. In accordance with these Regulations, climate change constitutes an important element in assessment and decision-making processes. While the TII *Environmental Impact Assessment of National Road Schemes – A Practical Guide* notes that climate change and transboundary pollution issues are largely outside the scope of an EIS (now EIAR) for individual road developments, this Air Quality & Climate Assessment, as part of the EIAR, assesses whether the road development will impact positively or negatively on carbon dioxide emissions.

8.2 Methodology

8.2.1 **Relevant Guidance**

This Air Quality and Climate Impact Assessment is prepared in accordance with the requirements of Section (50) of the Roads Act 1993, (as amended), and having regard to the following TII guidance documents:

- Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes (Rev. 1) (TII 2011).
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (TII 2008).
- UK DMRB (1993) Design Manual for Roads and Bridges, Volume 11 Consolidated Edition, Part 1, HA207 / 07 Air Quality.

Based on the above, site specific baseline air quality monitoring has been carried out. Future air quality trends due to the predicted small traffic variations and the proposed road improvements have been predicted.

8.2.2 Baseline Surveys

Site specific baseline air quality monitoring has been carried out in proximity to the existing and proposed road alignment. The site-specific monitoring identifies the existing pollutant levels in the area and establishes compliance with relevant ambient air legislation.

Baseline air quality data has been undertaken at roadside monitoring locations along the existing and *Proposed Road Development*. Owing to the proximity of residential receivers to the *Proposed Road Development* and the potential for traffic derived emissions, nitrogen dioxide (NO_2) was monitored using diffusion tube monitoring at three locations throughout June 2018. The diffusion tubes were installed at roadside locations and then analysed using ultra violet spectrophotometry at a UKAS accredited laboratory, giving an average concentration over the period. The diffusion tube monitoring locations are presented in Figure 8.1.1 and 8.1.2 contained within Volume 3 of this EIAR. [Note: The diffusion tube at AQML 2 was removed during the monitoring period and was not collected from site for subsequent analysis].

8.2.3 Construction Phase Impact Assessment

8.2.3.1 Dust Emissions

Construction dust has the potential to cause local impacts at the nearest sensitive receivers and ecosystems. The potential for dust generation from the construction activities associated with the *Proposed Road Development* have been assessed based on a review of the construction methodologies and the proximity of these activities to sensitive receivers. The degree of dust generation depends on the nature of the dust (soils, peat, sands, gravels, silts etc.) the nature of the construction activity (excavation, stone importation, backfilling etc.) and the potential for dust dispersion and deposition related to local meteorological factors such as rainfall, wind speed and wind direction. The potential for dust emissions from the construction phase of the project has been addressed qualitatively in accordance with the TII Guidelines.

8.2.4 Operation Phase Impact Assessment

8.2.4.1 Air Quality Impact Prediction Methodology

A prediction of ground level concentrations of traffic derived pollutants was carried out using the procedures outlined in the local model of the *Design Manual for Roads and Bridges: Volume 11 Environmental Assessment, Part 1, HA207 / 07 Air Quality* as recommended by the TII Guidelines.

The DMRB screening model provides a means of predicting pollutant concentrations associated with road traffic emissions. The method is a suitable approach in circumstances where the predicted environmental concentrations (i.e. ambient background + predicted concentration) lie sufficiently below the air quality standards (taken to be <90% of the standard), and where there are no complex or unusual features, e.g. grade separated junctions or road links with gradients >2.5%. Therefore, the DMRB Screening Method, Version 1.03c (July 2007) and subsequently the NO_X to NO_2 calculator, (version 6.1, 17 October 2017) has been used to predict the resultant pollutant concentrations associated with road traffic emissions from the *Proposed Road Development*.

Predictions of the concentrations of oxides of nitrogen (NO_x), nitrogen dioxide (NO_2) and particulate matter (PM_{10}) for the following future scenarios was undertaken:

- 2018 Base Year
- 2021 Do-Minimum (road remains as per existing alignment)
- 2021 Do-Something (proposed upgrade in operation)

- 2036 Do-Minimum (road remains as per existing alignment)
- 2036 Do-Something (proposed upgrade in operation)

The changes in emissions will be influenced by changes in traffic flow, composition and speed. The model requires input data on Annual Average Daily Traffic flow (AADT), annual average speeds, the proportion of different vehicle types, the type of road, and the distance from the center of the road to the receiver.

In accordance with the TII Guidelines receivers within 200m of the *Proposed Road Development* were identified and assessed for constructional and operational phase air quality related impacts. The selected receivers include relevant locations where the impact of the *Proposed Road Development* is expected to be greatest. The five sensitive residential locations (receivers) considered as part of the air quality assessment are:

- AQSR 1 – Receiver No. 104
- AQSR 2 – Receiver No. 118
- AQSR 3 – Receiver No. 125
- AQSR 4 – Receiver No. 129
- AQSR 5 – Receiver No. 132

8.2.4.2 Sensitive Ecosystems

The impact of oxides of nitrogen (NO_x) on sensitive ecosystems can be a concern in relation to road projects. The TII has developed a mechanism for the assessment of the significance of this impact. The TII Guidelines state that should the predicted concentrations exceed 90% of the annual NO_x limit (30 $\mu g/m^3$ as specified in S.I. 180 of 2011) or predict an increase of 2 $\mu g/m^3$ in the annual average, then the sensitivity of the relevant species should be assessed by the project ecologist. If any of the designated sites are sensitive to nitrogen deposition, then the incremental nitrogen deposition rate should be calculated for the proposed development, both with and without the road development. Sites within 3km of the middle point of the *Proposed Road Development* were considered. Table 8-1 outlines the location of these nearest designated sites to the *Proposed Road Development*.

Table 8-1: Nearest designated sites to the proposed road development (distance from centre of proposed road development)

Name	Distance (km)	Designation	Easting	Northing
Sligo/Leitrim Uplands SPA	0.181	SPA	572074	841123
Crockauns/Keelogyboy Bogs NHA	0.239	NHA	572107	841206
Benbulben, Gleniff and Glenade, Complex SAC	2.308	SAC	571801	873396

The nearest potentially sensitive ecosystem to nitrogen deposition is located at Crockauns/Keelogyboy Bogs NHA, which encroaches on the *Proposed Road Development*. At the closest point Sligo/Leitrim Uplands SPA is approximately 70m from the *Proposed Road Development*.

The TII Guidelines requires the Air Quality specialist to liaise with the Biodiversity specialist on all road developments where there is a designated conservation area, including a European site, within 2 km of the route corridor. The Biodiversity specialist will undertake the assessment of impacts on sensitive ecological sites, and the Air Quality specialist should therefore liaise with the Biodiversity specialist to assist in this process from an Air Quality perspective. However, as the potential impact of a road development is limited to a local-scale assessment, detailed consideration need only be given to roads where there is a significant change to traffic flows (>5%) and the designated site lies within 200 m of the road centre line. As outlined in the Chapter 4 of the EIAR, there will be no change to traffic flows due to the *Proposed Road Development* (no reassignment) and therefore, will be no significant air quality impact on local air quality at the designated sites within 200m of the road centre line.

8.2.4.3 Impact Assessment Criteria

During the construction phase, dust is considered the main potential pollutant. However, there is no Irish or European Union or Commission guideline or legislative limits for total suspended particles, so the limits provided by the TA Luft guidance '*Technical Instructions on Air Quality Control*' (TA Luft, 2002) are employed. Under this guidance, the Main Contractor will be required to maintain monthly dust levels below the guideline limit of 350mg/m^2/day as an annual average at sensitive receivers. Below this threshold, the potential for dust nuisance to impact on people in the nearest residential, commercial or other structures will be minimised. In addition to the human impact, dust or particles falling onto plants can physically smother the leaves affecting photosynthesis, respiration and transpiration. The DMRB has reported that based on a literature review the most sensitive species (Epiphytic lichen and Sphagnum dominated communities) appear to be affected by dust deposition at levels above 1,000 mg/m^2/day which is significantly greater than the level at which dust deposition may start to cause a perceptible nuisance to humans (350 mg/m^2/day).

For the operational phase, 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. In May 2008, the European Commission introduced a new Directive on ambient air quality and cleaner air for Europe (2008/50/EC), which has been transposed into Irish Legislation through the Air Quality Standards Regulations (S.I. 180 of 2011). The legislation specifies limit values in ambient air for sulphur dioxide (SO_2), lead (Pb), benzene (C_6H_6), particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x). (See Table 8-2). These limits are mainly for the protection of human health and are largely based on review of epidemiological studies on the health impacts of these pollutants. Only the standards related to nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x) and particulate matter (PM_{10}) are relevant for the assessment of national road schemes.

In addition, the Air Quality Standards Regulations (S.I. 180 of 2011) specify limits that apply to the protection of the wider environment and any sensitive ecosystems (i.e. sensitive designated protected areas for flora and fauna within 200m of any road that could be affected by the proposed development, both during construction and operation).

The TII Guidelines specifies the significance criteria for determining air quality impacts. Any potential increases or decreases along the route were identified in order to determine the significance of any impact in relation to the TII Guidelines criteria as presented in Table 8-3 to Table 8-5.

Table 8-2: Air Quality Standards Regulations (S.I. 180 of 2011)

Pollutant	**Criteria**	**Limit Value**
Nitrogen Dioxide (NO_2)	Hourly limit for protection of human health - not to be exceeded more than 18 times / year	200 µg/m^3
	Annual limit for protection of human health	40 µg/m^3
Nitrogen oxides (NOx)	Annual limit for protection of vegetation	30 µg/m^3
Benzene (C_6H_6)	Annual limit for protection of human health	5 µg/ m^3
Carbon Monoxide (CO)	Maximum daily 8-hour running mean	10 µg/ m^3
Lead (Pb)	Annual limit for protection of human health	0.5 µg/ m^3
Sulphur Dioxide (SO_2)	Hourly limit for protection of human health - not to be exceeded more than 24 times / year	350 µg/ m^3
	Daily limit for protection of human health - not to be exceeded more than 3 times / year	125 µg/ m^3
	Annual limit for protection of vegetation	20 µg/ m^3
Particulate Matter (PM_{10})	24-hour limit for protection of human health - not to be exceeded more than 35 times / year	50 µg/ m^3
	Annual limit for protection of human health	40 µg/m^3
Particulate Matter ($PM_{2.5}$)	Annual target value for the protection of human health (Stage 1 to be achieved by 2015)	25 µg/m^3
	Indicative limit for the protection of human health (Stage 2 to be achieved by 2021)	20 µg/m^3

Table 8-3: Definition of Impact Magnitude for Changes in Ambient Air Pollutant Concentrations (TII Guidelines, 2011)

Magnitude of Change	**Annual Mean NO_2 / PM_{10}**	**No. of Days with PM_{10} concentration greater than 50 µg/m3**	**Annual Mean $PM_{2.5}$**
Large	Increase / decrease ≥4 µg/m^3	Increase / decrease >4 days	Increase / decrease ≥2.5 µg/m^3
Medium	Increase / decrease 2 - <4 µg/m^3	Increase / decrease 3 of 4 days	Increase / decrease 1.25 - <2.5 µg/m^3
Small	Increase / decrease 0.4 - <2 µg/m^3	Increase / decrease 1 or 2 days	Increase / decrease 0.25 - <1.25 µg/m^3
Imperceptible	Increase / decrease <0.4 µg/m^3	Increase / decrease <1 day	Increase / decrease <0.25 µg/m^3

Table 8-4: Air Quality Impact Descriptors for Changes in Annual Mean Nitrogen Dioxide and PM10 and PM 2.5 Concentrations at a Receiver (TII Guidelines, 2011)

Absolute Concentration in Relation to Objective / Limit Value	**Changes in Concentration**		
	Small	**Medium**	**Large**
Increase with Development			
Above Objective / Limit Value with Scheme (≥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 Scheme (36-<40 µg/m^3 of NO_2 or PM_{10}) (22.5-<25 µg/m3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective / Limit Value with Scheme (30-<36 µg/m3 of NO_2 or PM_{10}) (18.75-<22.5 µg/m3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective / Limit Value with Scheme (<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 Development			
Above Objective / Limit Value with Scheme (≥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 Scheme (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 Scheme (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

Absolute Concentration in Relation to Objective / Limit Value	Changes in Concentration		
	Small	Medium	Large
Well Below Objective / Limit Value with Scheme (<30 µg/m³ of NO_2 or PM_{10}) (<18.75 µg/m³ of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Table 8-5: Air Quality Impact Descriptors for Changes in Number of Days with PM_{10} Concentrations Greater than 50 µg/m3 at a Receiver (TII Guidelines, 2011)

Absolute Concentration in Relation to Objective / Limit Value	Changes in Concentration		
	Small	Medium	Large
Increase with Development			
Above Objective / Limit Value with Scheme (≥35days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective / Limit Value with Scheme (32-<35days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective / Limit Value with Scheme (26-<32days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective / Limit Value with Scheme (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Development			
Above Objective / Limit Value with Scheme (≥35days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective / Limit Value with Scheme (32-<35days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective / Limit Value with Scheme (26-<32days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective / Limit Value with Scheme <26 days)	Negligible	Negligible	Slight Beneficial

8.2.5 Climate Impact Assessment

The Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August 2018) state the following with regards to impact on climate;

The Directive 2014/52/EU requires the assessment of the impact on climate (e.g. greenhouse emissions) and the vulnerability of the project to climate change. There are two key aspects to be addressed:

- Climate change mitigation – impact of the project on climate change, primarily through greenhouse gas emissions (direct and indirect);

- Climate change adaptation – vulnerability of the project to future changes in climate and its capacity to adapt to the impacts of climate change.

An assessment of the impact on climate change (including greenhouse gas (GHG) emissions) from the construction phase and operational phase of the *Proposed Road Development* has been undertaken using the new Transport Infrastructure Ireland (TII) calculation tool for assessing lifecycle carbon emissions for national road and light rail infrastructure projects in Ireland. The purpose of the tool is to assist Transport Infrastructure Ireland (TII) and its contractors in complying with the requirements of the revised Environmental Impact Assessment (EIA) Directive 2014/52/EU, which requires European Union (EU) Member States to assess the impact of projects on climate change (including greenhouse gas (GHG) emissions) as part of the EIA process.

Using the TII Transport Infrastructure Ireland Carbon Tool for Road and Light Rail Projects: Guidance, the lifecycle carbon emissions for the road project have been calculated. The calculation tool for lifecycle carbon emissions assesses various stages of the road project as follows;

- "**Before Use - Pre-Construction"** stage, includes for clearance and demolition activities, including the area of land to be cleared.
- **"Before Use - Embodied"** stage, includes for details on the materials that will be used.
- **"Before Use - Construction"** stage, includes for details of the activities that will take place during construction, including excavation, fuel use, water use and potential for low-carbon alternatives.
- **"Before Use - Waste"** stage, considers construction waste and waste transport.
- The **"Use Stage"** of a project, includes for information on the operational emissions per year, including anticipated energy use during operation, anticipated water use during operation, anticipated waste arisings and transport of waste during use, anticipated plant and fuel use for maintenance, repair, replacement and refurbishment, anticipated emissions associated with use of the infrastructure and details of potential low-carbon alternatives.
- "**End of Life**" stage, in which decommissioning is considered.

8.3 Existing Environment

8.3.1 Background Air Pollutant Concentrations

8.3.1.1 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is classed as both a primary and a secondary pollutant. As a primary pollutant NO_2 is emitted from all combustion processes (such as a gas / oil fired boiler or a car engine). As a secondary pollutant NO_2 is derived from atmospheric reactions of pollutants that are themselves, derived mainly from traffic sources. NO_2 has been shown to reduce the pulmonary function of the lungs. Long-term exposure to high concentrations of NO_2 can cause a range of effects, primarily in the lungs, but also in the liver and blood. The diffusion tube monitoring results for the three selected roadside monitoring locations are presented in Table 8-6.

Table 8-6: Results of diffusion tube baseline monitoring.

Reference	Location	Grid Reference	NO_2 Concentration (µg/m^3)
AQML 1	Junction of N16 and L3404 near to Receiver 104	572413, 841616	8.23
AQML 2	Along existing N16 and near to Receivers 116 & 117	571646, 840709	7.39
AQML 3	Junction of N16 and L3406 (Drum Road) near to Receivers 131 & 132	571735, 839739	Diffusion Tube Missing
Annual limit for protection of human health			40

The results indicate that existing NO_2 concentrations in the area are less than 25% of the annual limit for the protection of human health (40 µg/m^3). Hence, air quality is very good in the study area.

8.3.1.2 Nitrogen Oxides (NOx)

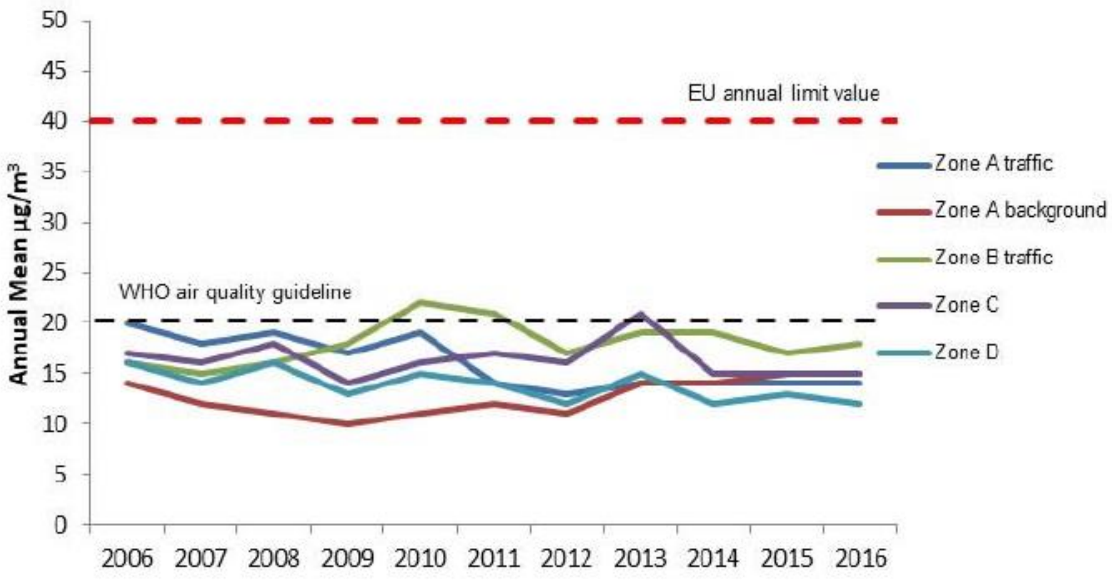
Oxides of nitrogen (NO_x) are the sum of NO_2 and NO and is both a primary and secondary pollutant. NO_x is an atmospheric precursor for acid rain on reaction with water to form nitric acid. NO_x may have a positive or negative impact by acting as a fertiliser or a phytotoxicant. Effects are mainly on growth, photosynthesis and nitrogen assimilation / metabolism. As such, there is an annual limit for the protection of vegetation of 30 µg/m^3.

8.3.1.3 Particulate Matter (PM_{10} & $PM_{2.5}$)

Particulate matter (PM_{10} & $PM_{2.5}$) may be emitted as a primary pollutant from road vehicle exhausts, which is a main source in urban areas. Also, combustion sources such as domestic fires, industrial boilers etc. are primary sources of PM_{10} & $PM_{2.5}$. PM_{10} & $PM_{2.5}$ may also be formed as secondary pollutants from the condensation or reaction of chemical vapours in the atmosphere. Health effects associated with PM_{10} & $PM_{2.5}$, in the long term, include chronic effects such as increased rates of bronchitis and reduced lung function.

No results for PM_{10} monitoring at an EPA Air Quality Monitoring Station in the vicinity of the *Proposed Road Development* are available. Figure 8-1 outlines annual mean PM_{10} concentrations measured by the EPA in the four zones in Ireland 2006 – 2016. This indicates that the PM_{10} levels for Zone D are approximately 12µg/m^3 and are well below the EU annual limit value of 40µg/m^3 and WHO air quality guideline of 20µg/m^3 respectively.

Figure 8-1: Annual mean PM10 concentrations in Zone A-D in Ireland 2006 – 2016



The EPA published a research report entitled *Nature and Origin of PM_{10} and Smaller Particulate Matter in Urban Air* (EPA, 2006) which examined the relationship between PM_{10} and $PM_{2.5}$ in Ireland. The study found that consistently between urban, rural and coastal locations in Ireland, the $PM_{2.5}$ fraction of PM_{10} is approximately 60%. This approximation is borne out by the $PM_{2.5}$ values recorded in Ireland in 2008, 2009 and 2010 in Zone A, B and C locations. Applying this fraction to the EPA PM_{10} data for Zone D would indicate an approximate $PM_{2.5}$ annual average of 7.2 µg/m^3 compared to the annual target value for the protection of human health of 25 µg/m^3.

A PM_{10} background concentration of 12 µg/m^3 in 2016 has been used in the DMRB screening model impact assessment predictions. This is considered representative of a worst-case background PM_{10} level for the study area of the *Proposed Road Development*.

8.4 Impact Assessment

There are two phases of the *Proposed Road Development* that may impact on the existing air quality environment in the area. These are:

- Construction phase, and
- Operation phase.

8.4.1 Construction Phase Impact Assessment

It is anticipated that the associated construction operations will extend over a period of 12 – 18 months. The majority of the works associated with the construction of the *Proposed Road Development* will be ground works that are required in order to excavate the cut sections and to form the embankments along the alignment of the *Proposed Road Development*. It is anticipated that varying degrees of overburden and bedrock removal and infilling will be required in a number of cut and fill sections as well as a proposed Soil Repository/Borrow Pit along the proposed alignment.

Construction works will also include road paving and installation of services, etc. along the proposed alignment. Equipment such as rock breakers, rock drilling (and blasting) excavators, dump trucks, rollers, generators, etc. will be the main dust sources associated with the construction phase of the *Proposed Road Development*. It is anticipated that, due to the relatively online nature of the works, the relatively small earthworks requirements and the requirement for maintaining the current traffic flows, the construction dust impact from the *Proposed Road Development* will be minimised and is likely to be relatively low impact in comparison to comparatively much larger offline road construction projects.

8.4.1.1 Construction Phase Dust Emissions

In accordance with the TII Guidelines, where there are operations at a construction site there is a risk that dust may cause an impact at sensitive receivers in close proximity to the source of the dust generated. The distances in Table 8-7 present the potential for dust impact with standard mitigation in place (source TII Guidelines).

Table 8-7: Assessment criteria for the impact of dust from construction, with mitigation in place.

Source		**Potential distance from source for significant effects**		
Scale	**Description**	**Soiling**	**PM_{10}**	**Vegetation Effects**
Major	Large constructions sites, with high use of haul roads.	100m	25m	25m
Moderate	Moderate sized construction sites, with moderate use of haul roads.	50m	15m	15m
Minor	Minor construction sites, with limited use of haul roads.	25m	10m	10m

The ground works associated with the construction of the *Proposed Road Development* will include cuttings, excavations, embankments and fill sections, road paving and installation of signage and services etc. along the proposed alignment. The main rock cut area along the proposed N16 alignment is at *Castlegal* (approximate Ch. 850 – 1,150). The cutting required in this area will at its deepest be approximately 12-13m deep (measured at the road centreline). It is anticipated that excavation will be carried out via rock ripping with some potential for blasting (appropriate blasting mitigation measures have been outlined in Section 8.5.1). The rock from the cutting at *Castlegal* will be reused as general fill and capping material along the proposed alignment. It is also proposed that there will be a Soil Repository/Borrow Pit constructed adjacent to the rock cutting at *Castlegal*. This site to the east of the alignment will provide suitable fill/capping material for use elsewhere along the proposed alignment and also accept unsuitable glacial till material in the repository stage. The construction of the Soil Repository/Borrow Pit will also require rock ripping with potential for blasting. Appropriate dust mitigation measures have been outlined in Section 8.5.1.

The closest receiver properties to the rock cut area at *Castlegal* are property No.'s 116, 117 & 118. Property No.'s 116 and 117 are approximately 100m from the rock cut area at *Castlegal*. Property No. 118 is approximately 80m from the Soil Repository/Borrow Pit at *Castlegal*. Given the size and scale of the proposed cutting and the Soil Repository/Borrow Pit at *Castlegal* along the *Proposed Road Development*, this can be considered to be a *'major sized construction site, with high use of haul roads'*. There are three sensitive receiver locations located within 100m of the extents of the proposed construction works at *Castlegal* that may be potentially exposed to dust impacts during the construction.

At *Lugatober*, Property No.'s 125 and 126 are approximately 50m and 20m respectively from a proposed 4m deep cutting which will have steepened earth slopes. At this location there is the potential for rock to be encountered at a depth of 3m. Therefore, in this localised area, excavation of the rock in close proximity to the nearby properties will be undertaken using a process of rock splitting rather than rock breaking or blasting. This method produces significantly less vibration and dust arisings.

To minimise the potential dust impact, a series of dust mitigation measures are presented in Section 8.4.2.2. Construction related dust impacts at sensitive receiver locations located in proximity to the proposed construction works is likely to result in a 'Temporary Slight Adverse' impact. As stated, dust mitigation measures will be put in place to reduce the impact level.

8.4.2 Operation Phase Impact Assessment

8.4.2.1 Air Quality Impact Assessment Predictions

The Air Quality impact from the *Proposed Road Development* has been calculated in accordance with the TII Guidelines and the DMRB Screening Methodology. The Air Quality Sensitive Receiver (AQSR) locations considered as part of the air quality assessment have been selected where the potential greatest impact of the *Proposed Road Development* may occur. The five Air Quality Sensitive Receiver (AQSR) locations considered are presented in Figure 8.1.1 and 8.1.2 contained within Volume 3 of this EIAR. The distance to the existing and proposed alignments is based on the distance from the front façade of the property to the road centreline.

Table 8-8: Air Quality Sensitive Receiver (AQSR) locations assessed in DMRB Screening Model.

Sensitive Receiver Reference & Location	Distance to Road - Do Nothing Scenario	Distance to Road - Do Something Scenario	Grid Reference
AQSR 1 – Receiver No. 104	50m to existing N16. 44m to L-3406 (Drum Road)	48m to proposed N16. 44m to L-3406-D (Drum Road)	571686, 839821
AQSR 2 – Receiver No. 118	153m to existing N16. 8m to L-7415	72m to proposed N16. 14m to L-7415	571821, 840520
AQSR 3 – Receiver No. 125	144m to existing N16. 21m to L-7413	58m to proposed N16. 26m to L-7413	571793, 841094
AQSR 4 – Receiver No. 129	56m to existing N16.	56m to proposed N16.	572066, 841322
AQSR 5 – Receiver No. 132	13.5m to existing N16	74m to proposed N16.	572335, 841699

The background pollutant concentrations presented in Table 8-9 have been used in the DMRB screening model impact assessment predictions, based on the information contained in Section 8.3. These are worst-case background concentrations.

To adjust annual mean NO_2, NO_x and PM_{10} concentrations to the Base Year (2018) and the Future Years (2021 and 2036), the correction factors shown in Boxes A5.1 to A5.4 of the TII Guidelines were used. As stated in the TII Guidelines, for years beyond 2021 it should be assumed that there would be no further reduction in background pollutant concentrations.

Table 8-9: Background Air Quality Concentrations (µg/m³) used in the DMRB Assessment (using the correction factors shown in Boxes A5.1 to A5.4 of the TII Guidelines)

Year	Annual Mean Concentration (µg/m³)		
	NO_2	NO_x	PM_{10}
2016	-	-	12
2018	10	15	11.86
2021	9.11	13.62	11.73
2036	9.11	13.62	11.73

The predicted pollutant concentrations in the vicinity of the *Proposed Road Development* due to existing and proposed traffic emissions are presented in Table 8-10 and Table 8-11. This is based on the existing and predicted Annual Average Daily Traffic Flow (AADT) and the relevant proportion of different vehicle types.

Table 8-12 presents the description of impact on NO_2 and PM_{10} concentrations as a result of *Proposed Road Development* at the receiver locations in 2021 and 2036.

Table 8-10: Predicted pollutant concentrations in the vicinity of the proposed road development due to traffic emissions.

Receiver Location	Year & Scenario	Predicted pollutant concentrations (incl. background)			
		NO_x	NO_2	PM_{10}	
		Annual mean µg/m³	Annual mean µg/m³	Annual mean µg/m³	Days >50 µg/m³
AQSR 1 – Receiver No. 104	2018 – Base Year	16.07	10.36	11.96	0.00
	2021 – Do Nothing	14.69	9.48	11.83	0.00
	2021– Do Something	14.90	9.55	11.87	0.00
	2036 – Do Nothing	14.81	9.52	11.84	0.00
	2036 – Do Something	15.00	9.58	11.89	0.00
AQSR 2 – Receiver No. 118	2018 – Base Year	15.16	10.05	11.88	0.00
	2021 – Do Nothing	13.78	9.17	11.75	0.00
	2021– Do Something	14.28	9.34	11.80	0.00
	2036 – Do Nothing	13.80	9.17	11.75	0.00
	2036 – Do Something	14.35	9.36	11.82	0.00
	2018 – Base Year	15.20	10.07	11.88	0.00

Receiver Location	Year & Scenario	Predicted pollutant concentrations (incl. background)			
		NO_x	NO_2	PM_{10}	
		Annual mean µg/m³	Annual mean µg/m³	Annual mean µg/m³	Days >50 µg/m³
AQSR 3 – Receiver No. 125	2021 – Do Nothing	13.78	9.16	11.75	0.00
	2021– Do Something	14.46	9.40	11.83	0.00
	2036 – Do Nothing	13.83	9.18	11.75	0.00
	2036 – Do Something	14.58	9.44	11.84	0.00
AQSR 4 – Receiver No. 129	2018 – Base Year	17.12	10.71	12.05	0.00
	2021 – Do Nothing	15.74	9.83	11.92	0.00
	2021– Do Something	14.18	9.31	11.79	0.00
	2036 – Do Nothing	15.97	9.91	11.95	0.00
	2036 – Do Something	14.24	9.33	11.80	0.00
AQSR 5 – Receiver No. 132	2018 – Base Year	15.40	10.14	11.91	0.00
	2021 – Do Nothing	14.02	9.25	11.78	0.00
	2021– Do Something	14.06	9.26	11.78	0.00
	2036 – Do Nothing	14.07	9.27	11.78	0.00
	2036 – Do Something	14.11	9.28	11.79	0.00
LIMIT VALUE		30 µg/m3	40 µg/m3	40 µg/m3	35

Table 8-11: Predicted Nitrogen Dioxide (NO_2) concentrations in the vicinity of the proposed road development due to traffic emissions, using the DEFRA NOx to NO_2 calculator (version 6.1, 17 October 2017).

Receiver Location	Year & Scenario	Road Increment NO_x µg/m³	Background µg/m³		Total NO_2 µg/m³	Road NO_2 µg/m³
			NO_x	NO_2		
AQSR 1 – Receiver No. 104	2018 – Base Year	16.07	15	10	18.63	8.63
	2021 – Do Nothing	14.69	13.62	9.11	17.06	7.95
	2021– Do Something	14.90	13.62	9.11	17.17	8.06
	2036 – Do Nothing	14.81	13.62	9.11	16.85	7.74
	2036 – Do Something	15.00	13.62	9.11	16.95	7.84
	2018 – Base Year	15.16	15	10	18.15	8.15

Receiver Location	Year & Scenario	Road Increment NO_x µg/m³	Background µg/m³		Total NO_2 µg/m³	Road NO_2 µg/m³
			NO_x	NO_2		
AQSR 2 – Receiver No. 118	2021 – Do Nothing	13.78	13.62	9.11	16.58	7.47
	2021– Do Something	14.28	13.62	9.11	16.84	7.73
	2036 – Do Nothing	13.80	13.62	9.11	16.34	7.23
	2036 – Do Something	14.35	13.62	9.11	16.62	7.51
AQSR 3 – Receiver No. 125	2018 – Base Year	15.20	15	10	18.17	8.17
	2021 – Do Nothing	13.78	13.62	9.11	16.58	7.47
	2021– Do Something	14.46	13.62	9.11	16.94	7.83
	2036 – Do Nothing	13.83	13.62	9.11	16.35	7.24
	2036 – Do Something	14.58	13.62	9.11	16.73	7.62
AQSR 4 – Receiver No. 129	2018 – Base Year	17.12	15	10	19.17	9.17
	2021 – Do Nothing	15.74	13.62	9.11	17.6	8.49
	2021– Do Something	14.18	13.62	9.11	16.79	7.68
	2036 – Do Nothing	15.97	13.62	9.11	17.43	8.32
	2036 – Do Something	14.24	13.62	9.11	16.56	7.45
AQSR 5 – Receiver No. 132	2018 – Base Year	15.40	15	10	18.28	8.28
	2021 – Do Nothing	14.02	13.62	9.11	16.7	7.59
	2021– Do Something	14.06	13.62	9.11	16.73	7.62
	2036 – Do Nothing	14.07	13.62	9.11	16.48	7.37
	2036 – Do Something	14.11	13.62	9.11	16.5	7.39
LIMIT VALUE					40 µg/m³	40 µg/m³

Table 8-12: Description of impact on NO_2 and PM_{10} concentrations as a result of proposed development at the receiver locations in 2021 and 2036.

Receiver Name	Pollutant concentration / year	Absolute Change in 2021 / 2036	Relative Change (% of AQAL)	Percentage of predicted concentration relative to AQAL	Predicted Impact
AQSR 1 – Receiver No. 104	NO_2 / 2021	0.11	0.275%	42.925%	**Negligible**
	PM_{10} / 2021	0.04	0.1%	29.675%	**Negligible**
	NO_2 / 2036	0.10	0.04%	42.375%	**Negligible**

Receiver Name	Pollutant concentration / year	Absolute Change in 2021 / 2036	Relative Change (% of AQAL)	Percentage of predicted concentration relative to AQAL	Predicted Impact
	PM_{10} / 2036	0.05	0.125%	29.725%	**Negligible**
AQSR 2 – Receiver No. 118	NO_2 / 2021	0.26	0.65%	42.1%	**Negligible**
	PM_{10} / 2021	0.05	0.125%	29.5%	**Negligible**
	NO_2 / 2036	0.28	0.7%	41.55%	**Negligible**
	PM_{10} / 2036	0.07	0.175%	29.55%	**Negligible**
AQSR 3 – Receiver No. 125	NO_2 / 2021	0.36	0.95%	41.825%	**Negligible**
	PM_{10} / 2021	0.09	0.225%	29.6%	**Negligible**
	NO_2 / 2036	0.38	0.95%	41.825%	**Negligible**
	PM_{10} / 2036	0.09	0.225%	29.6%	**Negligible**
AQSR 4 – Receiver No. 129	NO_2 / 2021	-0.81	-2.025%	41.975%	**Negligible**
	PM_{10} / 2021	-0.13	-0.325%	29.475%	**Negligible**
	NO_2 / 2036	-0.87	-2.175%	41.4%	**Negligible**
	PM_{10} / 2036	-0.15	-0.375%	29.5%	**Negligible**
AQSR 5 – Receiver No. 132	NO_2 / 2021	0.03	0.075%	41.825%	**Negligible**
	PM_{10} / 2021	0	0%	29.45%	**Negligible**
	NO_2 / 2036	0.02	0.05%	41.25%	**Negligible**
	PM_{10} / 2036	0.01	0.025%	29.475%	**Negligible**

The predicted air quality pollutant concentration results have been compared with the relevant Air Quality Limit Value Regulations outlined in Table 8-2 and the TII Guidelines criteria in Table 8-3 to Table 8-5. Using the information as described, the results of the DMRB Screening assessment indicate that there will be a very slight increase or decrease in the NO_2 and PM_{10} concentrations in proximity to the *Proposed Road Development* at each of the receiver locations. Table 8-13 outlines the magnitude of change and the resulting air quality impacts which the *Proposed Road Development* will have on the receivers.

Table 8-13: Description of impact on NO_2 and PM_{10} concentrations as a result of proposed development at the receiver locations.

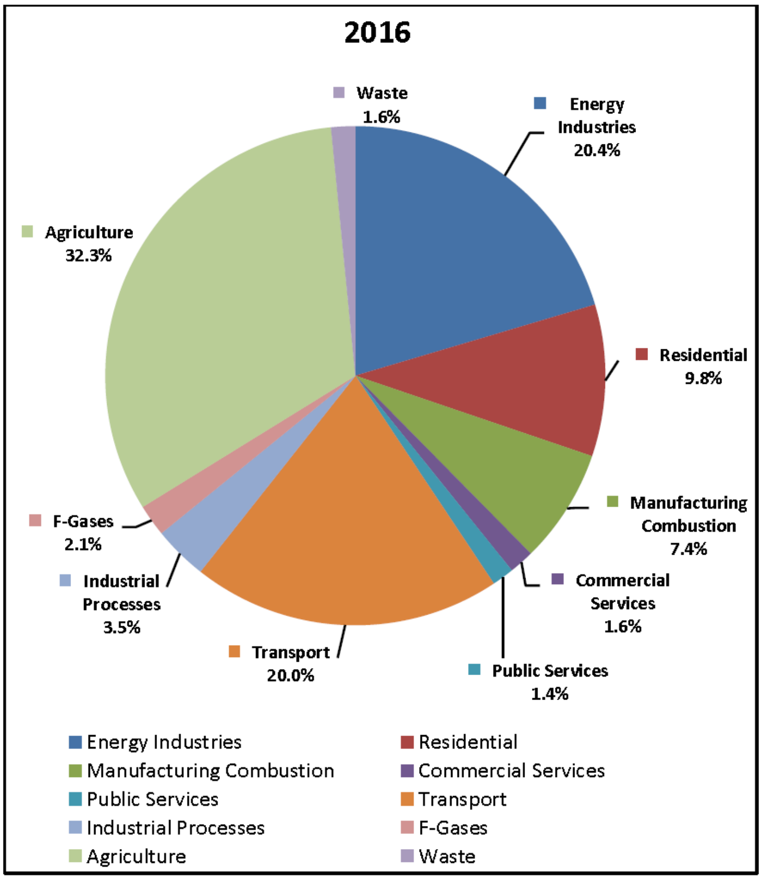
Receiver Name	Magnitude of Change	Impact Descriptor
AQSR 1 – Receiver No. 104	Imperceptible	Negligible
AQSR 2 – Receiver No. 118	Imperceptible	Negligible
AQSR 3 – Receiver No. 125	Imperceptible	Negligible

Receiver Name	Magnitude of Change	Impact Descriptor
AQSR 4 – Receiver No. 129	Small	Negligible
AQSR 5 – Receiver No. 132	Imperceptible	Negligible

8.4.2.2 Climate Impact Assessment Predictions

'Ireland's Final Greenhouse Gas Emissions 1990-2016' published by the EPA in April 2018 states that of all of Irelands Greenhouse Gas Emissions transport accounted for 20% in 2016. Road transport accounted for 19.1% of these transport greenhouse gas emissions. This is a steadily rising trend since 1990 when transport accounted for 9.3% of all of Ireland's greenhouse gas emissions.

Figure 8-2: Irelands Greenhouse Gas Emissions



Using the TII Transport Infrastructure Ireland Carbon Tool for lifecycle carbon emissions, the outputs for the construction and operation phase of the *Proposed Road Development* are outlined in Table 8-14, Table 8-15 and Table 8-16.

Table 8-14: CO_2 Emissions breakdown for the construction stage of the proposed N16 road project.

Before Use (kTonnesCO_{2e})			
Pre-Construction	**Embodied Carbon**	**Construction Activities**	**Total Construction**
0.00545	3.696135	1.045891	4.747477

The construction of the *Proposed Road Development* will take place over approximately 78 weeks and result in the emission of 4.75 kTonnesCO_{2e}. In comparison to the total greenhouse gas emissions in Ireland in 2016 of 61,545.82 kTonnesCO_{2e} the construction of the *Proposed Road Development* will result in 0.0077% of annual greenhouse gas emissions.

Table 8-15: CO_2 Emissions breakdown for the lifecycle operation stage of the proposed N16 road project.

Use (kTonnesCO_{2e})		
Use	**Vehicles using the infrastructure**	**Total Operation**
0.010320	22.183647	22.193967

Table 8-16: Annual CO_2 Emissions for the operation stage of the proposed N16 road project.

Estimated Annual Average Daily Traffic (AADT)	Estimated % HGVs	Average expected journey length (Km)	Annual Emissions (kTonnesCO_{2e})
3500	6%	2.55	0.739455

In comparison to road transport greenhouse gas emissions in Ireland in 2016 of 11,750.89 kTonnesCO_{2e} the operation of the *Proposed Road Development* will result in 0.006293% of annual road transport greenhouse gas emissions. In comparison to the total greenhouse gas emissions in Ireland in 2016 of 61,545.82 kTonnesCO_{2e} the operation of the *Proposed Road Development* will result in 0.001201% of annual greenhouse gas emissions. It is important to note that this road traffic volume already exists on the existing N16 road network and therefore, this is not an additional greenhouse gas emission. Due to the relatively small scale of the *Proposed Road Development* and the relatively small changes in alignment with no change in predicted traffic volumes with the proposed development in operation, there will be no climate impact due to the operation of the *Proposed Road Development* in comparison to the existing N16 alignment.

8.5 Mitigation Measures

8.5.1 Construction Phase Mitigation Measures

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 receiver locations and whether the wind can carry the dust to these locations. The implementation of a Dust Minimisation Plan during the construction phase of the project will include standard measures such as:

- Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only.
- Any site roads with the potential to give rise to dust will be regularly watered, as appropriate, during dry and/or windy conditions (also applies to vehicles delivering material with dust potential).
- Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary.
- Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind.
- Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods. Water bowers will be used across the areas as required on roads, stockpiles and material handling systems.
- All vehicles which present a risk of spillage of materials, while either delivering or removing materials, will be loaded in such a way as to prevent spillage on to the public road.
- The contractor will be required to ensure that all vehicles are suitably maintained to ensure that emissions of engine generated pollutants is kept to a minimum.
- Site traffic on haul roads will be restricted to 20 km/hr to minimise dust re-suspension.
- All material handling will be carried out to minimise drop heights from plant to plant or from plant to stockpile.

By adhering to good working practices and the implementation of the dust mitigation measures, the levels of dust generated will not cause an environmental nuisance. The Contractor will be required to maintain monthly dust levels below the guideline of 350 mg/m^2/day as an annual average at sensitive receivers. Where dust levels are found to be above this threshold, the mitigation measures in the area must be reviewed as part of the Dust Minimisation Plan.

8.5.1.1 Blasting mitigation measures

Blasting mitigation measures will form part of the Environmental Management System for the construction site. These measures relate to blasting procedures such as quantity of explosive and charge-hole spacing. Measures to control blasting impacts on air quality will include the following:

- Geological considerations in blast design.
- Dust filters fitted on the drilling rig when preparing blast holes.
- Optimise blast design with adequately spaced charges.
- Minimise air overpressure through proper blast design, spacing and timing of multiple charges.

- Inform nearby residents on day prior to planned blasting schedule using house-calls, written note/signage at entrance (or combination).
- A warning siren will be sounded prior to blast taking place.At *Lugatober*, Property No.'s 125 and 126 are approximately 50m and 20m respectively from a proposed 4m deep cutting which will have steepened earth slopes. At this location there is the potential for rock to be encountered at a depth of 3m. Therefore, in this localised area, excavation of the rock in close proximity to the nearby properties will be undertaken using a process of rock splitting rather than rock breaking or blasting. This method is significantly quieter and produces significantly less vibration.

8.5.2 Operation Phase Mitigation Measures

A series of EU Directives have outlined improved emission criteria which manufacturers are required to continually achieve from newly designed and manufactured vehicles. The introduction of the National Car Test (NCT) has also helped to reduce transport emissions by ensuring that all vehicles on Irish roads over 4 years old undergo an emissions test. The penetration of hybrids and electric cars in the national fleet into the future will have positive impacts on air quality.

As outlined above, if this development becomes operational, compliance with all the relevant limit values will be achieved at the nearest air quality sensitive receiver locations. Therefore, no route specific mitigation measures have been identified as a result of this assessment for the operational phase of the *Proposed Road Development*.

8.6 Residual Impacts

8.6.1 Construction Phase Residual Impacts

Residual impacts refer to the prevailing environment after the proposed mitigation measures have been implemented. Therefore, as the construction phase and its associated potential Air Quality and Climate impacts are temporary there will be no residual construction Air Quality and Climate impacts. Any construction related dust impacts at air quality sensitive receiver locations located in proximity to the proposed construction works is likely to result in a 'Temporary Slight Adverse' impact. As stated, dust mitigation measures will be put in place to reduce the impact level.

8.6.2 Operation Phase Residual Impacts

There will no significant change in traffic volumes in proximity to the *Proposed Road Development*. Therefore, there will be no long-term residual impact. At the level of changes presented for the proposed alignment coupled with the insignificant change in traffic volumes the predicted air quality impact on air quality sensitive receiver locations is classed as 'Negligible'.

8.7 Difficulties Encountered in Compiling Information

No difficulties were encountered in compiling this Air Quality and Climate impact assessment.

1.8 Cumulative Impacts

The *Proposed Road Development* involves a primarily online upgrade of the existing road network. The traffic assessment predicts that there will be no significant increase in traffic volumes over the

"Do-Minimum" scenario. Therefore, no cumulative impacts giving rise to a larger more significant impact are anticipated.

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 within Volume 3 of the EIAR:

Fig. 8.1.1: Air Quality & Climate Change Impact Assessment, Sheet 1 of 2;

Fig. 8.1.2: Air Quality & Climate Change Impact Assessment, Sheet 2 of 2;

8.8.2 **Appendices contained in Volume 4**

There are no appendices associated with this Chapter contained within Volume 4 of the EIAR.

9 Biodiversity

9.1 Introduction

This chapter has been prepared by McCarthy Keville O'Sullivan (MKO) and assesses the biodiversity of the receiving environment for the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*, Co. Sligo.

In this chapter, the biodiversity of the area within and surrounding the *Proposed Road Development* is first assessed in terms of habitats and species. The area over which the *Proposed Road Development* has the potential to result in effects (zone of influence) is then determined. Following this, the chapter identifies Key Ecological Receptors (KERs) within the zone of influence and assesses the potential for impacts thereon.

This chapter quantifies any potential impacts relating to flora/fauna and KERs and identifies the measures required to avoid, reduce and mitigate likely significant impacts. Identification of impacts and prescribed mitigation has been derived following a collaborative approach working with a multi-disciplinary team including project engineers, hydrologists, ecologists, landscape specialists and hydrogeologists. The results of ecological surveys have been utilised to inform the design of the *Proposed Road Development*, thereby minimising potential impacts on sensitive habitats and species of conservation interest.

The assessment of the development site began with a desk study of available published data on sites designated for nature conservation, other ecologically sensitive sites, habitats and species of interest in the vicinity of the *Proposed Road Development*. A review of OSI mapping, online environmental web-mappers and ortho-photography was also undertaken. The baseline information obtained from the desk study was the first stage in defining a zone of influence of the *Proposed Road Development*. The ecological surveys undertaken provided vital baseline information regarding the existing ecology of the study area.

This chapter includes the terms habitat, zone of influence and key ecological receptor in the impact assessment process. The meaning of these terms in the context of this chapter are described below:

- A habitat is the environment in which an animal or plant lives, generally defined in terms of vegetation and physical structures;
- Habitats and species of ecological significance occurring/likely to occur within the zone of influence (ZOI) were classified as Key Ecological Receptors (KERs);
- A KER is defined as a site, habitat, ecological feature, assemblage, species or individual that occurs within the vicinity of the *Proposed Road Development* and upon which impacts are likely.

The ZOI has been determined by careful scientific analysis of the *Proposed Road Development*, receiving environment within which the development is located. The ZOI includes the full extent of the surface water catchment to its coastal outfall. Habitats and potential foraging routes remote from the development, particularly for mammal species, were all considered in the establishment of the ZOI.

From 2016-2018 a range of specialist ecological survey work has been undertaken to provide comprehensive information on all ecological aspects of the ZOI. The studies and survey work undertaken provide a comprehensive inventory of the flora and fauna of the study area.

Using the comprehensive assessment of the existing environment (baseline conditions), it has been possible to accurately predict the likely impacts of the *Proposed Road Development* on the KERs and correctly assign an ecological significance to them.

Where potential impacts have been identified, detailed and specific mitigations have been developed in accordance with the hierarchy of options suggested in the research for the European Commission publication, 'Managing Natura 2000 Sites - The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC', 2000. The adopted approach, for the entire study area, was - avoid at source, reduce at source, abate on site, and finally abate at receptor. These measures have been incorporated into the *Proposed Road Development* as part of the avoidance and environmental protection strategy.

The information provided in this EIAR chapter, comprehensively describes the baseline ecological environment; provides an accurate prediction of the likely ecological impacts of the *Proposed Road Development*; prescribes mitigation as necessary; and, describes the residual ecological impacts. The specialist studies, analysis and reporting have been undertaken in accordance with the appropriate guidelines as fully described in the methodology section below.

9.1.1 Legislation, Guidance and Policy Context

This EIAR has been prepared and compiled in accordance with the provisions of the Roads Act, 1993 (as amended) and in accordance with the Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 as amended by Directive 2014/52/EU of the European Parliament of the Council of 16 April 2014 and we can also confirm, having reviewed the provisions of the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 that came into effect on 1 September 2018, that EIAR has also been prepared and compiled in accordance with those regulations, albeit we appreciate that regulations in relation to the Roads Act, 1993 are in the process of being prepared by the relevant Department.

This chapter addresses the effects on "biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC [Habitats Directive] and Directive 2009/147/EC [Birds Directive]".

This chapter should not be confused with the separate Natura Impact Statement and associated Screening Report prepared in compliance with Part XAB of the Planning and Development Acts 2000 to 2018 and Article 6(3) of the Habitats Directive. This chapter does not repeat the detailed assessment set out within the NIS.

In preparing this chapter, the principal legislative provisions applicable to habitats and species in Ireland:

- Irish Wildlife Acts 1976 to 2017;
- The European Communities (Birds and Natural Habitats) Regulations 2011, Part XAB of the Planning and Development Acts 2000 to 2018, the EU Birds Directive 2009/147/EC and the EU Habitats Directive 92/43/EEC);
- EU Regulation 1143/2014 on invasive alien species (and regulation 49 of European Communities (Birds and Natural Habitats) Regulations 2011).

The guidelines listed below were consulted in the preparation of this document to provide the scope, structure and content of the assessment.

- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002)
- European Commission (2002). Assessment of plans and projects significantly affecting Natura 2000 sites;
- Advice Notes on Current Practice (in preparation of Environmental Impact Statements) (Environmental Protection Agency (EPA), 2003);
- EPA (2003). Advice notes on current practice (in the preparation of Environmental Impact Statements. Environmental Protection Agency;
- Environmental Assessment and Construction Guidelines (NRA, 2006);

- Environmental Impact Assessment of National Road Schemes –A Practical Guide (NRA, 2009);
- Guidelines for assessment of Ecological Impacts of National Road Schemes, (NRA, 2009). (referred to hereafter as the NRA Ecological Impact Assessment Guidelines);
- NRA (2009). Guidelines for Assessment of Ecological Impacts of National Road Schemes (Revision 2). National Roads Authority
- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal (CIEEM, 2018);
- Draft Revised guidelines on the information to be contained in Environmental Impact Statements (EPA, 2017);

This assessment has been prepared with respect to the various planning policies and strategy guidance documents listed below:

- Sligo County Council. Sligo County Development Plan 2017 – 2023.
- Natura Impact Report of Sligo County Development Plan 2017 – 2023, Sligo County Council, (2017);
- DoEHLG (2013). Guidelines for Planning Authorities and An Bord Pleanála on Carrying out Environmental Impact Assessment. Department of the Environment, Community and Local Government;
- EU Biodiversity Strategy (2011); and,
- Irish National Biodiversity Action Plan 2017-2021.

9.2 Methodology

Assessing the impacts of any project and associated activities requires an understanding of the ecological baseline conditions prior to and at the time of the project proceeding. Ecological Baseline conditions are those existing in the absence of proposed activities (CIEEM 2016).

The following sections describe the methodologies utilised to establish the baseline ecological condition of the proposed development site.

9.2.1 Desk Study

The desk study undertaken for this assessment included a thorough review of the available ecological data associated with the study area of the *Proposed Road Development*. Sources of data included the following:

- Review of online web-mappers: National Parks and Wildlife Service (NPWS), Teagasc, Environmental Protection Agency (EPA), Water Framework Directive (WFD), Office of Public Works (OPW) flood Mapping;
- Review of Bird Atlases: (Sharrock, 1976; Lack, 1986; Gibbons et al., 1993; Balmer et al., 2013);
- Review of the Bat Conservation Ireland (BCI) Private Database;
- Review of the publically available National Biodiversity Data Centre web-mapper;
- Records from the NPWS web-mapper and review of specially requested records from the NPWS Rare and Protected Species Database for the hectads which overlap with the study area;
- Review of NPWS Article 17 Metadata and GIS Database Files

9.2.2 Consultation

An informal scoping exercise was undertaken during preparation of this EIAR. Table 9-1 provides a list of the organisations consulted with regard to Biodiversity during the scoping process, and notes where scoping responses were received. Details of the informal scoping carried out by the project team have already been referred to on Chapter 5 of this EIAR.

Copies of all scoping responses are included in Volume 4 (Appendices) of this EIAR. The recommendations of the consultees have informed the EIAR preparation process and the contents of this chapter.

Table 9-1: Consultation

Consultee	Scoping Date	Response Received
Development Applications Unit	13/03/2018	None received as of the 02/10/2018
Inland Fisheries Ireland	13/03/2018	None received by MKO as of the 02/10/2018. A response has been received by the Local Authority and further details are provided below and in Volume 4 (Appendices) of this EIAR.
BirdWatch Ireland	13/03/2018	None received as of the 02/10/2018
Transport Infrastructure Ireland	13/03/2018	None received as of the 02/10/2018
Sligo County Council	13/03/2018	None received as of the 02/10/2018
Environmental Protection Agency	13/03/2018	None received as of the 02/10/2018
National Parks and Wildlife Service (Rare and protected species records)	13/03/2018	Response received on the 08/03/2018
Development Application Unit, National Parks and Wildlife Service	13.03.2018 & 01/05/2018	A follow up call to the DAU and an email was sent on the 03/10/2018. No response has been received as of the 28/11/2018.
NPWS Local Ranger (Miriam Crowley)	28/06/2018	No written response received as of the 02/10/2018. Follow up phone conversation was held on the 03.10.2018 and no issues were highlighted in relation to the current proposal.

Inland Fisheries Ireland provided their recommendation regarding the proposal in a letter dated the 11th of July 2018. Key points, all of which have been considered in the EIAR, include the following:

- Pollution and silt control measures to be included to protect fish bearing waters
- There should be no net loss of habitat as part of stream realignments and no change to the hydrological regime downstream.
- The potential for the spread and introduction of invasive species should be assessed.

9.2.3 Identification of Target Receptors and Key Ecological Receptors

The methodology for assessment followed a precautionary screening approach regarding the identification of Key Ecological Receptors (KERs). Following a comprehensive desk study, initial site visits and stakeholder consultation; "Target receptors" likely to occur in the zone of influence of the *Proposed Road Development* were identified. The target receptors included habitats and species that were protected or listed under the following:

- Protected under the articles of the Habitats Directive and listed in its associated Annexes;

- Qualifying Interests (QI) of Special Areas of Conservation (SAC)/ Special Protection areas within the zone of influence;
- Species protected under the Wildlife Acts 1976-2012;
- Species listed in the Flora Protection Order 2015;
- Red listed species

9.2.4 Methodology for Assessment of Effects

9.2.4.1 Ecological Evaluation

Ecological evaluation and effect assessment within this chapter follows a methodology that is set out in Chapter 3 of the 'Guidelines for Assessment of Ecological Impacts of National Roads Schemes' (NRA, 2009) and CIEEM, 2018 'Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal'. These guidelines set out the context for the determination of value on a geographic basis with a hierarchy assigned in relation to the importance of any particular receptor. The guidelines provide a basis for determination of whether any particular site is of importance on the following scales:

- International
- National
- County
- Local Importance (Higher Value)
- Local Importance (Lower Value)

The (NRA 2009) Ecological Impact Guidelines, clearly sets out the criteria by which each geographic level of importance can be assigned. Locally Important (lower value) receptors contain habitats and species that are widespread and of low ecological significant and of any importance only in the local area. Internationally Important sites are either designated for conservation as part of the Natura 2000 Network (SAC or SPA) or provide the best examples of habitats or internationally important populations of protected flora and fauna.

All habitats and species within the development site were assigned a level of significance on the above basis and the Zone of Influence (ZOI) and Key Ecological Receptors (KERs) were established and classified on this basis.

9.2.4.2 Assessment of Effects

The methodology used to assess the effects of the project on the receiving environment is described in accordance the EPA 2017 document '*Guidelines on the information to be contained in environmental impact assessment reports*', specifically Table 3.3. Reference is made to the following parameters wherever appropriate when characterising effects:

- Magnitude relates to the quantum of effect, 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 effect occurs;
- Duration is intended to refer to the time during which the effect is predicted to continue, until recovery or re-instatement;
- Reversibility should be addressed by identifying whether an effect is ecologically reversible either spontaneously or through specific action; and,
- Timing/frequency of effects in relation to important seasonal and/or life-cycle constraints should be evaluated. Similarly, the frequency with which activities (and associated effects) would take place can be an important determinant of the effect on receptors.

It is necessary to ensure that any assessment of effect takes account of construction and operational phases; direct, indirect and synergistic effects; and, those that are temporary, reversible and irreversible. The criteria for assessment of effect magnitude, type and significance are given in Table 9-2 and Table 9-3. The following terms are defined when quantifying duration (EPA, 2017):

- Momentary effects - Effects lasting from seconds to minutes
- Brief effects - Effects lasting less than a day
- Temporary effects - Effects lasting less than a year
- Short-term – 1 to 7 years
- Medium term – 7 to 15 years
- Long term – 15 to 60 year
- Permanent – over 60 years
- Reversible effects - Effects that can be undone, for example through remediation or restoration.

Table 9-2: Criteria for assessing significance of effects, as per (EPA, 2017) guidelines

Effect Magnitude	Definition
No change	No discernible change in the ecology of the affected feature
Imperceptible Effect	An effect capable of measurement but without noticeable consequences
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight Effect	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate Effect	An effect that alters the character of the environment that is consistent with existing and emerging trends
Significant Effect	An effect which, by its character, its magnitude, duration or intensity alters a sensitive aspect of the environment
Very Significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment.
Profound Effect	An effect which obliterates sensitive characteristics

Table 9-3: Criteria for assessing effect quality as per (EPA, 2017)

Effect Type	Criteria
Positive	A change which improves the quality of the environment e.g. increasing species diversity, improving reproductive capacity of an ecosystem or removing nuisances
Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
Negative	A change which reduces the quality of the environment e.g. lessening species diversity or reducing the reproductive capacity of an ecosystem or by causing nuisance.

9.2.5 Field Surveys

A comprehensive survey of the fauna and flora of the site of the *Proposed Road Development* has been undertaken over a period between 2016 and 2018.

The following sections fully describe the ecological surveys that have been undertaken and provide details of the methodologies, dates of survey and guidance followed.

9.2.5.1 Multi-disciplinary Walkover Surveys (as per NRA Guidance 2009)

The walkover surveys were undertaken on the 27th of September 2017 and the 24/25th of May 2018. The survey timing falls within the recognised optimum period for vegetation surveys/habitat mapping, i.e. April to September (Smith et al., 2011). Additional visits were also conducted outside the optimum survey period in October 2017.

The previously completed habitat and faunal surveys, conducted at constraints stage of the N16 Sligo to County Boundary Route Selection Process, were ground-truthed and habitats were classified in accordance with the Heritage Council's 'Guide to Habitats in Ireland' (Fossitt, 2000). Habitat mapping was undertaken with regard to guidance set out in 'Best Practice Guidance for Habitat Survey and Mapping' (Smith et al., 2011).

Plant nomenclature for vascular plants follows 'New Flora of the British Isles' (Stace, 2010), while mosses and liverworts nomenclature follows 'Mosses and Liverworts of Britain and Ireland - a field guide' (British Bryological Society, 2010).

The walkover surveys were designed to detect the presence, or likely presence, of a range of protected species. The survey included a search for Badger setts and areas of suitable habitat, potential features likely to be of significance to Bats and additional habitat features for the full range of other protected species that are likely to occur in the vicinity of the *Proposed Road Development* (e.g. Otter etc.).

Habitats considered to be of ecological significance and in particular those corresponding to habitats listed in Annex I of the EU Habitats Directive 92/43/EEC were identified and classified as KERs.

The multi-disciplinary walkover surveys comprehensively covered the entire study area and based on the survey findings, further detailed targeted surveys were carried out for habitats, features and locations of ecological significance. These surveys were carried out in accordance with NRA Guidelines on Ecological Surveying Techniques for Protected Flora and Fauna on National Road Schemes (NRA, 2009).

During the multidisciplinary surveys, a search for Invasive Alien Species (IAS), with a focus on those listed under the Third Schedule of the European Communities Regulations 2011 (S.I. 477 of 2011), was also conducted.

9.2.5.2 Annex I habitat Assessment

Areas identified as having potential to correspond the Annex I habitats were subject to detailed assessment to determine their conservation status and condition. The results of the detailed assessment are provided in *the Annex I Wetland Survey Report* contained with Volume 4 of this EIAR (Appendix 9.1) to this Environmental Impact Assessment Report. Areas that were subject to detailed surveys included a site of Tufa Springs at *Lugatober* (identified as Springs, West of *Castlegal*), *Lugatober* North and a spring and flush area at *Lugnagall*.

At each site, wetland (fen and spring) habitats of potential conservation interest were walked over by an ecologist (Bryophyte specialist) and hydrogeologist. The vascular plant and bryophyte species present were recorded. All wetland sites of interest were classified using A Guide to Habitats in Ireland (Fossitt, 2000) and additional habitat specific classification systems as relevant.

Detailed botanical survey (relevé sampling) was undertaken at each site. At Lugnagall Flush, one relevé was undertaken in the petrifying spring area and one relevé in the alkaline fen area. At *Lugatober* (West of Castlegal), one relevé was undertaken in the westernmost (and most developed) petrifying spring in the woodland. At Lugatobar North the relevé was positioned in the best example of the habitat. The relevés were positioned to contain representative spring vegetation in each habitat. The following were recorded from within the relevé and adjacent vegetation (as relevant):

- Grid reference;
- Relevé aspect and slope;
- Spring water pH and Electrical Conductivity (measured, where possible, from flowing water in field using handheld device);
- Tufa type and cover in relevé;
- Water type and cover in relevé;
- Surface cover of vegetation, bare tufa, leaf litter, bare soil and stone etc.;
- Vascular plant, bryophyte and *Chara* species presence and percentage cover;
- Presence and cover of other algae (not *Chara*) (not identified);
- Woody species and canopy cover;
- Vegetation height

The condition of the springs was assessed using the 'Monitoring Guidelines for the Assessment of Petrifying Springs in Ireland' (Lyons & Kelly, 2016).

There are currently no standard published guidelines for the assessment of alkaline fen in Ireland. The currently accepted method is to use the 'Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland' (Perrin et al., 2014). These were developed for upland survey but have been found to be relevant for lowland fen examples.

9.2.5.3 Faunal Surveys

The results of the desk study, scoping replies and multidisciplinary walkover survey were utilised to inform the scope of targeted ecological surveys required. The non-volant mammal surveys covered the entire study area.

9.2.5.3.1 *Otter Survey*

Following a review of the previously completed ecological surveys at the route selection stage and the results of the multi-disciplinary walkover survey; areas identified as providing potential habitat for Otter were subject to specialist targeted survey. The Tully Stream, Lugatober Stream, Collinsford Stream, Lugnagall Stream and the Willsborough Stream were subject to survey on the 27th of September 2017, 31st of October 2017 & 24th of May 2018. All potential supporting habitat for the species within the study area was surveyed.

The Otter survey was conducted as per NRA (2009) guidelines (Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes). This involved a search for all Otter signs e.g. spraints, scat, prints, slides, trails, couches and holts. In addition to the width of the rivers/watercourses, a 10m riparian buffer (both banks) was considered to comprise part of the Otter habitat (NPWS 2009, Threat Response Plan: Otter (2009-2011). The dedicated Otter survey also followed the guidance as set out in NRA (2008) 'Guidelines for the Treatment of Otters Prior to the Construction of National Roads Schemes'.

9.2.5.3.2 *Badger Survey*

Following a review of the previously completed ecological surveys as part of the route selection process; areas identified as providing potential habitat for Badger and previously identified activity locations were subject to specialist targeted survey. The badger surveys covered the entire study area.

The Badger survey was conducted on the 27th of September 2017, 31st of October 2017 & 24th of May 2018. The October visit ensured that the survey was not constrained by season/vegetation (NRA 2006a).

The Badger survey was conducted to determine the presence or absence of Badger signs within and outside (areas of identified suitable habitat) the *Proposed Road Development* footprint and study area. This involved a search for all potential Badger signs as per NRA (2009) (latrines, badger paths and setts). If encountered, setts would be classified as per the convention set out in NRA (2009) (i.e. Main, Annex, Subsidiary, Outlier).

The Badger survey was conducted adhering to best practice guidance (NRA, 2009) and was cognisant of 'Guidelines for the Treatment of Badger Prior to the Construction of National Roads Schemes' (NRA, 2006a).

9.2.5.3.3 *Bird Survey*

The methodology employed for the identified study areas was as detailed in 'Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes, National Roads Authority (NRA, 2009)'.

The surveys focused on potential habitat, within the land take boundary, for sensitive breeding bird species listed on Annex I of the EU Birds Directive and Birds listed on the Birds of Conservation Concern in Ireland (BoCCI) Red and Amber list (Colhoun & Cummins, 2013). In addition, common species listed on the BoCCI Green list were also recorded in order to determine the breeding bird assemblages within the study area which would in turn aid in determining the significance of the study area to all bird species.

Based on the results of the multidisciplinary walkover survey, no potential for significant impact on important assemblages of birds was identified. However, taking a precautionary approach, bird surveys were conducted on the 24th /25th of May 2018, 28/29th of June and 30/ 31st of July 2018. A 'scaled-down' survey protocol, based upon the specifications of the Common Bird Census (CBC) methodology was utilised to fulfil the survey objectives.

The study area was slowly walked in a manner that enabled the surveyor to pass within 50m of all habitat features. Birds were identified by sight and song. Information pertaining to sex, habitat and breeding behaviour was noted and breeding status was recorded using the standard evidence classifications as per Table 2.2 of Balmer et al., (2013): Non-breeding, Possible breeding, Probable breeding and Confirmed breeding.

Bird song allowed identification within acoustic range beyond the walked survey areas. Features of ecological interest for breeding birds, e.g. hedgerows, less-improved farmland, woodlands, scrub, wetlands, and rivers were surveyed for water fowl, waders and passerines as relevant.

The survey was also consistent with the recommended Chough survey techniques described in Gilbert et .al (1998). This guidance recommends two survey visits between May and June and involved transects with regular stops to listen and scan the area for Chough.

Ecologists carrying out bat surveys at night were trained in the identification of signs/calls of crepuscular and nocturnal species such as woodcock and owl species that are typically active at this time. Nocturnal bird surveys undertaken as part of bat survey work during the breeding bird season were conducted on the 24/25th of May 2018 and on the 28/29th of June and 30/31st of July 2018. In addition, buildings/outbuildings which were subject to bat roost surveys were also surveyed in relation to Barn Owl.

9.2.5.3.4 *Vertigo Survey*

Areas identified as having potential to provide supporting habitat for *Vertigo* species were subject to detailed assessment to determine the presence or absence of the species. The results of the detailed assessment are provided in *the Geyer's Whorl Snail Survey Report* contained with Volume 4 of this EIAR (Appendix 9.2) to this Environmental Impact Assessment Report. Two field visits were undertaken on 22nd and 24th October 2018 to survey six identified areas of potential supporting habitat. Surveys were undertaken by Dr Maria Long. Survey locations are illustrated in Figure 1 of the aforementioned appendix to this EIAR. Each study area was visited and walked, and a decision was made on whether to sample (based on habitat suitability) and how many samples to take. Notes were taken on habitat and vegetation type, and grid references were taken at regular intervals.

The potential of each habitat area for supporting *Vertigo geyeri* was rated as follows:

N – not suitable for supporting Vertigo geyeri.

L – low suitability, low chance of the target species occurring.

M – moderate suitability, moderate chance of occurrence of species. H – high suitability, species may occur.

Vertigo geyeri is the most difficult of the three *Vertigo* species to survey for because the species cannot be easily found in the field. It is usually found in the saturated moss/litter layer in fens, flushes and springs, and cannot be easily spotted due to the muddy and wet conditions. Thus samples were bagged and returned to the lab for the laborious process of drying, sieving and sorting.

Mollusc species found were identified with reference to Cameron (2003), Kerney & Cameron (1979) and other relevant works (e.g. Cameron et al., 2003).

9.2.5.3.5 *Bat Survey*

Dedicated surveys were conducted with specific reference to the recommended survey periods outlined in NRA (2006) and BCT (2016). The Appendix II of the NRA Guidelines state that activity surveys can be undertaken between March and September but the most effective detector survey period is June, July and August. Structural surveys for potential roosts and surveys of potential tree roosts can be conducted at any time of the year. The NRA Guidelines recommend 2-4 survey rounds during the active season to confirm species presence and activity in an area. The number of rounds required depends on the habitat type. Based on the habitats in the study area, including woodland, four rounds of activity surveys were conducted during the 2018 survey period: May, June, July and September. As no winter roosts sites such as caves were identified within the study area winter surveys were not considered necessary.

Targeted Night Time Detection Surveys were conducted along the entire route corridor but focused on areas where high quality bat habitats were identified in the multi-disciplinary walkover survey. These surveys were conducted over four nights (i.e. dusk and dawn) and the study areas were divided and systematically surveyed. A combination of driven and walked transects were utilised to cover the large extent of the study area. Batlogger real time expansion bat detectors and Pettersson Ultrasound D200 heterodyne bat detectors were used by the surveyors to pick up the echolocation calls of any bats on the site. Heterodyne detectors were set to 45KHz to pick up the majority of bat calls and varied to suit where contacts were made.

Surveys commenced ¼ hour before sunset and continued for approximately 2.5 – 3 hours. The survey then recommenced between 1.5 and 2 hours before sunrise and continued until sunrise. Each contact with a bat was recorded. Where possible, a positive identification to species level was made. Information on the behaviour, derived from visual observation, was also recorded where available.

Buildings to be demolished were surveyed as were existing bridge crossings on the N16. Close-focusing binoculars were used to inspect the outside of buildings and bridges from the ground. Signs of bat activity that were searched for included: droppings, the animals themselves, staining at potential roost entrances and features that may lend themselves to use by bats.

During the desk study and multi-disciplinary walkover surveys the entire route was assessed and the areas with trees and treelines that are most likely to serve as bat roosts were identified from aerial photography and ground inspection (As per Section 5.3 (NRA 2006). Results from the desktop review and walkover surveys were used to assess habitats for their suitability to support foraging and commuting bats, and roosting bats, according to Collins (2016). Suitability categories are divided into High, Moderate, Low and Negligible.

Manual transects comprising walked and driven transects were undertaken at dusk and dawn recording bats in real time. Surveys were undertaken in May June, July & September 2018.

Table 9-4: Summary of Bat Survey Periods and Conditions

Date	Period	Temperature	Rain	Wind	Cloud
24th May 2018	Dusk	12°C	Occasional Light showers	Light breeze	Clear (5%)
25th May 2018	Dawn	12°C	Dry	Light breeze	Clear (5%)
28th June 2018	Dusk	22°C	Dry	Light breeze	Clear (0%)
29th June 2018	Dawn	14°C	Dry	Light Breeze	Clear (0%)
31st July 2018	Dusk	14°C	Dry	Calm	Overcast (80-100)
01st August 2018	Dawn	13°C	Dry	Calm	Overcast (66-100)
06th Sept 2018	Dusk	13°C	Dry	Calm	Overcast (0-33%)
07th Sept 2018	Dawn	12°C	Dry	Calm	Overcast (33-66%)

9.2.5.4 Survey Limitations

The information provided in this EIAR chapter accurately and comprehensively describes the baseline ecological environment; provides an accurate prediction of the likely ecological effects of the proposed development; prescribes mitigation as necessary; and, describes the residual ecological impacts. The specialist studies, analysis and reporting have been undertaken in accordance with the appropriate guidelines.

No significant limitations in the scope, scale or context of the assessment have been identified.

9.3 Establishing the Ecological Baseline

9.3.1 **Desk Study**

A desk study was undertaken in order to review available information concerning the Biodiversity (i.e. flora and fauna) within the site of the *Proposed Road Development* and surrounding area.

The following sections detail the results of the thorough review of published material that was consulted as part of the desk study. These include NPWS site synopses for designated conservation sites, bird and plant atlases and specialist research publications.

9.3.1.1 Designated Areas

9.3.1.1.1 *European Sites*

Potential for effects on European sites is summarised in this report and is fully addressed in the Natura Impact Statement submitted as part of the statutory consent process. The European sites in the likely zone of impact are presented in Table 9-5 below.

9.3.1.1.2 *Nationally Designated Sites*

Natural Heritage Areas (NHAs) are heritage sites that were designated for the protection of flora, fauna, habitats and geological sites under the Wildlife (Amendment) Act 2000. Proposed Natural Heritage Areas (pNHAs) were published on a non-statutory basis in 1995 but have not since been statutorily proposed or designated. These sites do not form part of the Natura 2000 network and the Appropriate Assessment process, or screening for same, does not apply to NHAs or pNHAs.

9.3.1.1.3 *Identification of the Designated Sites within the Likely Zone of Influence of the Proposed Development*

Using the GIS software, MapInfo (Version 10.0), European and nationally designated sites within the likely zone of influence were identified. Initially, sites within a 15km radius of the proposed development were identified (as per the DoEHLG Guidance (2010)). In addition, using the precautionary principle, designated sites located outside the 15km buffer zone were also considered and assessed. In this case, no potential for effects on sites located outside the 15km zone was identified.

The designated sites located within the 15km radius are listed below in Table 9-5 and with those in closest proximity shown in Figure 9.1 contained within Volume 3 of this EIAR.

Table 9-5: Designated Sites in the Likely Zone of Impact

Designated Site & Distance	Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)	Conservation Objectives
Special Areas of Conservation		
Ben Bulben, Gleniff and Glenade Complex SAC (000623) **Distance:** 1.3km north-east.	▪ Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (3260) ▪ Northern Atlantic wet heaths with Erica tetralix [4010] ▪ European Dry Heaths (4030) ▪ Alpine and Boreal heaths (4060) ▪ *Juniperus communis* formations on heaths or calcareous grasslands (5130) ▪ Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210] ▪ Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) [6230] ▪ Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430] ▪ Transition mires and quaking bogs [7140] ▪ Petrifying springs with tufa formation (7220)* ▪ Alkaline fens [7230] ▪ Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani) [8110] ▪ Calcareous and calcshist screes of the montane to alpine levels (8120) ▪ Calcareous rocky slopes with chasmophytic vegetation (8210) ▪ Vertigo geyeri (Geyer's Whorl Snail) [1013] ▪ Lutra lutra (Otter) [1355]	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected'.'* (NPWS Generic version 6.0, 2018)
Lough Gill SAC (001976) **Distance:** 3.2km south	▪ Natural eutrophic lakes with Magnopotamion or Hydrocharition – type vegetation (3150) ▪ Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210] ▪ Old sessile oak woods with Ilex and Blechnum in the British Isles (91A0) ▪ Alluvial forests with Alnus glutinosa and Fraxinus excelsior (91E0)* ▪ Austropotamobius pallipes (White-clawed crayfish) [1092] ▪ Petromyzon marinus (Sea Lamprey) [1095] ▪ Lampetra planerii (Brook Lamprey) ▪ Lampetra fluviatilis (River Lamprey) ▪ Salmo salar (Salmon) [1106] ▪ Lutra lutra (Otter) [1355]	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected'.* (NPWS Generic version 6.0, 2018)

Designated Site & Distance	Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)	Conservation Objectives
Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC (000627) **Distance:** 3.3km west	▪ Estuaries (1130) ▪ Mudflats and sandflats not covered by seawater at low tide (1140) ▪ Embryonic shifting dunes (2110) ▪ Shifting dunes along the shoreline with Ammophila arenaria (2120) ▪ Fixed coastal dunes with herbaceous vegetation (2130)* ▪ Juniperus communis formations on heaths or calcareous grasslands (5130) ▪ Petrifying springs with tufa formation (7220) ▪ Vertigo angustior (Narrow mouthed whorl snail) [1014] ▪ Petromyzon marinus (Sea Lamprey) [1095] ▪ Lampetra fluviatilis (River Lamprey) [1099] ▪ Phoca vitulina (Harbour seal) [1365]	Detailed conservation objectives for this site (Version 1, September 2013) were reviewed as part of the assessment and are available at www.npws.ie
Glenade Lough SAC (001919) **Distance:** 9.7km north-east	▪ Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation [3150] ▪ Austropotamobius pallipes (White-clawed Crayfish) [1092] ▪ Najas flexlis (Slender Naiad) [1833]	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected'.* (NPWS Generic version 6.0, 2018)
Ballysadare Bay SAC (000622) **Distance:** 10km south-west	▪ Estuaries (1130) ▪ Mudflats and sandflats not covered by seawater at low tide (1140) ▪ Embryonic shifting dunes (2110) ▪ Shifting dunes along the shoreline with Ammophila arenaria (2120) ▪ Fixed coastal dunes with herbaceous vegetation (2130)* ▪ Humid dune slacks (2190) ▪ Vertigo angustior (Narrow mouthed whorl snail) [1014] ▪ Phoca vitulina (Harbour seal) [1365]	Detailed conservation objectives for this site (Version 1, September 2013) were reviewed as part of the assessment and are available at www.npws.ie
Arroo Mountain SAC (001403) **Distance:** 10.4km north-east	▪ Northern Atlantic wet heaths with Erica tetralix (4010) ▪ European dry heaths [4030] ▪ Alpine and Boreal heaths [4060] ▪ Blanket bogs (7130) ▪ Petrifying springs with tufa formation (7220)* ▪ Calcareous and calcshist screes of the montane to alpine levels (8120)	Detailed conservation objectives for this site (Version 1, August 2016) were reviewed as part of the assessment and are available at www.npws.ie

Designated Site & Distance	**Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)**	**Conservation Objectives**
	▪ Calcareous rocky slopes with chasmophytic vegetation (8210)	
Union Wood SAC (000638) **Distance:** 10.5km south	▪ Old sessile oak woods with Ilex and Blechnum in the British Isles (91A0)	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected'.'* (NPWS Generic version 6.0, 2018)
Streedagh Point Dunes SAC (001680) **Distance:** 10.6km north-west	▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ Perennial vegetation of stony banks [1220] ▪ Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330] ▪ Mediterranean salt meadows (Juncetalia maritimi) [1410] ▪ Shifting dunes along the shoreline with Ammophila arenaria (white dunes) [2120] ▪ Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130] ▪ Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]	Detailed conservation objectives for this site (Version 1, March 2015) were reviewed as part of the assessment and are available at www.npws.ie
Bunduff Lough And Machair/Trawalua/Mullaghmore SAC (000625) **Distance:** 10.9km north-west	▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ Large shallow inlets and bays [1160] ▪ Reefs [1170] ▪ Shifting dunes along the shoreline with Ammophila arenaria (white dunes) [2120] ▪ Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130] ▪ Machairs (* in Ireland) [21A0] ▪ Juniperus communis formations on heaths or calcareous grasslands [5130] ▪ Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210] ▪ Alkaline fens [7230] ▪ Euphydryas aurinia (Marsh Fritillary) [1065] ▪ Petalophyllum ralfsii (Petalwort) [1395]	Detailed conservation objectives for this site (Version 1, March 2015) were reviewed as part of the assessment and are available at www.npws.ie
Unshin River SAC (001898) **Distance:** 11km south	▪ Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (3260) ▪ Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210] ▪ Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410] ▪ Alluvial forests with Alnus glutinosa and Fraxinus excelsior (91E0)* ▪ Salmo salar (Salmon) [1106]	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC*

Designated Site & Distance	Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)	Conservation Objectives
	▪ Lutra lutra (Otter) [1355]	*has been selected'*.' (NPWS Generic version 6.0, 2018)
Special Protection Area		
Sligo/Leitrim Uplands SPA (004187) **Distance:** Adjacent to the eastern boundary of the site.	▪ *Falco peregrinus* (Peregrine) [A103] ▪ *Pyrrhocorax pyrrhocorax (Chough) [A346]*	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests of this SPA'*. (NPWS Generic version 6.0, 2018)
Cummeen Strand SPA (004035) **Distance:** 3.3km south-west	▪ *Branta bernicla hrota* (Brent Goose) [A046] ▪ *Haematopus ostralegus* (Oystercatcher) [A130] ▪ *Tringa totanus* (Redshank) [A162] ▪ Wetlands (A999)	Detailed conservation objectives for this site (Version 1, September 2013) were reviewed as part of the assessment and are available at www.npws.ie
Drumcliff Bay SPA (004013) **Distance:** 4.1km west	▪ *Calidris alba* (Sanderling) [A144] ▪ *Limosa lapponica* (Bar-tailed Godwit) [A157] ▪ Wetlands (A999)	Detailed conservation objectives for this site (Version 1, September 2013) were reviewed as part of the assessment and are available at www.npws.ie
Ballintemple & Ballygilgan SPA (004234) **Distance:** 7.2km north-west	▪ Branta leucopsis (Barnacle Goose) [A045]	This site has the generic conservation objective: *'To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests of this SPA'*. (NPWS Generic version 6.0, 2018)
Ballysadare Bay SPA (004129) **Distance:** 10km south-west	▪ *Branta bernicla hrota* (Brent Goose) [A046] ▪ *Pluvialis squatarola* (Grey Plover) [A141] ▪ *Calidris alpine alpine* (Dunlin) [A149] ▪ *Limosa lapponica* (Bar-tailed Godwit) [A157] ▪ *Tringa totanus* (Redshank) [A162]	Detailed conservation objectives for this site (Version 1, October 2013) were reviewed as part of the assessment and are available at www.npws.ie

Designated Site & Distance	Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)	Conservation Objectives
	▪ *Wetlands (A999)*	
Natural Heritage Areas		
Crockauns/Keelogyboy Bogs NHA (002435) **Distance:** 1.9km east	▪ Peatlands [4]	Not applicable to Nationally designated sites
Slieveward Bog NHA (001902) **Distance:** 12.1km	▪ Peatlands [4]	Not applicable to Nationally designated sites
Proposed Natural Heritage Areas		
Ben Bulben, Gleniff And Glenade Complex (000623), **Distance:** 1.3km		
Lough Gill (001976), **Distance:** 3.2km		
Cummeen Strand/Drumcliff Bay (Sligo Bay) (000627), **Distance:** 3.3km		
Colgagh Lough (001670), **Distance:** 3.4km		
Knocknarea Mountain and Glen (001670), **Distance:** 9.6km		
Glenade Lough (001919), **Distance:** 9.7km		
Ballysadare Bay (000622), **Distance:** 10.0km		
Ballygawley Lough (001909), **Distance:** 10.3km		
Arroo Mountain (001403), **Distance:** 10.4km		
Union Wood (000638), **Distance:** 10.5km		
Streedagh Point Dunes (001680), **Distance:** 10.6km		
Bonet River (001404), **Distance:** 10.9km		
Lough Dargan (001906), **Distance:** 11.0km		

Designated Site & Distance	**Qualifying Interest/Special Conservation Interest/Feature of Interest for which the Site has been designated (Sourced from NPWS online Conservation Objectives, www.npws.ie on the 03/12/2018)**	**Conservation Objectives**
Bunduff Lough And Machair/Trawalua/Mullaghmore (000625), **Distance:**11.2km		
Unshin River (001898), **Distance:** 11.3km		

9.3.1.2 New Flora Atlas

A search was made in the New Atlas of the British & Irish Flora (Preston et al. 2002) to identify if any rare or protected plant species have been previously recorded from the hectads in which the *Proposed Road Development* is located i.e. (G73 & G74). The search targeted vascular plants that are listed in Annex II of the EU Habitats Directive, the Flora (Protection) Order (FPO) of 2015, and those listed in The Irish Red Data Book (Jackson *et. al*. 2016). The results of the Atlas search are provided in Table 9-6 below.

Table 9-6: Plant Species of Conservation Concern within Hectads G73 & G74

Common Name	Scientific Name	Hectad	Conservation Status
Northern Rock-cress	*Arabis petraea*	G74	FPO, RL
Strawberry tree	*Arbutus unedo*	G73	RL
Fragrant Agrimony	*Agrimonia procera*	G73	RL
Alchemilla	*Alchemilla glaucescens*	G73	RL
Fringed Sandwort	*Arenaria ciliata*	G74	FPO, RL
Good King Henry	*Chenopodium bonus-henricus*	G74	RL
Long-bracted green orchid	Coeloglossum viride	G73	RL
Hoary Whitlowgrass	*Draba incana*	G74	RL
Chickweed Willowherb	*Epilobium alsinifolium*	G74	FPO, RL
Spring quillwort	*Isoetes echinospora*	G74	RL
Yellow bird's-nest	*Monotropa hypopitys*	G73	RL
Green-winged Orchid	*Orchis morio*	G74	RL
Alpine Bistort	*Persicaria vivipara*	G74	FPO, RL
Alpine Meadow-grass	*Poa alpina*	G74	RL
Northern Holly Fern	*Polystichum lonchitis*	G74	RL
Small-white Orchid	*Pseudorchis albida*	G73, G74	FPO, RL
Intermediate Wintergreen	*Pyrola media*	G74, G73	RL
Tea-leaved Willow	*Salix phylicifolia*	G74	RL
Alpine Saw-wort	*Saussurea alpina*	G74	RL
Yellow Saxifrage	*Saxifraga aizoides*	G74	RL
Dwarf Willow	*Salix herbacea*	G74	RL
Alpine Saxifrage	*Saxifraga nivalis*	G74	FPO, RL

Common Name	Scientific Name	Hectad	Conservation Status
Northern Rock-cress	*Arabis petraea*	G74	FPO, RL
Strawberry tree	*Arbutus unedo*	G73	RL
Fragrant Agrimony	*Agrimonia procera*	G73	RL
Alchemilla	*Alchemilla glaucescens*	G73	RL
Purple Saxifrage	*Saxifraga oppositifolia*	G74	RL
Moss Campion	*Silene acaulis*	G74	RL
Irish Whitebeam	*Sorbus hibernica*	G73	RL
Rock Whitebeam	*Sorbus rupicola*	G73	RL
Least Bur-reed	*Sparganium natans*	G73	RL

RL – Red List, FPO – Flora Protection Order, Annex II – Of EU Habitats Directive

9.3.1.3 EPA Water Quality

The EPA Envision map viewer was consulted on 26th of July 2018 regarding the water quality status of the watercourses in the study area. There are no monitoring points of the Tully Stream or the two tributaries of the Drumcliff River in *Lugatober*. There are two sampling points downstream of the development site on the Drumcliff River: Station ID RS35D040400 and Station ID. RS35D040300.

The Biotic Index of Water Quality (BIWQ) was developed in Ireland by the Environmental Protection Agency (EPA). Q-values are assigned using a combination of habitat characteristics and structure of the macro-invertebrate community within the waterbody. Individual macro-invertebrate families are ranked according to their sensitivity to organic pollution and the Q-value is assessed based primarily on their relative abundance within a sample. The current status of the Drumcliff River at the two sampling points downstream of the *Proposed Road Development* is Q4 *Good Status*.

River Basin Management Plans (RBMPs) have been published for all River Basin Districts in Ireland in accordance with the requirements of the Water Framework Directive. The online EPA Envision map viewer provides access to water quality information at individual waterbody level and at Water Management Unit level for all the River Basin Districts in Ireland. Waterbodies can relate to surface waters (these include rivers, lakes, estuaries [transitional waters] and coastal waters) or to groundwater.

9.3.1.4 Water Frameworks Direct Fish Sampling (IFI)

There are no fish sampling points located within or downstream of the proposed development site.

In 2013, Inland Fisheries Ireland (IFI) conducted fish sampling in Glencar Lough which is located approximately 2km up gradient of the *Proposed Road Development* site in the Drumcliff catchment. The results give an indication of the species richness in the Drumcliff catchment. A total of six fish species (sea trout were included as a separate 'variety' of trout) were recorded in Glencar Lough in August 2013, with 253 fish being captured. Brown trout was the most abundant fish species recorded, followed by three-spined stickleback, eels and sea trout. Additional species recorded included Flounder (*Platichthys flesus*), Minnow (*Phoxinus phoxinus*) and Atlantic Salmon (*Salmo salar*).

Glencar Lough was also monitored in 2007 and 2010 as part of the WFD surveillance monitoring programme and the same species assemblage was recorded.

9.3.1.5 Designated Shellfish Areas

The Willsborough Stream discharges into the Garvogue Estuary which is a Shellfish Waterbody (EPA Geohieve, 2019). The Willsborough stream is not crossed or encroached directly by the *Proposed Road Development* but is to be a receiving watercourse for a proposed road storm drainage outfall draining the mainline section from Ch. 0m to Ch. 600m.

The two more northerly catchments of the Tully Stream and the Drumcliff River with its associated tributaries that include the Lugatober, Collinsford and Lugnagall streams discharge into Drumcliff Estuary c. 5km to the west of the *Proposed Road Development*. The Drumcliff Estuary a designated Shellfish Waterbody (EPA Geohieve, 2019). This EIAR has considered all potential pathway for impact on water quality and all necessary pollution prevention measures have been incorporated in the EIAR and Natura Impact Statement. All pathways for impact on water quality have been robustly blocked and designated shellfish waters are not considered further in this Biodiversity Chapter.

9.3.1.6 Bird Atlas 2007-2011

The most recent bird atlas project took place over four winters and four summers between November 2007 and July 2011. The data has been published in *Bird Atlas 2007-11, The breeding and wintering birds of Britain and Ireland*' (Balmer *et al*., 2013). Distribution map data is also available online from BirdWatch Ireland Map store http://blx1.bto.org/mapstore/StoreServlet.

Species of conservation interest that have been recorded from hectads G73 & G74 are listed in Table 9-7.

Table 9-7: Bird Species of Conservation Interest recorded within Hectads G73 & G74

Species Name	Breeding		Wintering		Conservation Status
	G73	G74	G73	G74	
Kingfisher (*Alcedo atthis*)	Poss	No	Yes	Yes	Annex I
Hen Harrier (*Circus cyaneus*)	No	Poss	No	Yes	Annex I
Whooper Swan (*Cygnus cygnus*)	No	Non-breeding	Yes	Yes	Annex I
Chough (*Pyrrhocorax pyrrhocorax*)	Non-breeding	Conf	Yes	Yes	Annex I
Merlin (*Falco columbarius*)	Possible	No	Yes	Yes	Annex I
Peregrine (*Falco peregrinus*)	No	Prob	No	Yes	Annex I
Curlew (*Numenius arquata*)	No	No	No	Yes	RL
Red Grouse (*Lagopus lagopus scoticus*)	No	No	No	Yes	RL

Species Name	Breeding		Wintering		Conservation Status
	G73	G74	G73	G74	
Woodcock (*Scolopax rusticola*)	Possible	No	Yes	No	RL
Golden Plover (*Pluvialis apricaria*)	Possible	No	Yes	No	Annex I, RL
Black-headed Gull *(Larus ridibundus)*	Confirmed	No	Yes	No	RL
Barn Owl *(Tyto alba)*	Possible	No	No	No	RL
Common Redshank *(Tringa totanus)*	No	No	No	Yes	RL

Annex I – of EU Birds Directive, RL- Red listed species in BoCCI

Conf – Confirmed Breeding

Poss – Possible Breeding

Prob – Probable Breeding

9.3.1.7 Previous Bird Atlases

Previous Bird Atlases have been the primary source of information on the distribution and abundance of British and Irish birds prior to Bird Atlas 2007–11. The three previously published atlases were:

- Sharrock, J.T.R. (1976) The atlas of breeding birds in Britain and Ireland;
- Lack, P.C. (1986) The atlas of wintering birds in Britain and Ireland;
- Gibbons, D.W., Reid, J.B. & Chapman, R.A. (1993), The new atlas of breeding birds in Britain and Ireland: 1988-1991.

Species of conservation interest for which breeding evidence has been historically recorded in hectads G73 and G74 are listed in Table 9-8 below. Species of conservation interest historically recorded as wintering in hectads G73 and G74 are listed in Table 9-9.

Table 9-8: Breeding Bird Species of Conservation Interest recorded within Hectads G73 & G74

Species name	Breeding Atlas 68-72		Breeding Atlas 88-91		Conservation Status
	G73	G74	G73	G74	
Kingfisher *(Alcedo atthis)*	Yes	Yes	No	No	Annex I
Hen Harrier *(Circus cyaneus)*	No	No	No	No	Annex I
Chough *(Pyrrhocorax pyrrhocorax)*	No	No	No	Yes	Annex I
Merlin *(Falco columbarius)*	No	No	No	No	Annex I
Peregrine *(Falco peregrinus)*	Yes	Yes	Yes	Yes	Annex I
Curlew *(Numenius arquata)*	Yes	No	No	Yes	Annex I

Species name	Breeding Atlas 68-72		Breeding Atlas 88-91		Conservation Status
	G73	G74	G73	G74	
Red Grouse *(Lagopus lagopus scoticus)*	No	No	No	No	Annex I
Corncrake *(Crex crex)*	Yes	Yes	Yes	No	Annex I, RL
Woodcock *(Scolopax rusticola)*	Yes	Yes	No	No	RL
Ring Ouzel *(Turdus torquatus)*	No	Yes	No	No	RL
Lapwing *(Vanellus vanellus)*	Yes	Yes	Yes	No	RL
Nightjar *(Caprimulgus europaeus)*	No	No	No	No	RL
Black-headed Gull *(Larus ridibundus)*	Yes	No	Yes	No	RL
Yellowhammer *(Emberiza citronella)*	Yes	Yes	No	No	RL

Annex I – Of EU Birds Directive, RL- Red listed species in BoCCI

Table 9-9: Bird Species of Conservation Interest recorded within Hectad G73 & G74

Common Name	Scientific Name	Wintering Atlas 68-72	Conservation Status
Whooper Swan	*Cygnus cygnus*	Yes	Annex I
Curlew	*Numenius arquata*	Yes	Annex I
Woodcock	*Scolopax rusticola*	No	Annex I
Black-headed Gull	*Larus ridibundus*	Yes	RL

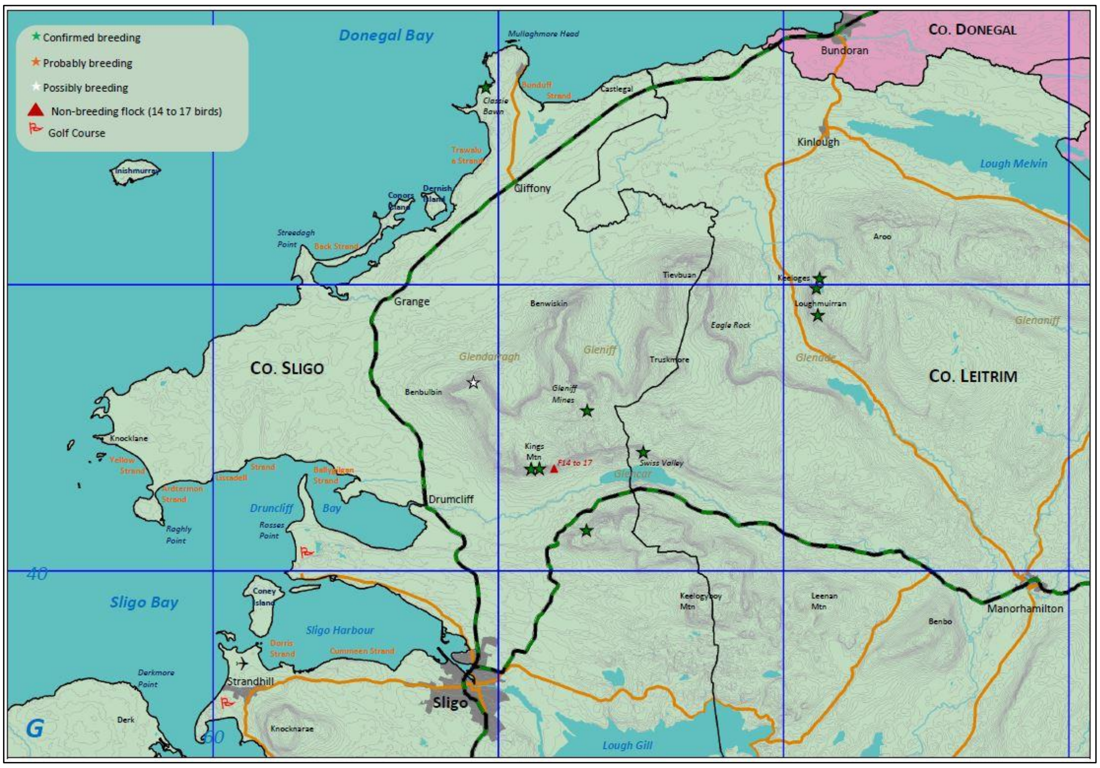
Annex I – Of EU Birds Directive, RL- Red listed species in BoCCI

9.3.1.8 Chough of Sligo/Leitrim Upland SPA

The majority of breeding chough within the SPA are found along the south facing cliffs of King's Mountain. Trewby et.al (2010) found that 84% of the Chough numbers recorded within the SPA occur along the stretch from Glendarragh (Benbulbin) to Glencar. Breeding within the SPA appeared to be associated with activity radiating out from the Kings Mountain communal roost which is located more than 2km from the *Proposed Road Development*. Low usage for some parts of the SPA – Cope's Mountain & Gleniff – could be explained by small numbers of birds (pairs) only being present seasonally (breeding season) (Trewby et.al (2010)).

The most recent distribution of breeding chough within the SPA, as determined by Trewby et al 2010 is shown in Plate 9-1 below. The closest suitable breeding habitat for chough occurs on the cliffs of Cope's Mountain approximately 500m east of the northern tie in with the existing N16. Chough tend to utilise the same nesting area in subsequent years and the same nest site was recorded at Cope's Mountain in both 2003 and 2009. The nest site is in a hidden canyon on the northern cliff face of the Mountain.

Plate 9-1: Distribution of breeding chough in north Co Sligo from the 2009 breeding season (Trewby et al 2010)



9.3.1.9 National Parks and Wildlife Service Data

NPWS online records were searched to see if any rare or protected species of flora or fauna have been recorded from hectads G73 & G74. An information request was also sent to the NPWS requesting records from the NPWS Rare and Protected Species. Table 9-10 - Table 9-12 list rare and protected species records obtained from NPWS.

Table 9-10: Records of species protected under the E.U. Habitats Directive

Common Name	Scientific Name	Status
Otter	*Lutra lutra*	Annex II, IV, Flora Protection Order - Wildlife Acts
Slender Naiad	*Najas flexilis*	Annex II & IV Flora Protection Order - Wildlife Acts

Table 9-11: Records of species listed under the Flora Protection Order 2015 and E.U. Habitats Directive

Common Name	Scientific Name	Status
Small-white Orchid	*Pseudorchis albida*	Flora Protection Order - Wildlife Acts
Chickweed Willowherb	*Epilobium alsinifolium*	Flora Protection Order -

Common Name	Scientific Name	Status
		Wildlife Acts
Alpine Saxifrage	*Saxifraga nivalis*	Flora Protection Order - Wildlife Acts
Fringed Sandwort	*Arenaria ciliata*	Flora Protection Order - Wildlife Acts
Alpine Bistort	*Persicaria vivipara*	Flora Protection Order - Wildlife Acts
Rough Poppy	*Papaver hybridum*	Flora Protection Order - Wildlife Acts
Large White-moss	*Leucobryum glaucum*	Annex V
Flat-leaved Bog-moss	*Sphagnum platyphyllum*	Annex V
Reindeer Moss	*Cladonia rangiferina*	Annex V

Table 9-12: Species protected under the Wildlife Acts 1976-2012), NPWS.

Common Name	Scientific Name	Status
Irish Hare	*Lepus timidus subsp. hibernicus*	Wildlife Acts Annex V
Pine Marten	*Martes martes*	Wildlife Acts Annex V
Badger	*Meles meles*	Wildlife Acts
Red Squirrel	*Sciuris vulgaris*	Wildlife Acts
Common Frog	*Rana temporaria*	Wildlife Acts
Fallow deer	*Dama dama*	Wildlife Acts
West European Hedgehog	*Erinaceus europaeus*	Wildlife Acts
Irish Stoat	*Mustela erminea hibernica*	Wildlife Acts
Sea Lamprey	*Petromyzon marinus*	Annex II
Geyer's Whorl Snail	*Vertigo geyeri*	Annex II, Wildlife Acts

9.3.1.10 Biodiversity Ireland Database

A search of the National Biodiversity Data Centre (NBDC) website was conducted with a focus on records of protected fauna recorded from hectads G74 and G84. The results of the database search are provided below in Table 9-13. Table 9-14 includes records non-native invasive species listed under the Third Schedule of the European Communities Regulations 2011 (S.I. 477 of 2011).

In relation to Annex I birds, the NBDC database incorporates records from the Bird Atlases listed above. As the records from the Atlases have already been provided above, they are not repeated below.

Table 9-13: NBDC records for protected species records for hectad G73 and G74.

Common Name	Scientific Name	Conservation Status	Hectad
Freshwater White-clawed Crayfish	*Austropotamobius pallipes*	Annex II, Annex V, Wildlife Acts	G73, G74
Common Frog	*Rana temporaria*	Annex V, Wildlife Acts	G73, G74
Otter	*Lutra Lutra*	Annex II, Annex IV, Wildlife Acts	G73, G74
Pine Marten	*Martes martes*	Annex V, Wildlife Acts	G73, G74
Pipistrelle	*Pipistrellus pipistrellus sensu lato*	Annex IV, Wildlife Acts	G73, G74
Daubenton's Bat	*Myotis daubentonii*	Annex IV, Wildlife Acts	G73, G74
Natterer's Bat	*Myotis nattereri*	Annex IV, Wildlife Acts	G73
Leisler’s Bat	*Nyctalus leisleri*	Annex IV, Wildlife Acts	G73, G74
Soprano Pipistrelle	*Pipistrellus pygmaeus*	Annex IV, Wildlife Acts	G73, G74
Brown Long-eared Bat	*Plecotus auritus*	Annex IV, Wildlife Acts	G73, G74
Whiskered Bat	*Myotis mystacinus*	Annex IV, Wildlife Acts	G74
Marsh Fritillary	*Euphydryas aurinia*	Annex II	G73
Grey Seal	*Halichoerus grypus*	Annex II, Annex V, Wildlife Acts	G73
Common Seal	*Phoca vitulina*	Annex II, Annex V, Wildlife Acts	G73
Geyer's Whorl Snail	*Vertigo (Vertigo) geyeri*	Annex II, Wildlife Acts	G74
Fir Clubmoss	*Huperzia selago*	Annex V	G73, G74
Large White-moss	*Leucobryum glaucum*	Annex IV	G73, G74
Badger	*Meles meles*	Wildlife Acts	G74
Eurasian Pygmy Shrew	*Sorex minutus*	Wildlife Acts	G74
Eurasian Red Squirrel	*Sciurus vulgaris*	Wildlife Acts	G74
West European Hedgehog	*Erinaceus europaeus*	Wildlife Acts	G74

Common Name	Scientific Name	Conservation Status	Hectad
Smooth Newt	*Lissotriton vulgaris*	Wildlife Acts	G73

Annex I – Of EU Birds Directive, Annex II, Annex IV, Annex V – Of EU Habitats Directive, Wildlife Acts – Irish Wildlife Acts (1976, 2000).

Table 9-14: Records for Third Schedule non-native invasive species from hectad G73 and G74.

Common Name	Scientific Name	Hectad
Canadian Waterweed	*Elodea canadensis*	G73
Rhododendron	*Rhododendron ponticum*	G73, G74
Japanese Knotweed	*Fallopia japonica*	G73, G74
Indian Balsam	*Impatiens glandulifera*	G73, G74
Zebra Mussel	*Dreissena (Dreissena) polymorpha*	G73, G74
Fallow Deer	*Dama dama*	G73
American Mink	*Mustela vison*	G73, G74
Roach	*Rutilus rutilus*	G73

9.3.1.11 Bryophytes of Ireland Database (Via NBDC)

The Bryophytes of Ireland Database was consulted regarding records of species that are listed in Ireland Red List No 8. *Bryophytes* (Lockhart et al 2012[71]). The dataset comprises the data that is published in the Atlas of British & Irish Bryophytes (Blockeel et al. 2014). In total, 42 species listed in the red data book have been recorded from hectads G73 and G74 (See Table 9-15 below).

Table 9-15: Bryophytes of Ireland Database records for hectads G73 and G74.

Hectad	Species Name	Date of Last Record	Red Data Book Designation
G74	*Acute-leaved Bog-moss (Sphagnum capillifolium subsp. capillifolium)*	*16/07/2012*	*Threatened Species: Data deficient*
G74	*Alpine Extinguisher-moss (Encalypta alpina)*	*30/06/2003*	*Threatened Species: Vulnerable*
G73	*Atlantic Pocket-moss (Fissidens monguillonii)*	*04/08/2000*	*Threatened Species: Near threatened*
G74	*Awl-leaved Swan-neck Moss (Campylopus subulatus)*	*31/12/1912*	*Threatened Species: Vulnerable*

[71] Lockhart, N., Hodgetts, N.& Holyoak, D. (2012) Ireland Red List No.8: Bryophytes. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

Hectad	Species Name	Date of Last Record	Red Data Book Designation
G74	*Bent-leaved Beard-moss (Leptodontium flexifolium)*	*16/07/1963*	*Threatened Species: Near threatened*
G74	*Bent-moss (Campylostelium saxicola)*	*31/12/1963*	*Protected Species: Flora Protection Order || Threatened Species: Endangered*
G74	*Blushing Bryum (Bryum elegans)*	*09/08/2005*	*Threatened Species: Vulnerable*
G74	*Bordered Screw-moss (Tortula marginata)*	*03/08/2005*	*Threatened Species: Near threatened*
G73	*Chalk Hook-moss (Drepanocladus sendtneri)*	*06/07/2003*	*Threatened Species: Near threatened*
G74	*Clint Crisp-moss (Tortella densa)*	*24/06/2003*	*Threatened Species: Near threatened*
G74	*Compact Feather-moss (Conardia compacta)*	*31/12/1928*	*Threatened Species: Regionally Extinct*
G74 G73	*Downy Plait-moss (Hypnum callichroum)*	*16/07/1963 & 08/09/1967*	*Threatened Species: Near threatened*
G74	*Felted Thyme-moss (Rhizomnium pseudopunctatum)*	*03/07/2003*	*Threatened Species: Near threatened*
G73	*Fine-leaved Marsh Feather-moss (Campyliadelphus elodes)*	*31/05/1965*	*Threatened Species: Near threatened*
G74	*Fountain Feather-moss (Amblystegium tenax)*	*31/12/1928*	*Threatened Species: Near threatened*
G74	*Greville's Forklet-moss (Dicranella grevilleana)*	*09/08/2005*	*Threatened Species: Near threatened*
G74	*Hook-beak Tufa-moss (Hymenostylium recurvirostrum)*	*12/09/2012*	*Threatened Species: Near threatened*
G74 &G73	*Irish Beard-moss (Didymodon maximus)*	*26/06/2012 & 06/07/2003*	*Protected Species: Flora Protection Order || Threatened Species: Near threatened*
G74	*Irish Rock-bristle (Seligeria oelandica)*	*12/09/2012*	*Threatened Species: Vulnerable*
G74 & G73	*Large White-moss (Leucobryum glaucum)*	*23/06/2003 & 27/06/2003*	*Protected Species: EU Habitats Directive || Protected Species: EU Habitats Directive >> Annex IV*
G73	*Lesser Striated Feather-moss (Eurhynchium striatulum)*	*04/08/2000*	*Threatened Species: Near threatened*
G74	*Lurid Cupola-moss (Cinclidium stygium)*	*01/07/2003*	*Threatened Species: Vulnerable*
G74 & G73	*Norway Timmia (Timmia norvegica)*	*09/08/2005 & 06/07/2003*	*Threatened Species: Vulnerable*
G74	*Oeder's Apple-moss (Plagiopus oederianus)*	*31/12/1909*	*Threatened Species: Critically Endangered*
G74	*Pendulous Wing-moss (Antitrichia curtipendula)*	*31/12/1892*	*Threatened Species: Near threatened*

Hectad	Species Name	Date of Last Record	Red Data Book Designation
G74	*Pohlia wahlenbergii var. glacialis*	*31/12/1963*	*Threatened Species: Regionally Extinct*
G74	*Pointed Beard-moss (Didymodon acutus)*	*31/12/1928*	*Protected Species: Flora Protection Order || Threatened Species: Endangered*
G74 & G73	*Red Leskea (Orthothecium rufescens)*	*12/09/2012 & 06/07/2003*	*Threatened Species: Near threatened*
G74	*Ribbed Extinguisher-moss (Encalypta rhaptocarpa)*	*31/12/1963*	*Protected Species: Flora Protection Order || Threatened Species: Critically Endangered*
G74	*Robust Grimmia (Schistidium robustum)*	*04/07/2003*	*Threatened Species: Data deficient*
G74	*Russow's Bog-moss (Sphagnum russowii)*	*31/12/1991*	*Threatened Species: Near threatened*
G74	*Seligeria patula*	*11/09/2012*	*Threatened Species: Near threatened*
G73	*Shaded Wood-moss (Hylocomium umbratum)*	*31/07/1967*	*Threatened Species: Near threatened*
G74	*Short-beaked Thyme-moss (Mnium thomsonii)*	*29/08/2005*	*Threatened Species: Near threatened*
G73	*Showy Feather-moss (Eurhynchium speciosum)*	*27/06/2003*	*Threatened Species: Near threatened*
G74	*Small Mouse-tail Moss (Myurella julacea)*	*02/07/2003*	*Protected Species: Flora Protection Order || Threatened Species: Endangered*
G74	*Spruce's Leskea (Platydictya jungermannioides)*	*10/08/2001*	*Threatened Species: Near threatened*
G73	*Tufted Feather-moss (Scleropodium cespitans)*	*31/12/1972*	*Threatened Species: Near threatened*
G74 & G73	*Upright Brown Grimmia (Schistidium strictum)*	*31/12/1962 & 17/07/1963*	*Threatened Species: Near threatened*
G73	*Willow Feather-moss (Amblystegium varium)*	*31/12/1972*	*Threatened Species: Near threatened*
G74 & G73	*Woodsy Thyme-moss (Plagiomnium cuspidatum)*	*09/08/2005 & 27/06/2003*	*Threatened Species: Near threatened*
G74	*Zierian Hump-moss (Plagiobryum zieri)*	*09/08/2005*	*Threatened Species: Near threatened*

9.3.1.12 Bat Conservation Ireland Database

The Bat Conservation Ireland (BCI) database was searched on the 20th of July 2018 for records within 10km of study area. The results included 62 roosts, 54 survey transects and 78 ad-hoc observations.

The database contained records for the following species; Daubenton's bat (*Myotis daubentonii*), Whiskered/Brandt's Bat (*Myotis mystacinus/brandtii*), Natterer's bat (*Myotis natterreri*), Myotis spp., Leisler's bat (*Nyctalus leisleri*), Common pipistrelle (*Pipistrellus pipistrellus*), Soprano pipistrelle

(*Pipistrellus pygmaeus*), Pipistrelle spp. (*Pipistrellus* spp.), and Brown long-eared bat (*Plecotus auritus*). Details of these are provided in Table 9-16 – Table 9-18.

Table 9-16: BCI records for roosts within 10km of the study area

Roosts		
Common Name	Scientific Name	Number of Records
Whiskered bat	*Myotis mystacinus*	1
Daubenton's bat	*Myotis daubentonii*	9
Natterer's bat	*Myotis natterreri*	7
Myotis spp.	*Myotis spp.*	2
Leisler's bat	*Nyctalus leisleri*	1
Common pipistrelle	*Pipistrellus pipistrellus*	3
Soprano pipistrelle	*Pipistrellus pygmaeus*	21
Brown long-eared bat	*Plecotus auritus*	12
Unidentified Bat	-	3

Table 9-17: BCI records for transects within 10km of the study area

Transects		
Common Name	Scientific Name	Number of Records
Daubenton's bat	Myotis daubentonii	3
Myotis spp.	Myotis spp.	2
Leisler's bat	Nyctalus leisleri	11
Common pipistrelle	Pipistrellus pipistrellus	18
Soprano pipistrelle	Pipistrellus pygmaeus	13
Unidentified Bat	Nyctalus leisleri	7

Table 9-18: BCI records for ad-hoc observations within 10km of the study area

Ad hoc Observations		
Common Name	Scientific Name	Number of Records
Daubenton's bat	Myotis daubentonii	8
Whiskered/Brandt’s	Myotis mystacinus/bradtii	2
Nattererer’s Bat	Myotis nattereri	6
Myotis spp.	Myotis spp.	4
Leisler's bat	Nyctalus leisleri	10

Ad hoc Observations		
Common Name	Scientific Name	Number of Records
Common pipistrelle	Pipistrellus pipistrellus	10
Soprano pipistrelle	Pipistrellus pygmaeus	26
Pipistrelle spp.	Pipistrellus spp.	4
Brown long-eared bat	Plecotus auritus	5
Unidentified bat	-	3

9.3.1.13 Conclusions of the Desk Study

The desk study reveals that the site of the *Proposed Road Development* is located adjacent to Sligo/Leitrim Uplands SPA (004187) and Crockauns/Keelogyboy Bogs NHA (002435). In addition, European designated sites occur downstream in the catchment (i.e. Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC (000627), Cummeen Strand SPA (004035))

A number or rare and protected species have been recorded from the hectads in which the *Proposed Road Development* is located and further assessment and field surveys were required (as outlined below) to determine the suitability of the study area for such species.

9.3.2 **Field Survey Results**

9.3.2.1 Habitats and Flora

A dedicated habitat surveys of the area within and in the vicinity of the *Proposed Road Development* were undertaken on the 27th of September 2017, 31st October 2017 and 24th of May 2018.

Habitats recorded during the surveys are listed in Table 9-19 below. The habitat classifications and codes correspond to those described in ‘A Guide to Habitats in Ireland’ (Fossitt, 2000). Habitat mapping is provided in Figures 9.2.1 and 9.2.2 contained within Volume 3 of this EIAR.

Table 9-19: Habitats recorded within the study area

Habitat	Code
Buildings and Artificial Surfaces	BL3
Dry Meadows and Grassy Verges	GS2
Improved Agricultural Grassland	GA1
Wet Grassland	GS4
Mixed broadleaved woodland	WD1
Wet Willow Alder Ash Woodland	WN6
Oak Ash Hazel Woodland	WN2
Immature Woodland	WS2
Scrub	WS1
Calcareous Springs	FP1

Habitat	Code
Rich Fen and Flush	PF1
Drainage Ditch	FW4
Upland/eroding River	FW1
Recolonising bare ground	ED3
Hedgerow	WL1
Treeline	WL2

The route is described from the southern tie-in in the townlands of *Drumkilsellagh*/*Doonally* to the northern tie-in with the existing N16 road in the townland of *Lugnagall*.

Initially the *Proposed Road Development* follows the route of the existing N16. The road was classified as ***Buildings and artificial surfaces (BL3)*** (Plate 9-2). The roadside verge was dominated by ***Dry meadows and Grassy Verges (GS2)***. Land boundaries were dominated by a mixture of coppiced Hawthorn (*Crataegus monogyna*) dominated ***Hedgerows (WL1)*** and ***Treelines (WL2).***

After approximately 380m the route diverges from the N16 and traverses fields of ***Improved agricultural grassland (GA1).***The fields are managed and maintained but have a wet grassland influence, as was evident by the extensive presence of Soft Rush (*Juncus effuses*).

There is a proposed new crossing of the Tully Stream at circa Ch. 610m. The crossing point is located on the *Drumkilsellagh*/*Castlegal* townland boundary at Grid Ref: ITM 571777, 840343. The watercourse consists of an ***Upland/eroding river (FW1)*** (see Plate 9-3). During the May site visit the watercourse was approximately 2-3m wide, 10-20cm deep, with a substrate dominated by gravels, small cobbles and occasional boulders. The river comprised a series of small riffles and glides with some pools and natural bends. ***Treelines (WL2)*** dominated by Sycamore (*Acer pseudoplatanus*) and Ash (*Fraxinus excelsior*) occur along the extent of the watercourse. However, a natural gap in the treeline occurs at the proposed crossing point. The river banks are dominated by ***Wet grassland (GS4)*** and ***Scrub (WS1).*** Bankside flora included, cow parsley (*Anthriscus sylvestris*), hogweed (*Heracleum sphondylium*), creeping bent grass (*Agrostis stolonifera*), cocksfoot (*Dactylis glomerata*), angelica (*Angelica sylvestris*), bramble (*Rubus fruticosus*), blackthorn (*Prunus spinosa*), ivy (*Hedera helix*), herb robert (*Geranium robertianum*), cleavers (*Galium aperine*), yellow pimpernel (*Lysimachia nemorum*), wood sorrell (*Oxalis acetosella)*, meadowsweet (*Filipendula ulmaria*), water figwort (S*crophularia auriculata*), hawthorn, bluebells (*Hyacinthoides non-scripta*) and hemlock (C*onium maculatum*).

Continuing North, the route traverses fields of ***Improved agricultural grassland GA1*** and ***Wet grassland (GS4)***, before crossing the existing N16 in the townland of *Lugatober*. Wooded areas were recorded to the east of the *Proposed Road Development* at this location. Most of the woodlands have been avoided by the design of the *Proposed Road Development* and will be retained.

Up gradient of the existing N16 the woodland was classified as ***Mixed Broadleaved Woodland (WD1)*** (Plate 9-4). The canopy layer was dominated by Sycamore, Ash and Alder (*Alnus glutinosa*). Ground flora included: soft rush, opposite-leaved golden saxifrage (*Chrysosplenium oppositifolium)*, sorrell (*Rumex acetolla*), creeping thistle (*Cirsium arvense*), bittercress (*Cardamine flexuosa*), cuckoo flower (*Cardamine pratense*), creeping buttercup (*Ranunculus repens)*, primrose (*Primula vulgaris*), bluebell (*hyacinthoides non-scripta), l*esser stitchwort (*Stellaria graminea),* dog violet (*Viola riviniana*), honeysuckle (*lonicera periclymenum*), lords and ladies (*Arum maculatum*) and bramble (*Rubus fruticosus* agg.).

Downgradient of the N16, the woodland habitat was categorised as ***Wet willow alder ash woodland (WN6)***. The vegetation composition was indicative of wetter ground conditions and the canopy layer was dominated by willow (*Salix* sp.), alder and ash. The understory was sparse, with hawthorn and holly (*Ilex aquifolium*) recorded occasionally. The ground flora was also indicative of slightly wetter conditions with species such as meadowsweet (*Filipendula ulmaria*), water mint (*Mentha aquatica*), yellow iris (*Iris pseudacorus*) and lesser celandine (*Ficaria verna*) recorded. The potential for this habitat to correspond to the Annex I priority habitat 91E0 was considered. The European Commission (2012) states that all 91E0 types occur on heavy soils (generally rich in alluvial deposits) that are periodically inundated by the annual rise of river levels. The woodland does not fulfil this criterion; it is located on the side of a sloping valley, the soil type is classified as *Coarse loamy with limetone* (Teagasc web mapper 2018), there are no associated watercourses and the woodland is not subject to periodic inundation by rising river waters. The woodland does not conform to Annex I status.

Calcareous springs (PF1) were recorded in the wet woodland area with three springheads recorded on the sloping hillside (Figure 9.2.1 contained within Volume 3 of this EIAR).

The springs (See Appendix 9.1 contained within Volume 4 of this EIAR) are examples of the Annex I habitat 'Petrifying springs' due to the presence of typical petrifying spring vegetation and locally abundant tufa. The spring vegetation had most affinity to Group 2 *Palustriella commutata-Geranium robertianum* Springheads vegetation community (Lyons & Kelly, 2017). Releve data was collected from the best example of the spring habitat. This spring had the most well-developed tufa formation and cover of the typical tufa bryophyte *Palustriella commutata*. The species richness for the relevé was 15, including 3 positive indicator species. For comparison, a mean species richness of 14, was recorded by Lyons (Lyons, 2015) for similar vegetation communities in a survey of tufa springs across Ireland. The characteristic species *Palustriella commutata*, *Carex remota* and *Equisetum telmateia* were locally abundant. The cover of the key indicator species *Palustriella commutata* (25%) was within the recorded range (25-95%) for this community. The relevé did not fail any criteria in the condition assessment (See Annex 1 Wetland Survey contained within Volume 4 (Section 7) of this EIAR) and is in good condition with no current negative threats or pressures.

Moving northwards, the proposed route enters *Lugatober* valley which is dominated by ***Improved agricultural grassland (GA1)*** (Plate 9-6). The grassland is intensively grazed by sheep. A small natural stream (i.e. Lugatober stream) occurs in the valley. The Lugatober Stream is a tributary of the Drumcliff River. At the proposed crossing location, the stream banks have been damaged by livestock. The watercourses is reminiscent of a drainage ditch at this location with little perceivable flow and a benthic substrate dominated by silt. Instream/bankside vegetation included floating sweet-grass (*Glyceria fluitans*), fools watercress (*Apium nodiflorum*), soft rush, yellow iris (*Iris pseudacorus)* and duckweed (*Lemna sp.)*. Downstream of the *Proposed Road Development* area the stream enters a steep sided natural cut in the valley and it has a more natural flow regime characterised by small riffles and pools.

At the route selection stage, a wetland area in a field of wet grassland, referred to as East of Drum (See KER 04 in Figure 9.3.1 contained within Volume 3 of this EIAR), was recorded approximately 320m west of the *Proposed Road Development*. The wetland area comprised rich fen and flush vegetation. Indicator species of alkaline fens were scare, and no brown mosses were recorded. The vegetation was considered to have slight affinity to the Annex I habitat Alkaline Fen.

Emerging from the valley, the route continues through an existing farmyard. The farm buildings were categorised as ***Buildings and Artificial Surfaces (BL3)***. Continuing North, the route passes through fields of ***Improved agricultural grassland (GA1)*** and ***Wet grassland (GS4)***. The field boundaries are increasingly demarcated by semi-mature ash dominated Treelines and Hedgerows become less frequent.

A wetland area, comprising an apparent springhead at the start of a small stream which flows away from the *Proposed Road Development*, was recorded 70m to the west of the proposed route corridor. For ease of reference the wetland has been labelled wetland 'South of *Collinsford*' (See KER 04 contained within Figure 9.3.2 of Volume 3). The wetland area comprises species-rich Fen and Flush vegetation but did not contain indicative species of highly calcareous water. In the west of the flush, adjacent to an area of wet woodland there was a small area with tufa deposits on the bryophyte *Calliergonella Cuspidata*. This species in not typically associated with tufa formation and the habitat was considered to have some affinity to Irish petrifying springs plant community: Group 6 *Carex lepidocarpa* Small Sedge Springs (Lyons, 2015). Slightly further downgradient the small stream flows through an area of wet willow-alder-ash woodland (WN6). More typical vegetation of petrifying springs was recorded at this location, but tufa formation was low with only occasional patches. The vegetation had some affinity to the Irish petrifying springs plant community: Group 2 *Palustriella commutate-Geranium robertianum* Springheads (Lyons, 2015). The spring/flush vegetation has some affinity to the Annex I habitat Petrifying Springs.

Approaching the *Lugatober*/*Collinsford* townland boundary, petrifying spring (7210) vegetation was recorded within man made drains within and area of wet grassland. The vegetation was indicative of the Annex I habitat 'Petrifying springs' due to the presence of typical petrifying spring vegetation and locally frequent tufa. The spring vegetation has most affinity to Group 4 *Palustriella commutata-Agrostis stolonifera* Springheads vegetation community (Lyons & Kelly, 2017). Relevé data was collected from the best example of the habitat (i.e. area with the highest water flow, cover of tufa, cover of the typical tufa bryophyte *Palustriella commutata*, frequency of additional positive indicator species and diversity). The species richness for the relevé was 30, including 12 positive indicator species. For comparison, a mean species richness of 20, was recorded by Lyons (Lyons, 2015) for that vegetation community in a survey of tufa springs across Ireland. The relevé at *Lugatober* North has typical species composition for this vegetation community but has high diversity. The cover of the main indicator species *Palustriella commutata* (35%) is within the recorded range (10-95%) and was present throughout most of the unwooded section of channel. The relevé did not fail any criteria in the condition assessment (See Appendix 9.1, Annex I Wetland Survey contained within Volume 4 of this EIAR) contained within Volume 4 of this EIAR) and is in good condition with no current negative threats or pressures.

Continuing North, the route enters an area of woodland mosaic with ***Mixed Broadleaved Woodland (WD1),*** with a wet woodland influence, and ***Immature Woodland (WS2)***. The canopy layer was dominated by ash, willow and hazel. Hawthorn was recorded from the understory. Ground flora included yellow iris (*Iris pseudacorus*), herb robert (*Geranium robertianum*), primrose (*Primula vulgaris*), meadowsweet (*Filipendula ulmaria*), honeysuckle (*Lonicera periclymenum*), lords and ladies (*Arum maculatum*), enchanter's nightshade (*Circaea lutetiana*), nettle (*Urtica dioica*) and bugle (*Ajuga reptans*).

A small stream (i.e. *Collinsford* Stream) categorised as and ***Upland/eroding river (FW1)*** was recorded in the woodland area. The stream is a tributary of the Drumcliff River. During the May site visit the watercourse was approximately 0.5-1m wide and 10-15cm deep, with a substrate dominated by gravel and small cobbles. Bankside flora included yellow iris, water mint (*Mentha aquatica*), cuckoo flower, floating sweet grass (*Glyceria fluitans*), hard rush (*Juncus inflexus*) and soft rush effuses.

On emerging from the immature woodland, the proposed route re-joins and follows the alignment of the existing N16. Woodland areas are present to the north-west and south-east of the alignment at this location and will be retained. The woodland to the north-west is classified as ***Oak Ash Hazel Woodland (WN2)*** while the woodland to the south- east is classified as ***Mixed broadleaved woodland (WD1)***.

The route partially overlaps with the boundary of Crockauns/Keelogyboy Bogs NHA (002435) at the *Lugatober*/*Lugnagall* townland boundary but does not overlap with any upland habitat for which the NHA is designated. The area within the NHA boundary has been recently cleared (by private operations) of vegetation and a new land boundary fence has been constructed (Plate 9-7). The altered habitat at this location was classified as ***Recolonising bare ground (ED3)***.

There is a requirement to modify the existing N16 junction with the L-3404. The realigned junction is to be located in areas of formerly disturbed ground which has revegetated with ***Scrub (WS1)*** and ***Dry meadows and Grassy Verges (GS2)***.

A wetland area, labelled Lugnagall Flush, occurs to the south- east of the alignment just north of the junction with the L-3404 (See Figure 9.2.2 & 9.3.2 contained within Volume 3 of this EIAR). This area is drained by the Lugnagall Stream which is culverted under the existing N16. At the proposed crossing point the watercourses is modified and reminiscent of a drainage ditch however the watercourse is classified as an **Upland/eroding River (FW1)** given that it is identified as a river on the EPA river database. The watercourses is approximately 1-1.5m wide and 20cm deep, with a substrate dominated by silt. Downstream of the N16 the watercourses is shrouded by willows while upstream there are recently cleared sections and areas shrouded in **Scrub (WS1)**.

The spring area in the west of the Lugnagall Flush (Figure 3.1 of Appendix 9.1, Annex I Wetland Survey contained within Volume 4 of this EIAR) is considered to support the Annex I habitat 'Petrifying springs' due to the presence of some typical petrifying spring vegetation and occasional tufa. The spring vegetation has most affinity to ***Group 4 Palustriella commutata-Agrostis stolonifera springheads vegetation community*** (Lyons & Kelly, 2017). The relevé was located in the best example of spring vegetation remaining in this area (R01; Figure 3.1 of Appendix 9.1 contained within Volume 4 of this EIAR). The species richness for the relevé was 23, including 8 positive indicator species for the Annex I habitat type. For comparison, a mean species richness of 20, was recorded by Lyons (Lyons, 2015) for that vegetation community in a survey of tufa springs across Ireland. The relevé at *Lugnagall* has typical species composition and diversity for this vegetation community and the cover of the main indicator species *Palustriella commutata* (15%) is within the recorded range (10-95%). However, this relevé was positioned in the best example of spring vegetation at the site and cover of typical tufa species was lower across the general spring area. The relevé failed the conservation status assessment on two criteria: presence of regenerating woody species (Ash *Fraxinus excelsior*) and water flow. Water flow from the spring is being abstracted by a pipe from the spring at the source. The presence of regenerating woody species suggests that the spring area is drying out.

The remnant wetland area in the east of the Lugnagall Flush (Figure 3.1 of Appendix 9.1 contained within Volume 4 of this EIAR) supports the Annex I habitat 'Alkaline fen due to the presence of some typical alkaline fen vegetation. However, the area of typical fen vegetation is localised and occurs in a mosaic with wet grassland and scrub. The fen/ flush vegetation has most affinity ***to RFLU4 Schoenus nigricans–Scorpidium scorpioides flush*** (Perrin et al., 2014). The relevé was located in the best example of fen vegetation remaining in this area (R02; Figure 3.1 of Appendix 9.1 contained within Volume 4 of this EIAR). The species richness for the relevé was 31, including 1 'brown' moss and 3 positive indicator species. The relevé at *Lugnagall* supports some typical species for this vegetation community, but grades into less species rich wet grassland and brown mosses are rare. The relevé was positioned in the best example of spring vegetation at the site and cover of typical fen species was lower across the general fen area. The wetland is becoming overgrown with scrub and trees. The relevé failed the conservation status assessment on three criteria: cover of positive indicator species and brown mosses; cover of scattered tress and scrub; and, drainage impacts in the local vicinity. There is a well and water abstraction from a spring to the south of the fen area which may be impacting on the vegetation. There is also significant infilling with rubble in the surrounding area.

Approaching the northern terminus of the *Proposed Road Development* the roadside verges are dominated by ***Dry meadow and grassy verges (GS2)*** and the land boundaries are demarcated by coppiced ***Hedgerows (WL1).***

None of the rare or protected flora identified in the desk study were recorded during the site visits.

Plate 9-2: Existing N16 at Southern tie-in (proposed roundabout location)

Plate 9-3: Crossing location of the Tully Stream *showing natural gap in Treeline*

Plate 9-4: Mixed Broadleaved Woodland (WD1) at Lugatober (Woodland will be retained)

Plate 9-5: Wet Woodland (WN6) at Lugatober (Woodland will be retained)

Plate 9-6: Lugatober Valley (Watercourse evident in centre of image)

Plate 9-7: Existing N16 at the location where the NHA overlaps the Proposed Road Development

Attenuation Ponds

There are four proposed attenuation ponds (in the form of constructed wetlands) associated with the *Proposed Road Development*. They occur at circa Ch. 0m, between c. Ch. 600m and c. Ch. 700m, between c. Ch 1,800m and c. 1,900m and the terminus of the road project at c. Ch. 2,400m. All the ponds are in areas of ***Improved agricultural grassland (GA1)/Wet grassland (GS4***).

Soil Repository and Borrow pit

The proposed Soil Repository and Borrow Pit are to be in a field of ***Improved agricultural grassland (GA1)*** which has a wet grassland influence (circa. Ch 1,000m). The field boundaries are demarcated by hawthorn dominated hedgerows at this location.

Site Compound

The proposed site compound will be in a field of ***Improved agricultural grassland (GA1)*** which has a wet grassland influence (circa. Ch 450m).

Discharge to Willsborough Stream

The Willsborough Stream is not traversed by the *Proposed Road Development* but surface water draining from the new road will be attenuated and discharged to this watercourses via a drainage ditch which will run along the boundary of improved agricultural fields. The watercourse is classified as an ***Upland/eroding River (FW1)***. It is approximately 6-8m wide and dominated by a substrate of gravels, cobbles, bedrock and boulders. Salmonids were recorded instream and an Otter Spraint was recorded on a rock underneath the existing N16 Bridge. The riverbanks are dominated by mature ***Treelines (WL2)***. Species recorded include ash, hawthorn, alder, sycamore and brambles.

Invasive Alien Species (IAS)

During field surveys, observations of Invasive Alien Species (IAS) listed under the Third Schedule of the European Communities Regulations 2011 (S.I. 477 of 2011) were recorded. Regulations 49 and 50 of these Regulations include legislative measures to deal with the dispersal and introduction of invasive alien species. Regulation 50 has not yet been commenced. IAS are also addressed by EU Regulation 1143/2014, which seeks to address the problem of invasive alien species in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have.

The non-native invasive species Japanese Knotweed (*Fallopia japonica*) was recorded on the *Proposed Road Development* in the townland of *Lugatober* (Grid Ref 571878 841098). This infestation consisted of a linear strip (approximately 20m) recorded in the road side hedgerow.

A second infestation was recorded in the townland of *Lugnagall* (Grid Ref 572380, 841629). The infestation consisted of two small stands which measures approximately 2m x 2m.

There was also signage present at the Southern tie-in (Grid Ref 571723, 839775) which indicated that Japanese knotweed had been recorded and treated in the past. No evidence of Knotweed was recorded at this location during the 2017 and 2018 surveys.

The identified infestations occur at c. 571,887; 841,096 and 572,388; 841,620 as outlined in Appendix 9.3 contained within Volume 4 of this EIAR.

An IAS Management Plan has been prepared (Appendix 9.3 contained within Volume 4 of this EIAR) in relation to the treatment of the identified stands of Knotweed. The plan has taken consideration of ongoing treatment of Japanese Knotweed which commenced in July 2018 and is scheduled to continue into 2019. The management plan shall follow the guidance outlined in the following document:

- National Roads Authority TII/NRA (2010). Guidelines on management of noxious weeds and non-native invasive plant species on national roads;

9.3.2.1.1 *Significance of Habitats and Flora*

Ecological evaluation within this Section follows a methodology that is set out in Chapter three of the '*Guidelines for Assessment of Ecological Impacts of National Roads Schemes*' (NRA, 2009)

The habitats within and adjacent to the *Proposed Road Development* site were evaluated in accordance with the criteria developed by the National Roads Authority (NRA) –outlined in *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (NRA, 2009) which classifies sites in terms of their ecological importance, *i.e*. International Importance, National Importance, County Importance, Local Importance (Higher Value) or Local Importance (Lower Value). The evaluation methodology also took cognisance of the geological context evaluation criteria outlined in Chapter 4 of CIEEM 2016.

None of the habitats within the *Proposed Road Development* footprint correspond to habitats listed on Annex I of the EU Habitats Directive. However, the Annex I habitats Alkaline Fen [7230] and Petrifying springs [7220] were recorded outside the *Proposed Road Development* footprint but within the EIAR study area boundary.

The spring and fen habitats at Lugnagall Flush are in poor condition and have been significantly disturbed and altered in recent times. As an ecological receptor the Flush has been classified as ***County Importance***. The Flush area including the spring and fen habitats is classified as a Key Ecological Receptors. The KER boundary is demarcated in Figure 9.3.2, contained within Volume 3 of this EIAR , and labelled as **KER 01**.

The springs at Lugatober North are examples of Annex I [7220] which are in favorable conservation condition. The Lugatober spring habitats are have a high species diversity and are assigned ***National Importance***. The Lugatober North habitat is classified as a Key Ecological Receptor. The KER boundary is demarcated in Figure 9.3.2, contained within Volume 3 of this EIAR,and labelled as **KER 02**.

The flush/springs South of *Collinsford* have some affinity with Annex I [7220]. As an ecological receptor the Flush has been classified as ***County Importance***. The Flush area is classified as a Key Ecological Receptor. The KER boundary is demarcated in Figure 9.3.2, contained within Volume 3 of this EIAR, and labelled as **KER 03**.

The flush vegetation recorded East of Drum is located approximately 320m from the *Proposed Road Development*. The habitat was considered to have slight affinity to the Annex I habitat Alkaline fen and was assigned ***Local Importance (Higher Value*)**. The Flush area is classified as a Key Ecological Receptor. The KER boundary is demarcated in Figure 9.3.1, contained within Volume 3 of this EIAR, and labelled as **KER 04**.

The springs at *Lugatober* (reported as site West of *Castlegal*) are examples of Annex I [7230] which are in favorable conservation condition. The *Lugatober* spring habitats are relatively small and localised and were assigned ***County Importance***. The *Lugatober* springs are classified as a Key Ecological Receptor. The KER boundary is demarcated in Figure 9.3.1, contained within Volume 3 of this EIAR, and labelled as **KER 05**.

The following woodland habitats were recorded within/adjacent to the development footprint: Mixed broadleaved Woodland (WD1), Wet willow alder ash woodland (WN6), Oak ash hazel Woodland (WN2) and Immature woodland (WS2). The woodlands stands, none of which conform to Annex I status, are classified as being of ***Local Importance (higher value)*** on the basis of supporting semi-natural habitat types with high biodiversity and a high degree of naturalness in a local context. The woodland habitats are classified as a Key Ecological Receptor. The KER boundary is demarcated in Figure 9.3.1 and 9.3.2, contained within Volume 3 of this EIAR, and labelled as **KER 06**.

The hedgerows/treelines within the study area were assigned ***Local Importance (Higher Value).*** The hedgerows/treelines provide potential habitat for a range of protected fauna including those listed on IV of the EU Habitat Directive and those protected under the Wildlife Acts 1976-2017. Hedgerows and Treelines in the study area are classified as Key Ecological Receptors. The KER boundary is demarcated in Figure 9.3.1 to 9.3.2, contained within Volume 3 of this EIAR, and labelled as **KER 07**.

The watercourses within the study area, (i.e. Tully Stream, Lugatober Stream, Collinsford Stream, Lugnagall Stream and Willsborough Stream) provide potential habitat for a range of protected fauna including those listed on Annex II and IV of the EU Habitat Directive. The watercourses were assigned ***Local Importance (Higher Value).*** The watercourses in the study area are classified as Key Ecological Receptors. The KER boundary is demarcated in Figure 9.3.1 to 9.3.2, contained within Volume 3 of this EIAR, and labelled as **KER 08**.

The remaining terrestrial habitats within the land acquisition boundary, including at the location of the proposed Attenuation ponds, Soil Repository/Borrow Pit and Site compound were assigned ***Local Importance (Lower Value)*** and are not classified as Key Ecological Receptors.

Table 9-20: Summary of habitat evaluation and KER identification

Habitat	Conservation Listing	Receptor Importance. Ecological evaluation (NRA 2009)	KER Yes/No
Rich Fen and Flush PF1 and Calcareous Springs FP1 at Lugnagall	Habitats Directive Annex I [7330] & Annex I [7230]	County Importance)	Yes. Labelled KER 01
Calcareous spring FP1 at Lugatober North	Habitats Directive Annex I [7230]	National Importance	Yes. Labelled KER 02
South of Collinsford- Rich Fen and Flush PF1 and Calcareous Springs FP1	Habitats Directive Annex I [7330] & Annex I [7230]	County Importance	Yes. Labelled KER 03
Flush Area east of Drum	Slight affinity to Habitats Directive Annex I [7230]	Local Importance (Higher Value)	Yes. Labelled KER 04
Calcareous spring FP1 West of Castlegall (Lugatober)	Habitats Directive Annex I [7230]	County Importance	Yes. Labelled KER 05
Woodland Habitats	-	Local Importance (Higher value)	Yes. Labelled KER 06
Treelines and Hedgerows	-	Local Importance (Higher value)	Yes. Labelled KER 07
Watercourses within the Study Area	-	Local Importance (Higher value)	Yes. Labelled KER 08
Additional Habitats within study area	-	Local Importance (Lower Value)	No

9.3.2.2 Fauna

9.3.2.2.1 *Bats*

Activity

All bat species in Ireland are protected under the Bonn Convention (1992), Bern Convention (1982) and the EU Habitats Directive (92/43/EEC). Additionally, in Ireland bat species are afforded further protection under the Birds and Natural Habitats Regulations (2011) and the Wildlife Acts, 1976-2017.

In total, four dusk and four dawn car/walked transect surveys, covering 27.5 hours were completed between May and September 2018. In additional landscape suitability surveys were conducted during the multidisciplinary surveys. Monthly survey results are presented on Figures 9.4.1 and 9.4.2 contained within Volume 3 of this EIAR.

In order of dominance the following species were recorded during the bat surveys:

- Soprano pipistrelle
- Common pipistrelle
- Pipistrelle spp.
- Myotis sp. (noted following the analysis of sonogram data)
- Leisler's bat
- Brown Long-eared bat (noted following the analysis of sonogram data)

The entire length of the *Proposed Road Development* was assessed for its potential as bat habitat during both desk top and field assessments followed by targeted transect surveys. Bat activity was highest to the south of the *Proposed Road Development* area in the townland of *Castlegal* and in proximity to *Castlegal* House.

Bat activity throughout the remainder of the study area had a constant but patchy distribution and where recorded, activity was positively associated with treelines and mature hedgerows.

Areas of woodland, treelines, uncoppiced hedgerows as well as rivers and associated riparian habitat were assessed as *Moderate* suitability for foraging and commuting bats. Vegetated drains and areas of scrub were assessed as *Low* suitability, agricultural grassland habitats which dominate the study area were considered to offer *Negligible* suitability.

Roosts

Castlegal house was identified as a pipistrelle roost. A minimum of nine pipistrelle bats were recorded emerging from under loose slates in the roof during emergence surveys.

The agricultural buildings to be demolished at *Lugatober* do not currently support roosting Bats and no evidence of emergence or dawn swarming activities at the buildings was recorded during the surveys. The buildings were assigned *Low* suitability regarding supporting roosting bats.

No tree roosts were specifically identified and most trees to be removed to facilitate the *Proposed Road Development* are semi-mature and do not provide suitable roosting features for large bat roosts.

The existing N16 bridge structures over the Tully Stream and the Willsborough Stream were surveyed regarding their potential to support roosting bats. Both structures contain some masonry elements but the pointing was in good condition and no evidence of roosting bats was recorded. The bridges were assigned *Low-Negligible* suitability regarding supporting roosting bats. In addition, a stone culvert under the N16 (Grid Ref 572247 841469) was surveyed but no evidence of roosting bats was recorded. The culvert was assigned *Low* suitability regarding supporting roosting bats.

9.3.2.2.2 *Otter*

Evidence of Otter in the form of spraints was observed under the existing N16 *Castlegal* Bridge at Grid Reference (E571690 N840299) (Plate 9-8). A sprainting site was also recorded under the existing N16 Bridge over the Willsborough Stream (E571997, N839422). No breeding or resting sites of Otter were observed during the site visits. The tributaries of the Drumcliff River, within the land take boundary, do not provide optimal habitat for Otter due to their size and ability to support prey species for Otter. However, the watercourses may be utilised on occasion for commuting. Survey results are presented on Figures 9.3.1 and 9.3.2 contained within Volume 3 of this EIAR.

No additional evidence of Otter was recorded within the study area.

Plate 9-8: Otter spraint on rock under Castlegal Bridge

9.3.2.2.3 *Badger*

A thorough survey of the study area for evidence of badger activity was conducted in accordance with NRA guidance. The results of previously completed survey work at the constraints stage of the N16 Sligo to County Boundary Route Selection Report were reviewed and ground truthed.

No badger setts occur within the footprint of the *Proposed Road Development*. Two active Main setts, recorded at the constraints stage in the townlands of *Doonally* and *Lugatober*, were revisited. These setts were still active. The *Lugatober* sett is located a minimum distance of 100m from the proposed land take boundary and the *Doonally* sett is located more than 500m from the Land acquisition boundary. Survey results are presented on Figures 9.3.1 and 9.3.2 contained within Volume 3 of this EIAR.

Table 9-21 provides details of the badger evidence recorded during the multidisciplinary and dedicated surveys.

Table 9-21: Evidence of Badger recorded

Townland	Grid reference (ITM)	Observation	Location in Relation to N16 Land take
Doonally	E571229 N 839430	Main Badger Sett	520m from land take
Lugatober	E571615 N840955	Main Badger Sett	100m from land take
Drumkilsellagh	E571699 N840518	Latrine and Mammal Trail	Within Land take

Townland	Grid reference (ITM)	Observation	Location in Relation to N16 Land take
Castlegal	E571761 N840332	Snuffle holes (Feeding sign)	Within Land take
Lugatober	E571772 N840852	Latrine & mammal trail	Within Land take

Plate 9-9: Badger Sett at Lugatober

9.3.2.2.4 *Additional Fauna*

No evidence of additional fauna was recorded. No evidence of Red squirrel, Irish stoat, Pine marten, Irish Hare or other protected fauna was recorded. However suitable habitat areas exist within and outside the study area.

9.3.2.2.5 *Amphibians and Reptiles*

Common Frog (*Rana temporaria*) was encountered during the walkover surveys. Drainage ditches and wet areas within fields at various locations throughout the study area provide potential breeding habitat for the species. However, it is considered that the *Proposed Road Development* will not result in a significant overall loss of suitable habitat for this species. The road will provide attenuation ponds and ditches as part of the design and it is considered that suitable wet fields, ditches and drains are extremely widespread in the study area and beyond. No likely significant effects on this species are anticipated and therefore further survey/ assessment was not deemed necessary.

Smooth Newt (*Lissotriton vulgaris*) was recorded in the desk study from hectads G73 which overlap with the footprint of the *Proposed Road Development*. It was not however encountered during field surveys. No ponds or optimal wetland habitats for this species are traversed by the *Proposed Road Development* and many of the drainage ditches were deep, shaded or choked with vegetation and thus did not provide the preferred habitat for this species. No shallow unshaded ditches with limited flow and good diversity of submerged or emergent vegetation, which are favoured by this species, were recorded during the multidisciplinary walkover survey. The *Proposed Road Development* will result in the provision of attenuation ponds that are likely to provide new and better quality habitat for this species than any drains that may be lost. Drainage ditches form part of the proposed road drainage design. On the basis of lack of high quality habitat for the species encountered, or any field evidence of presence, no likely significant effects on this species are anticipated and therefore further survey/ assessment was not deemed necessary.

The desk study revealed no records for Viviparous Lizard and none were recorded during the site surveys. It is not considered that the *Proposed Road Development* will impact significantly on this species or result in a significant loss of habitat given the abundance of suitable habitat in the area. No requirement for further survey was identified.

9.3.2.2.6 *Fisheries & White clawed crayfish*

AS per NRA guidance it is "*only appropriate to undertake detailed surveys where significant impacts are anticipated on potentially valuable assemblages of fish, or important populations of a particular species*". Based on the results of the desk study and walkover surveys and taking into inconsideration the nature of the watercourses in the study area; no potential for significant impact on valuable assemblages of fish or aquatic invertebrates was identified. Therefore, the results of the walkover surveys were utilised to provide an assessment with regard to the fisheries potential of the watercourses in the study area.

Willsborough Stream

Inland fisheries Ireland in their consultation letter on the 11th of July 2018 identify that the Willsborough Stream (a.k.a. *Doonally* River) provides habitat for sea trout and brown trout.

The Willsborough Stream is not traversed by the proposed project but surface water draining from the new road will be attenuated and discharged to this watercourses via a drainage ditch which will run along the boundary of improved agricultural fields. The watercourse is classified as an Upland/eroding River (FW1). It is approximately 6-8m wide and dominated by a substrate of gravels, cobbles, bedrock and boulders. The watercourse provides suitable spawning and nursery habitat for salmonids and has potential to support Lamprey species, European Eel and White Clawed Crayfish.

Tully Stream

Inland Fisheries Ireland in their consultation letter on the 11th of July 2018 identify that the Tully Stream is likely to support a population of brown trout.

The Tully Stream consists of an ***Upland/eroding river (FW1)***. During the May site visit the watercourse was approximately 2-3m wide, 10-20cm deep, with a substrate dominated by gravels, small cobbles and occasional boulders. The river was dominated by a series of small riffles and glides with some pools and natural bends. The watercourse provides suitable spawning and nursery habitat for salmonids and has potential to support Lamprey species, European Eel and White Clawed Crayfish.

No diversion is required on this watercourse and it will be crossed via a clear span structure (in accordance with IFI requirements).

Lugatober Stream

The Lugatober stream is a tributary of the Drumcliff River. At the proposed crossing location, the stream banks have been damaged by livestock. The watercourse is reminiscent of a drainage ditch at this location with little perceivable flow and a benthic substrate dominated by silt. The watercourse has negligible suitability with regard to providing habitat for Salmonids, Lamprey species, European Eel or White Clawed Crayfish at the proposed crossing point. However, the watercourse has connectivity to potential supporting habitat downstream in the Drumcliff catchment.

This watercourse will be diverted, and the proposed crossing will be constructed using a box culvert.

Collinsford stream

A small stream (i.e. Collinsford stream) categorised as and **Upland/eroding river (FW1)** was recorded in the woodland area. The watercourse has negligible suitability with regard to providing habitat for Salmonids, Lamprey species, European Eel or White Clawed Crayfish at the proposed crossing point. However, the watercourse has connectivity to potential supporting habitat downstream in the Drumcliff catchment.

This watercourse will be diverted, and the proposed crossing will be constructed using a box culvert.

Lugnagall Stream

The Lugnagall Stream at the proposed crossing point the watercourses is modified and reminiscent of a drainage ditch. However, it is still best classified as an ***Upland/eroding River (FW1)***. The watercourse is approximately 1m-1.5m wide and 20cm deep, with a substrate dominated by silt. The watercourse has negligible suitability with regard to providing habitat for Salmonids, Lamprey species, European Eel or White Clawed Crayfish at the proposed crossing point. However, the watercourse has connectivity to potential supporting habitat downstream in the Drumcliff catchment.

A minor diversion is required on this watercourse and it will be crossed via a box culvert.

9.3.2.2.7 *Terrestrial Invertebrates*

The desk study revealed records for Marsh Fritillary Butterfly; however, no potential supporting habitat for this species occurs within the study area.

The desk study revealed records for *Vertigo geyeri* and potential supporting habitat was identified, outside the development footprint, in the form of petrifying springs and alkaline fen. The identified areas were subject to detailed assessment to confirm habitat suitability and the presence or absence of the species. The results of the detailed assessment are provided in Appendix 9.2 contained within Volume 4 of this EIAR.

The report concludes that optimal conditions for the *Vertigo geyeri* were not present at any of the identified locations – e.g. carpets of brown mosses, areas of low- growing sedges, small to moderate tussocks of *Schoenus nigricans*. In addition, all samples collected for laboratory analysis were found to be negative for *Vertigo geyeri*.

9.3.2.2.8 *Birds*

General Species Assemblages

Breeding bird surveys were conducted along the proposed route corridor in 2018. The following species were recorded: Blackbird (*Turdus merula),* Great Tit (*Parus major*), Goldcrest (*Regulus regulus*)

Wren (*Troglodytes troglodytes*), Willow Warbler (*Phylloscopus trochilus*), Chaffinch (*Fringilla coelebs),* Cuckoo (*Cuculus canorus*), House Martin (*Delichon urbicum*), Meadow Pipit (*Anthus pratensis*), Wood Pigeon (*Columba palumbus*), Blackcap (*Sylvia atricapill*), Goldfinch (*Carduelis carduelis*), Jackdaw (*Corvus monedula*), Hooded Crow (*Corvus cornix*), Mistle Thrush (*Turdus viscivorus*), Magpie (*Pica pica*), Pheasant (*Phasianus colchicus*), Robin (*Erithacus rubecula*), Starling (*Sturnus vulgaris*), Song thrush (*Turdus philomelos*), Dunnock (*Prunella modularis*), Swallow (*Hirundo rustica*), Stonechat (*Saxicola torquata*) and Rook (*Corvus frugilegus*).

The banks of the Tully Stream and other watercourses in the study area do not provide suitable nesting habitat (vertical earthen banks) for the Annex I species Kingfisher (*Alcedo atthis*).

Qualifying Interests of Sligo Leitrim Upland SPA

Chough

There is no suitable nesting habitat for chough within the land acquisition boundary. The closest suitable breeding habitat for chough occurs on the cliffs of Cope's Mountain approximately 500m east of the northern tie in with the existing N16. As per the results of the desk study, chough have been confirmed breeding in this area in the past.

Chough were not recorded during the dedicated surveys undertaken during the 2018 breeding season. In addition, the species was not incidentally recorded during any additional survey work undertaken between 2017 and 2018.

The habitats within the land acquisition are suboptimal for foraging chough being dominated by improved and semi-improved pasture. Many of the fields are utilised for silage production and have a sward which is unsuitable for foraging chough. The species requires a short sward and feed mostly on insect's insects and their larvae, worms and other subterranean invertebrates, using their curved bills to probe the soil.

As per the NPWS Site Synopsis for the SPA, suitable foraging habitat utilised by chough within the SPA occurs on the steep slopes below the cliffs. Trewby et al (2010) found that 68% of all observations of Chough within the SPA occurred on unimproved, steep, sheep grazed slopes that were typically south facing. The report concluded that low usage for some parts of the SPA – Cope's Mountain & Gleniff – could be explained by small numbers of birds (pairs) only being present seasonally (breeding season). The report also found that all observations of chough recorded in the vicinity of Cope's Mountain between February 2009 and January 2010 occurred within the SPA boundary.

Peregrine

There is no suitable nesting habitat for Peregrine within the land acquisition boundary. The species was not recorded utilising habitats within the development footprint during the 2018 breeding bird surveys or during any additional survey conducted during the 2017-2018 survey period.

The closest suitable breeding habitat for Peregrine occurs on the cliffs of Cope's Mountain approximately 500m east of the northern tie-in with the existing N16. This area is traditionally utilised by one breeding pair of Peregrine.

David McNicholas of McCarthy Keville O'Sullivan has voluntarily monitored the pair in recent years. Confirmed breeding success was recorded for the 2017 breeding season (one chick fledged) and possible breeding success was recorded for the 2018 season.

9.3.2.2.9 *Significance of Fauna*

Ecological evaluation and within this Section follows a methodology that is set out in Chapter three of the '*Guidelines for Assessment of Ecological Impacts of National Roads Schemes'* (NRA, 2009).

All bat species in Ireland are protected under the Bonn Convention (1992), Bern Convention (1982) and the EU Habitats Directive (92/43/EEC). Additionally, in Ireland bat species are afforded further protection under the Birds and Natural Habitats Regulations (2011) and the Wildlife Acts 1976-2017 No bat roosts were identified within the footprint of the *Proposed Road Development* however a pipistrelle roost was identified in *Castlegal* House which is located adjacent to the land acquisition boundary. Bats as an Ecological Receptor have been assigned ***Local Importance (Higher value***) on the basis that the habitats within the land acquisition boundary are likely to be utilised by a regularly occurring bat population of Local Importance. Bat species are identified as a Key ecological receptor.

Otter is listed under Annex II and Annex IV of the EU Habitats Directive and is also protected under the Irish Wildlife Acts 1976-2017 and is evaluated as being 'Near Threatened' in the most recent Red Data list for mammals (Kingston, 2012). Evidence of Otter in the form of spraint was recorded at *Castlegal* Bridge and in proximity to the N16 bridge (Willowbrook Bridge) over the Willsborough Stream. Whilst not providing optimum habitat for Otter it is considered likely that the smaller watercourses and land drains located within the study area may be utilised, on occasion, as commuting corridors between larger watercourses. Otter as an Ecological Receptor has been assigned ***Local Importance (Higher value)*** on the basis that the habitats within the land acquisition boundary are suitable to support a locally important, regularly occurring population of the protected species. Otter is identified as a Key ecological receptor.

Badger is protected under the Wildlife Acts 1976-2012. Evidence of badger was recorded in the form of setts, trails and latrines. No setts were recorded within the land acquisition boundary but evidence of activity was noted. Badger as an Ecological Receptor has been assigned ***Local Importance (Higher value)*** on the basis that the habitats within the land acquisition boundary are utilised by a regularly occurring badger population of Local Importance. Badger is identified as a Key ecological receptor.

Fish and aquatic invertebrates are likely to occur in the zone of influence due to the presence of potential supporting habitat. The ecological receptor has been assigned ***Local Importance (Higher value)*** on the basis that the habitats within and downstream of the land acquisition boundary are suitable to support a locally important, regularly occurring population of the protected species. Fish and aquatic invertebrates are classified as a Key ecological receptor.

Terrestrial invertebrate populations of conservation importance were not recorded within the study area.

Meadow Pipit (*Anthus pratensis*) is a Red listed species in relation to its breeding status in Ireland. Additional Birds Species of Conservation Interest were not recorded during the site visits.

SCI species populations of the Sligo Leitrim Upland SPA (i.e. Chough and Peregrine) are of International Importance. However, there is no suitable nesting habitat for SCI species of the Sligo Leitrim Upland SPA within the land acquisition boundary. The closest suitable breeding habitat for both species occurs on the cliffs of Cope's Mountain approximately 500m east of the northern tie in with the existing N16. Neither species was recorded utilising habitats within the land acquisition boundary during breeding bird surveys. With the exception of the northern tie within the exiting N16, the majority of the new road alignment is located further from the Cope's mountain section of the SPA than the existing N16 and will be buffered from it by extensive networks of Hedgerow, Treeline and Woodland. No potential for habitat loss, displacement or disturbance to Chough or Peregrine is anticipated because of the *Proposed Road Development*.

Potential for effects on Peregrine and Chough is also fully assessed in the Natura Impact Statement submitted as part of the statutory consent process. The key findings of the NIS are summarised in Section 9.4.2.2 of this EIAR.

Table 9-22: Summary of faunal evaluation and KER identification

Habitat	Conservation listing	Receptor Importance. Ecological evaluation (NRA 2009)	KER Yes/No
Bat Species	Habitats Directive Annex IV species, Wildlife Acts 1976-2017	Local Importance (Higher value)	Yes
Otter	Habitats Directive Annex II & IV species, Wildlife Acts 1976-2017	Local Importance (Higher value)	Yes
Badger	Wildlife Acts 1976-2017	Local Importance (Higher value)	Yes
Additional Fauna	Wildlife Acts 1976-2017	Local Importance (Higher value)	No
Reptiles and Amphibians	Wildlife Acts 1976-2017 Habitats Directive Annex V	Local Importance (Lower Value)	No
Terrestrial Invertebrates of conservation significance	-	None Recorded	No
Fish and Aquatic invertebrates	Habitats Directive Annex II species, Wildlife Acts 1976-2017	Local Importance (Higher value)	Yes
Breeding Birds (General assemblage)	Wildlife Acts 1976-2017 (no Annex I species recorded)	Local Importance Lower Value	No
Breeding Bird Populations associated with Sligo/Leitrim Uplands SPA (Chough and Peregrine)	Wildlife Acts 1976-2017 (Annex I species)	International Importance	Potential for effect on Peregrine and Chough is fully assessed in the Natura Impact Statement and key findings are presented in Section 9.4.2.2 of this EIAR.

9.4 Likely Significant Effects on Biodiversity

Assessment of effects within this chapter follows a methodology that is set out in Chapter 3 of the '*Guidelines for Assessment of Ecological Impacts of National Roads Schemes'* (NRA, 2009). The assessment of effects also follows the guidance outlined in EPA 2017.

All elements of the *Proposed Road Development* have been considered in assessing effects on ecological receptors:

9.4.1 **Do-Nothing Effect**

If the *Proposed Road Development* were not to go ahead, it is likely that the site would continue to exist as a national road (N16) situated in pastoral setting with no significant changes anticipated.

9.4.2 **Effects on Designated Areas**

The location of the *Proposed Road Development* in relation to designated sites is shown on Figure 9.1 contained within Volume 3 of this EIAR.

9.4.2.1 Nationally Designated Sites

The *Proposed Road Development* is partially located along the boundary of Crockauns/Keelogyboy Bogs NHA (002435) near the *Lugatober*/*Lugnagall* townland boundary. The Feature of Interest for which this NHA is designated is *Peatlands [4]*. The NPWS site synopsis, describes the NHA as a primarily upland site incorporating large areas of blanket bog, heath, upland grassland and associated habitats.

The habitats within the NHA, adjacent to the *Proposed Road Development*, comprise Mixed Broadleaved Woodland (WD1) and a degraded and highly modified Flush area (i.e. Lugnagall Flush). The woodland along the existing N16 road verge has been recently cleared of woodland vegetation and a new land boundary fence has been constructed.

There will be no direct impacts on habitats or ecological significance within the NHA. The NHA is up gradient of the *Proposed Road Development* and therefore potential construction site runoff will not impact the NHA. As per the assessment provided in the Hydrology & Hydrogeology chapter (11) of the EIAR, the proposed development and its drainage treatment will have an imperceptible impact magnitude on the hydrological functioning of the NHA. Similarly, the *Proposed Road Development* will have an imperceptible impact magnitude on the biodiversity of the NHA.

Where a nationally designated site overlaps with the boundary of a European designated site the potential for impacts has been considered under the European designation (e.g. Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC (000627)).

None of the remaining NHAs or pNHAs within the ZOI were considered as KERs in their own right due to the lack of any identifiable pathway for direct or indirect effects.

9.4.2.2 European Sites

In relation to European sites, an Appropriate Assessment Screening Assessment and Natura Impact Statement have been prepared to provide the competent authorities with the information necessary to complete an Appropriate Assessment for the *Proposed Road Development* in compliance with Article 6(3) of the Habitats Directive.

As per EPA draft Guidance 2017, "a biodiversity section of an EIAR, should not repeat the detailed assessment of potential effects on European sites contained in a Natura Impact Statement" but should "incorporate their key findings as available and appropriate".

The impact assessment provided in the NIS and associated Screening Report identified a pathway for indirect effects on the marine/surface water dependent Qualifying Interests of Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC, Cummeen Strand SPA and Drumcliff Bay SPA in the form of deterioration of surface water quality resulting from pollution, associated with the construction and operational phases of the development. The pathway that would allow potentially adverse impacts to occur was considered in the design of the project elements. An Outline Erosion and Sediment Control Plan (OESC) (Appendix 4.3 contained within Volume 4 of this EIAR) sets out the environmental management framework to be adhered to during the pre-commencement, construction and operational phases of the development and it incorporates the mitigating principles to ensure that the work is carried out in a way that minimises the potential for any environmental impacts to occur. The OESC has been prepared in accordance with the mitigation measures and commitments made in the Environmental Impact Assessment Report (EIAR).

Specific measures to offset potential impacts relating to surface water runoff, during the operation of the road, have been incorporated into the design of the *Proposed Road Development*. These include the use of penstocks, attenuation systems and hydrocarbon interceptors. Full details are included in the Hydrology Chapter of the EIAR. It is noted that the *Proposed Road Development* will convey traffic diverted off the existing section of N16 road and, given the pollution prevention measures incorporated into the project design will result in a far greater level of ecological protection in relation to water pollution from such traffic during the operational phase of the *Proposed Road Development*. The *Proposed Road Development* is located adjacent to the Sligo/Leitrim Uplands SPA. Taking a precautionary approach, the site was assessed due to proximity. There is no suitable nesting habitat the SCI species (i.e. Peregrine and Chough) within the land acquisition boundary. Neither species was recorded utilising habitats within the development footprint during the 2018 breeding bird surveys or during any additional survey conducted during the 2017-2018 survey period. The closest suitable breeding habitat for both SCI species occurs on the cliffs of Cope's Mountain approximately 500m east of the northern tie-in with the existing N16. With the exception of the northern tie within the exiting N16, the majority of the new road alignment is located further from the Cope's mountain section of the SPA than the existing N16 and will be buffered from it by extensive networks of Hedgerow, Treeline and Woodland. No potential for habitat loss, displacement or disturbance to breeding SCI species is anticipated as a result of the *Proposed Road Development*.

This EIAR chapter and the NIS concludes that the that the Proposed Development, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site.

9.4.3 Effects on Key Ecological Receptors

The following sections provide the impact assessment regarding the Identified Key Ecological Receptors. Effects associated with construction, operation and decommissioning are assessed in accordance with EPA 2017 criteria and utilising the geographical scale described in NRA 2009.

9.4.3.1 KER 01 - Rich Fen and Flush PF1 & Calcareous Springs FP1 at *Lugnagall* (Lugnagall Flush)

Table 9-23: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017) Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The project has been designed to avoid this ecological receptor and it will be fenced off prior to construction. Therefore, no potential for direct effects exist.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime effects	The proposed road alignment is in embankment adjacent to this site and the flush and spring habitat is sufficiently upgradient of the works not to be impacted in term of the hydrological flow regime during the construction works.	
Water quality effects.	The feature is up gradient of the Proposed Road Development and therefore potential construction site runoff will not impact this receptor.	
Dust impacts	Dust from construction works could enter the sensitive wetland habitats leading to nutrient enrichment.	The impact associated with dust is assessed as a potential **Short-term Slight Negative effect** on a receptor of county importance. The effect is **reversible** and can be remediated through appropriate design and mitigation.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017) Geographical context as per NRA (2009)**
Construction Phase		
		No significant effect on this KER is anticipated at any geographical scale.
Operational Phase		
Habitat Loss	There will be no habitat loss during the operational phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime Impact - Changes to recharge	The Proposed Road Development avoids the recharge zone of this spring (which is from upland area to the southeast). The adjacent cutting of 3 to 4.5m is completely within the overburden boulder clay layer and avoids any potential localised impact on the underlying bedrock aquifer. Topographically this cutting is not within the catchment area feeding the spring and flush which is supplied off the hillslopes to the southeast.	
Hydrological regime Impact - Changes to drainage	A drainage neutral solution is proposed at this location with the existing culvert replaced by a similar sized box culvert and installed at similar invert levels to the existing drain. The existing drain on the southeast side is to be replaced by reformed drainage channel at similar invert levels. The features are sufficiently up gradient will not be drained.	
Water quality Impact - Surface water run-off & accidental Spillage	Surface water from the road pavement near the ecological site will be collected in a sealed drainage system passing through a petrol/ oil interceptors and attenuation ponds and discharge to the Lugnagall Stream downstream, northwest of the Lugnagall habitat. The potential risk of a road traffic spillage event is extremely low and the design measures represent an improvement over the existing N16 road.	
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.2 KER 02- Calcareous spring FP1 at 'Lugatober North'

Table 9-24: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The project has been designed to avoid this ecological receptor and it will be fenced off prior to construction. Therefore, no potential for direct effects exist.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime effects	Construction drainage and discharges affecting this habitat will be avoided as the road development is downgradient and will discharge naturally northwest to the Collinsford stream.	**No significant effect on this KER is anticipated at any geographical scale.**
Water quality effects.	Contaminated surface water from construction area could enter this site leading to pollution by sediment laden runoff waters. The habitat is upgradient and can be protected from impact of soiled site waters.	Deterioration of water quality is assessed as a potential **Short-term Slight Negative effect** on a receptor of National importance. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Dust impacts	Dust from construction works could enter the sensitive wetland habitats leading to nutrient enrichment.	The impact associated with dust is assessed as a potential **Short-term Slight Negative effect** on a receptor of National importance.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
		The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss	There will be no habitat loss during the operational phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime Impact - Changes to recharge	The road development is located downgradient and is in embankment adjacent to this habitat and therefore any potential dewatering and impact to recharge is avoided. There are no proposed works associated with the Road Development within the recharge zone of this petrifying spring and Tufa habitat	
Hydrological regime Impact - Changes to drainage	The Proposed Road Development will involve a shallow toe drain at the edge of the road embankment to collect overland flows and convey them to the Collinsford Stream. This drain is shallow at an invert of 1m below existing ground level and will not exert a drainage effect up the steep sloping land (at 10degrees) on the tufa habitat.	
Water quality Impact - Surface water run-off & accidental Spillage	Potentially contaminated surface water from the road will be collected in a sealed drainage system, undergo treatment and discharge to the Collinsford Stream at c. Ch.1,900. The drainage design protects the groundwater aquifer from pollution and the proposed road is sufficiently down gradient and will not impact the habitat even in flood conditions. All storm outfalls will include pollution control facilities at their outfalls. In any event the road drainage outfalls discharge downgradient of the habitat. The potential risk of a road traffic spillage event is extremely low and the design measures represent an improvement over the existing N16 road.	
Decommissioning Phase		

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development	**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
No effects are anticipated given that the proposed road is anticipated to be a permanent development.	

9.4.3.3 KER 03 - Flush Area (South of Collinsford)

Table 9-25: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017) Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The project has been designed to avoid this ecological receptor and it will be fenced off prior to construction. Therefore, no potential for direct effects exist.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime effects	All construction site runoff waters will be discharged to the Collinsford stream and no direct discharge to this habitat is proposed or will be permitted. Some excavation works will be required into the hillslope to the southeast of the receptor will be required but such excavation is unlikely to encounter groundwater table. There is no construction excavation dewatering required for this section of road works.	
Water quality effects.	Contaminated surface water from construction area could enter this site as it is located c. 70m downgradient from the site leading to pollution by sediment laden runoff waters.	Deterioration of water quality is assessed as a potential **Short-term Slight-Moderate Negative effect** on a receptor of County importance. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017) Geographical context as per NRA (2009)
Dust impacts	Dust from construction works could enter the sensitive wetland habitats leading to nutrient enrichment.	The impact associated with dust is assessed as a potential **Short-term Slight Negative effect** on a receptor of County importance. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss	There will be no habitat loss during the operational phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Change to groundwater yield	The southeast side of the main line road is in cut into the hillslope between Ch1500 and 1650 and the north western side of the road alignment is in embankment. The Proposed Road Development cutting into the upper slope is completely within the overburden boulder clay layer and avoids any potential localised impact on the underlying bedrock aquifer and thus on groundwater supply to the downstream receptor.	
Hydrological regime Impact - Changes to recharge - Changes to drainage	The diversion of natural overland flow, interflow and groundwater seepage flows and the loss of recharge from the road pavement and cut-slope area has the potential to moderately impact the local downstream hydrological regime which has the potential to impact the receptor.	The effect is assessed as a **Permanent Slight Negative effect** on a receptor of County importance. The effect is **reversible** and can be remediated through appropriate design and mitigation.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017) Geographical context as per NRA (2009)**
		No significant effect on this KER is anticipated at any geographical scale.
Water quality Impact - Surface water run-off & accidental Spillage	Potentially contaminated surface water from the road will be collected in a sealed drainage system, undergo treatment and discharge to the Collinsford Stream at c. Ch.1,900. The drainage design protects the groundwater aquifer from pollution. All storm outfalls will include pollution control facilities at their outfalls. The potential risk of a road traffic spillage event is extremely low and the design measures represent an improvement over the existing N16 road.	**No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.4 KER 04 - Flush Area (East of Drum)

Table 9-26: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The project has been designed to avoid this ecological receptor which is located approximately 320m west of the Proposed Road Development.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime effects	All construction site runoff waters will be discharged to the Lugatober stream and no direct discharge from the construction site to this habitat will be permitted. The proposed road alignment near the receptor is in embankment and no impact from excavation dewatering or construction drainage will affect the hydrological regime of this site. T	
Water quality effects.	Contaminated surface water from construction area could if not controlled reach the site being 320m downgradient of the works.	Impact to water quality is assessed as a **Short-term Slight Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Dust impacts	None anticipated given the separation distance of 320m	**No significant effect on this KER is anticipated at any geographical scale.**

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Operational Phase		
Habitat Loss	There will be no habitat loss during the operational phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Change to groundwater yield	The site is located downgradient and well over 320m from the road alignment. The proposed road alignment is in embankment through its recharge catchment and therefore will not intercept the groundwater table.	
Hydrological regime Impact - Changes to recharge - Changes to drainage	This area is drained by the Lugatober stream and the proposed land drainage treatment is to maintain the status-quo and ensure that road embankment does not represent an obstacle to flow. No impact on drainage or recharge of the receptor is anticipated.	**No significant effect on this KER is anticipated at any geographical scale.**
Water quality Impact - Surface water run-off & accidental Spillage	Potentially contaminated surface water from the road will be collected in a sealed drainage system, undergo treatment and discharge to the Lugatober Stream. The drainage design protects the groundwater aquifer from pollution. All storm outfalls will include pollution control facilities at their outfalls. The potential risk of a road traffic spillage event is extremely low and the design measures represent an improvement over the existing N16 road.	**No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.5 KER 05 - Calcareous spring FP1 at *Lugatober* (Reported as 'West of *Castlegal*')

Table 9-27: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The project has been designed to avoid this ecological receptor and it will be fenced off prior to construction. Therefore, no potential for direct effects exist.	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime effects	All construction site runoff waters will be discharged away from this site westward. Some excavation works will be required into the hillslope to the south of the existing N16 to widen the road. These excavation works are unlikely to encounter groundwater, nor will they involve dewatering. Construction drainage and discharges will be collected and discharged westward away from the site and no excavation dewatering is required at this location	
Water quality effects.	The proposed Road Alignment is located downgradient to the west/northwest of the site boundary by c 40 to 50m to the edge of the road embankment. Some widening and realignment works are proposed for the existing N16 and extend up to adjacent to this site. Contaminated surface water from construction area could enter this site leading to pollution by sediment laden runoff waters.	Deterioration of water quality is assessed as a **Short-term Slight-Moderate Negative effect** on a receptor of County Importance. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Dust impacts	Dust from construction works could enter the sensitive wetland habitats leading to nutrient enrichment.	The impact associated with dust is assessed as a potential **Short-term**

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
		Slight Negative effect on a receptor of County Importance. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss	There will be no habitat loss during the operational phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Change to groundwater yield/recharge	The proposed road alignment is located downgradient of the site and will not affect the Recharge zone of this habitat. The proposed works to the Existing N16 road within the recharge catchment of the habitat are superficial and related to road pavement restoration	**No significant effect on this KER is anticipated at any geographical scale.**
Hydrological regime Impact - Changes to drainage	The mainline road drainage is downgradient and will not affect this site. The realigned and widened N16 Road adjacent to the site will incorporated a sealed road pavement drainage which will discharge to the Mainline drainage system west of the site with no direct discharges to the site.	
Water quality Impact - Surface water run-off & accidental spillage	Potentially contaminated surface water from the existing realigned and widened N16 road will be collected in a sealed drainage system and discharged westward away from the ecological site to the mainline drainage system. The potential risk of a road traffic spillage event is extremely low, and the design measures represent an improvement over the existing N16 road.	
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.6 KER 06 - Woodland Habitats

Table 9-28: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss/ degradation	Felling associated with the Proposed Road Development will results is the loss of c. 0.4ha of Immature Woodland and c. 0.3 ha of Mixed Broadleaved woodland, with a wet woodland influence, in the townland of Lugatober (circa Ch 1950). The road will also result in the loss of 0.2ha of Mixed broadleaved woodland (WD1) and 0.07ha of Wet willow alder ash woodland (WN6) in the townland of Lugatober (Circa Ch 1150) The woodland to be lost does not conform to Annex I status. Post construction, the woodland areas will be reinstated (replanted to an equal area along the road corridor) with native tree species which are indigenous to the local area. The road has been designed to minimise impacts to woodlands by avoiding woodland in the design of the project. The anticipated habitat loss will not result in any significant impacts to the wooded landscape features in the area. Indirect effects during construction are not anticipated.	Habitat loss is assessed as a **Permanent Slight Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss/ degradation	No effects are anticipated	**No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.7 KER 07 -Treelines and Hedgerows

Table 9-29: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss/ degradation	Felling associated with the Proposed Road Development will results is the loss of 3.3km of Hedgerow and 2.7km of Treeline habitat. The identified habitat loss calculations are conservative and account for the worst case scenario. The road has been designed to minimise impacts to hedgerows/treelines and the loss will not result in any significant impacts to the linear landscape features in the area. Post construction, the hedgerow/treelines will be reinstated (replanted to an equal length along the road corridor) with native hedge/tree species which are indigenous to the local area. Indirect effects during construction are not anticipated.	Habitat loss is assessed as a **Permanent Slight Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss/ degradation	No effects are anticipated	**No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.8 KER 08 -Tully Stream and Additional watercourses

Table 9-30: Impact Characterisation for Ecological Receptor based on EPA (2017)

<table>
<tr><th colspan="2">Analysis of potential effects during construction, operation and decommissioning phases of the proposed development</th><th>Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009).</th></tr>
<tr><td colspan="3">Construction Phase</td></tr>
<tr><td>Habitat Loss/ degradation</td><td>The Tully Stream, Lugatober Stream. Collinsford Stream, Lugnagall Stream and Willsborough Stream are classified as being of Local Importance (higher value). The Tully Stream will be crossed via a clear span bridge structure. The tributaries of the Drumcliff River (i.e. Lugatober stream. Collinsford Stream, Lugnagall Stream) will required diversion and culverting under the proposed road.

The Willsborough Stream is not traversed by the proposed project but surface water draining from the new road will be attenuated and discharged to this watercourses via a drainage ditch which will run along the boundary of improved agricultural fields.

<u>Tully Stream and Tributaries of the Drumcliff River</u>

Potential Impacts Include:
• Potential direct effects include the loss of aquatic habitat.
• Indirect effects may include the run off of silt and other pollutants during the construction phase of the development from the construction site to the river. This could potentially reduce the ability of the watercourses to maintain fish stocks and the macroinvertebrate populations that support them.

<u>Willsborough Stream</u>

• Indirect effects may include the run off of silt and other pollutants during the construction phase of the development from the construction site to the river. This could potentially reduce the ability of the watercourses to maintain fish stocks and the macroinvertebrate populations that support them.</td><td>Habitat loss and degradation are assessed as a Permanent Slight-Moderate Negative Impact on a receptor of Local Importance higher value.

Indirect water pollution is assessed as a Short-term Moderate-Significant Negative effect on a receptor of Local Importance higher value.

The effects are reversible and can be remediated through appropriate design and mitigation.

No potential for significant effect is anticipated at the county, national, or international geographical scale.</td></tr>
<tr><td colspan="3">Operational Phase</td></tr>
<tr><td>Habitat Loss/ degradation</td><td>There will be no loss of habitat associated with the operational phase of the development.</td><td>Indirect water pollution is assessed as a Permanent Slight-Moderate Negative effect on a receptor of Local Importance higher value</td></tr>
</table>

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009).
	Potential indirect impacts include the run off of silt and discharge of pollutants from road drainage during the operation of the road	The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.9 Bat Species

Table 9-31: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
Construction Phase		
Habitat Loss &Fragmentation	The entire length of the *Proposed Road Development* was assessed for its potential as bat habitat during both desk top and field assessments followed by targeted transect surveys. Activity Bat activity was highest to the south of the *Proposed Road Development* in the townland of *Castlegal* in proximity to *Castlegal* House. Bat activity throughout the remainder of the study area had a constant but patchy distribution and where recorded, activity was positively associated with treelines and mature hedgerows. Felling associated with the *Proposed Road Development* will results is the loss of 3.3km of Hedgerow and 2.7km of Treeline habitat. The identified habitat loss calculations are conservative and account for the worst-case scenario.	Habitat loss and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
	The *Proposed Road Development* has the potential to result in the loss of commuting and foraging habitat for bat species and the fragmentation of habitat where the proposed road blocks commuting routes between areas of foraging habitat and roosts (i.e. in proximity to *Castlegal* house). <u>Roost sites</u> *Castlegal* house which is located adjacent to the *Proposed Road Development* was identified as a pipistrelle roosting site. This house will not be directly impacted by the *Proposed Road Development*. The agricultural buildings to be demolished at *Lugatober* do not currently support roosting Bats and no evidence of emergence or dawn swarming activities at the buildings was recorded during the 2018 surveys. No tree roosts were specifically identified. It is not anticipated that large bat roosts are present in trees given that no trees with multiple, highly suitable features for roosting bats were recorded. Nonetheless, all trees will be the subject of a pre-commencement survey (As per TII/NRA 2005b).	**No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss &Fragmentation	There will be no habitat loss associated with the operational phase of the road development. Ongoing indirect effects are likely to include barrier effect and fragmentation of habitat.	Habitat fragmentation is assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Displacement as a results of Lighting proposals	Lighting is proposed at the southern tie in. Species recorded at this location included pipistrelles and Leisler's bat. As per BCT guidance note (08/18) *Bats and artificial Lighting in the UK*, pipistrelles and Leisler's bat can congregate around street lights feeding on insects attracted to the light. Therefore, no significant displacement of pipistrelles or Leisler's bat is anticipated as a result of the lighting proposals.	Displacement as a result of lighting proposals is assessed as a **Permanent Imperceptible Negative effect** on a receptor of Local Importance higher value.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
	The BCT guidance note acknowledges that congregation behaviour is not true for all species and states that Myotis and Brown long-eared bat (*Plecotus* sp) enerally avoid all street lights. However, neither species were recorded utilising habitats at the proposed lighting location and potential for impact on Myotis and Brown Long-eared bat as a result of the lighting proposal are not anticipated. No potential for significant impact on bats as a result of the lighting proposal was identified.	**No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.10 Otter

Potential for effects on Otter has been considered with regard to NPWS Threat Response Plan72 (TRP) which identifies four significant threats facing Otter in an Irish context:

- Habitat destruction (including fragmentation)
- Water pollution
- Disturbance (Recreational sources)
- Accidental death/persecution

Table 9-32: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Destruction (including fragmentation)	Evidence of Otter was recorded at two watercourses in the ZOI: Tully Stream and Willsborough Stream. No breeding or resting site were recorded and none will be lost as part of the Proposed Road Development. No significant effects regarding habitat destruction are anticipated. Whilst not providing optimum habitat for Otter it is considered likely that the Lugatober stream, Collinsford stream and Lugnagall stream may be utilised, on occasion, as commuting corridors between larger watercourses. Therefore, habitat fragmentation and barrier effect may occur along the Tully Stream, Lugatober stream, Collinsford stream and Lugnagall stream if Otter are not able to migrate along the watercourses following the construction of the proposed bridges/culverts.	Habitat destruction and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**

[72] NPWS (2009)Threat Response Plan: Otter (2009-2011). National Parks & Wildlife Service, Department of the Environment, Heritage & Local Government, Dublin.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Water Pollution	Emissions to surface water, with the potential to result in a deterioration of supporting habitat for Otter, was identified as a potential indirect effect.	Indirect water pollution effect is assessed as a **Short-term Moderate-Significant Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Disturbance	Otter are predominantly crepuscular in nature and construction work will be confined to daytime hours, thus minimizing disturbance related impacts to the species. Irish Wildlife Manual No 76 (National Otter Survey of Ireland 2010/2012) notes that the occurrence of Otter was unaffected by perceived levels of disturbance at the survey sites. It also notes that there is little published evidence demonstrating any consistent relationship between Otter occurrence and human disturbance (Mason & Macdonald 1986, Delibes et al. 1991; Bailey &Rochford, 2006). Based on the above it can be concluded that no significant disturbance effects to Otter are likely.	The potential for disturbance is considered to constitute a potential indirect **Short-term Slight Negative effect** on a receptor of Local Importance higher value. **No significant effect on this KER is anticipated at any geographical scale.**
Accidental death/persecution	No Otter breeding or resting sites were recorded during the dedicated Otter surveys. Direct effects on the species are not anticipated during the construction phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Destruction	There will be no destruction of habitat associated with the operational phase of the Proposed Road Development. Fragmentation and barrier effect are potential ongoing effects during the operational phase.	Habitat fragmentation is assessed as a **Permanent Slight-Moderate Negative effect.** on a receptor of Local Importance higher value.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
		The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.** .
Water Pollution	Emissions to surface water, with the potential to result in a deterioration of supporting habitat for Otter, was identified as a potential ongoing indirect effect.	Indirect water pollution effect is assessed as a **Permanent Slight to Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Disturbance	Given that Otter spirant was recorded under the existing N16 bridges, it can be concluded that Otter are habituated to the operation of the existing N16. Following construction, no increase in traffic volume is anticipated and no potential for significant effect with regard to disturbance was identified.	**No significant effect on this KER is anticipated at any geographical scale.**
Accidental death/persecution	Accidental death by collision was identified as a potential direct effect and is applicable where the Proposed Road Development crosses traditional/potential commuting routes between/along watercourses in the wider area (i.e. Tully Stream, Lugatober Stream, Collinsford Stream, and Lugnagall stream).	Death by collision is assessed as a **Permanent-Moderate-Significant Negative effect** on a receptor of Local Importance higher value.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
		The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.11 Badger

Table 9-33: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
Construction Phase		
Habitat Loss (including fragmentation)	Badger activity was recorded within the ZOI. Evidence observed included active setts, latrines, trails and snuffle holes. As per NRA Guidance construction of roads 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 (TII/NRA 2006). There are no badger setts located within the land acquisition boundary. Therefore, direct effects on the species are not anticipated during the construction stage. In addition no blasting or piling is proposed within 150m of the identified badger setts; therefore no requirement for badger exclusion under licence is necessary and the existing setts will not be impacted by the proposed works.	Habitat loss and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation.

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
	At *Castlegal* and *Lugatober* there is potential for loss of badger foraging habitat given that Badger feeding signs and latrines were observed in these areas. There is also potential for loss of foraging habitat and dissection of foraging areas.	**No significant effect on this KER is anticipated at any geographical scale.**
Disturbance	Badger are predominantly crepuscular in nature and construction work will be confined to daytime hours, thus minimizing disturbance related impacts to the species. In addition no blasting or piling is proposed within 150m of the identified badger setts; therefore no potential for disturbance in this regard is anticipated.	The potential for disturbance is considered to constitute a potential indirect **Short-term Slight Negative effect** on a receptor of Local Importance higher value. **No significant effect on this KER is anticipated at any geographical scale.**
Accidental death/persecution	No badger setts will be effected by the proposed works. Therefore direct effects on the species are not anticipated during the construction phase.	**No significant effect on this KER is anticipated at any geographical scale.**
Operational Phase		
Habitat Loss (including fragmentation)	There will be no destruction of habitat associated with the operational phase of the *Proposed Road Development*. Fragmentation and barrier effect are potential ongoing effects during the operational phase.	Habitat fragmentation is assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Disturbance	Following construction, no increase in traffic is anticipated and no potential for significant effect with regard to disturbance was identified.	**No significant effect on this KER is anticipated at any geographical scale.**
Accidental death/persecution	Accidental death by collision was identified as a potential direct effect and is applicable where the *Proposed Road Development* crosses traditional/potential commuting routes (i.e. in the townland of Lugatobar and along the Tully Stream).	Death by collision is assessed as a **Permanent-Moderate-Significant Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Decommissioning Phase		
No effects are anticipated given that the proposed road is anticipated to be a permanent development.		

9.4.3.12 Fish and Aquatic Invertebrates

Table 9-34: Impact Characterisation for Ecological Receptor based on EPA (2017)

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase		
Habitat Loss	The Tully Stream, Lugatober stream. Collinsford Stream, Lugnagall Stream and Willsborough Stream are classified as being of Local Importance (higher value). The Tully Stream will be crossed via a clear span bridge structure. The tributaries of the Drumcliff River (i.e. Lugatober stream, Collinsford Stream, Lugnagall Stream) will require diversion and culverting under the proposed road. The proposed culverting and diversion works have the potential to results in the loss of aquatic habitat. The Willsborough Stream is not traversed by the proposed project but surface water draining from the new road will be attenuated and discharged to this watercourses via a drainage ditch which will run along the boundary of improved agricultural fields. Therefore, there is no potential for loss of aquatic habitat with regard to the Willsborough Stream	The potential for habitat loss is assessed as a potential **Permanent Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Fragmentation	Habitat fragmentation and barrier effect may occur if aquatic species are not able to migrate along the watercourses following the construction of the crossings. This potential effect is relevant to the following watercourses: Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall stream. Regarding the Willsborough Stream, there is no potential for fragmentation or barrier effect.	The potential for habitat loss is assessed as a potential **Long-term Slight- Moderate Negative Impact** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
Construction Phase		
Water Pollution	Indirect impacts may include the run off of silt and other pollutants during the construction phase of the development from the construction site to the river. This could potentially reduce the ability of the watercourses to maintain fish stocks and the macroinvertebrate populations that support them.	Indirect water pollution effect is assessed as a **Short-term Moderate-Significant negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Accidental Kills	Accidental Kills, as a result of instream works, was identified as a potential direct effect and is applicable where the *Proposed Road Development* crosses the Tully Stream, *Lugatober* Stream, *Collinsford* Stream and *Lugnagall* stream.	The potential for accidental Kills is assessed as a **Short Term -Moderate-Significant Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No potential for significant effect is anticipated at the county, national, or international geographical scale.**
Operational Phase		

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development		Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)
Construction Phase		
Habitat Loss	There will be no destruction of habitat associated with the operational phase of the *Proposed Road Development*.	**No significant effect on this KER is anticipated at any geographical scale.**
Fragmentation	Fragmentation and barrier effect are potential ongoing effects during the operational phase.	Habitat fragmentation is assessed as a **Permanent Slight-Moderate Negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Water Pollution	Emissions to surface water, with the potential to result in a deterioration of supporting aquatic habitat, was identified as a potential ongoing indirect effect.	Indirect water pollution effect is assessed as a **Permanent slight to moderate negative effect** on a receptor of Local Importance higher value. The effect is **reversible** and can be remediated through appropriate design and mitigation. **No significant effect on this KER is anticipated at any geographical scale.**
Decommissioning Phase		

Analysis of potential effects during construction, operation and decommissioning phases of the proposed development	**Significance of potential effect in the absence of mitigation (EPA 2017). Geographical context as per NRA (2009)**
Construction Phase	
No effects are anticipated given that the proposed road is anticipated to be a permanent development.	

9.5 Mitigation Measures

This section describes the measures that are in place to mitigate any potentially harmful or negative effects associated with the *Proposed Road Development* and the identified KERs as described in the preceding sections. General avoidance and mitigation measures included within the design of the *Proposed Road Development* are described first, with more specific measures to prevent or minimise effects on the individual receptors provided subsequently.

9.5.1 Construction Stage

9.5.1.1 Mitigation by Avoidance

The *Proposed Road Development* has been designed to avoid ecologically sensitive areas and has been constraint led from the initial design phase (the N16 Sligo to County Boundary Route Selection Process).

The project design has followed the basic principles outlined below to eliminate the potential for ecological effects on KERs where possible and to minimise such effects where total elimination is not possible.

The *Proposed Road Development* has been designed to:

- avoid any direct, indirect or residual adverse effects on the integrity of European sites or other designated sites for nature conservation;
- to avoid/minimise effects on habitats that correspond to those that are listed on Annex I of the EU Habitats Directive outside of the European and nationally designated sites;
- minimise direct or indirect effects on any habitats or species that were classified as being of National, County or Local Importance (Higher Value) in the design of the *Proposed Road Development*.

Through careful planning and design, direct or indirect effects on receptors of International, National & County importance have been avoided at the design stage. In addition, the *Proposed Road Development* layout minimises the potential for effects on receptors of Local Importance (Higher Value).

9.5.1.2 Mitigation by Design

The *Proposed Road Development* has been progressed having regard to all relevant TII/NRA guidelines, for the planning and construction of National Road Schemes, and National and European legislation. The guidelines for the planning and construction of national roads provide, within the design, for the protection of the environment. The following is an overview of the design measures that will be employed throughout the entire length of the *Proposed Road Development* to minimise and avoid significant negative impacts on the ecological receptors within the ZOI.

- Landscaping associated with the *Proposed Road Development* will involve the planting of native hedgerow and woodland to mitigate for losses associated with the *Proposed Road Development*;
- The main watercourse crossings have been designed to minimise the potential for both short and long term negative ecological impacts on all watercourses including drainage ditches. The design of the *Proposed Road Development* minimises loss of habitat through appropriate design, ensuring that the points do not result in a barrier effect and that significant changes to the nature of the channel are avoided;
- An Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent watercourses including various tributaries of the

Drumcliff River (The (OESC) is contained within Volume 4 of this EIAR – Appendix 4.3). The potential for run off pollutants during the construction phase of the development will be fully managed with impacts on significant receptors avoided;

- The proposed operational road drainage has been designed to avoid the potential for ongoing pollution of the wider environment during the lifetime of the road and is likely to lead to a positive impact.

9.5.1.3 Hydrologically Sensitive Habitats

The *Proposed Road Development* passes within proximity to several hydrologically & hydrogeologically sensitive habitats that are included as KERs and where potential indirect impacts were identified. Through consultation with the hydrology team on the project, it has been possible to prescribe mitigation to maintain a drainage neutral situation in these areas thereby not altering the existing hydrological situation and thereby not impacting on the ecology of the habitats. Full details of the measures to be included are provided in Chapter 11 (Hydrology & Hydrogeology) of this EIAR. The measures have effectively removed the potential for significant hydrological or hydrogeological effects on Key Ecological Receptors outside the footprint of the *Proposed Road Development* during the construction phase. An Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent hydrologically sensitive habitats. The OESC also contains measures to minimise dust arisings during the construction stage.

9.5.1.3.1 *Culverts and Diversions*

General

All works in proximity to watercourses shall follow the specific protection and mitigation measures described in the Outline Erosion and Sediment Control Plan and the best practice guidance outlined in the following documents:

- TII/NRA 'Guidelines for the crossing of Watercourses During Construction of National Road Schemes (2008);
- Shannon Regional Fisheries Board (SRFB) Protection and Conservation of Fisheries Habitat with Particular reference to Road Construction (2009);
- Inland Fisheries Ireland requirements publication" Guidelines on protection of fisheries during construction works in and adjacent to waters" (2016)

All instream works in watercourses identified as having to support fish species will be undertaken in accordance with the IFI Guidelines 2016 which state: "*To minimise adverse impacts on the fisheries resource works in rivers, streams, watercourses, lakes, reservoirs and ponds should normally (except in exceptional circumstances with the agreement of IFI) be carried out during the period July-September.*"

Electrofishing and Translocation of Aquatic Fauna

This mitigation is applicable to works at the following watercourses: Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream.

Where dewatering of channels is required (i.e. for stream diversions) Inland Fisheries Ireland (IFI) or a suitably qualified contractor will conduct an electrofishing operation and white-clawed crayfish survey to remove any fish/crayfish from the channel prior to dewatering. Such surveys and translocation operations shall be conducted under license from IFI and the NPWS.

No Net Loss Principle (Shannon Regional Fisheries Bord 2009)

The no net loss principle is fundamental to the habitat conservation goal. The principle takes into consideration the habitat and water quality requirements of fish, in the context of site-specific evaluations, in order to avoid losses of habitats or habitat components that can limit the production of fisheries resources.

There will be no net loss of fish habitat or in the ability or potential for the fisheries and aquatic habitat to maintain fish stocks or the food of fish. All culverts and diversions on the Lugatober Stream, Collinsford Stream and Lugnagall Stream have been designed to ensure that will be no net loss of fisheries habitat occurs.

Structures

The Tully Stream will be crossed by a Clear Span Structure. The Lugatober Stream, Collinsford Stream and Lugnagall Stream will be crossed by a box culvert. All other crossing point (i.e. drainage ditches) will be crossed by pipe culverts.

The culverts have been designed so that velocities through them will allow the passage of fish at any time. The original bed material will be reinstated or where imported will consist of rounded washed gravels which will be either placed upstream of the culvert or will be placed in the culvert before it becomes live.

Where a box culvert is proposed, the invert of the culvert will be set at least 500mm (or 300mm where agreed with IFI) below the existing bed level, and at the same gradient or near the same gradient as the existing bed.

Over sized culverts will be designed with rock armour training from the inside of the headwalls back to natural channel width to form a low flow channel.

The screening of temporary or permanent culverts to prevent trash build up can cause an obstruction to fish passage and will not be permitted on the Lugatober Stream, Collinsford Stream or Lugnagall Stream.

Diversions

Where a temporary/permanent stream diversion is required (i.e. Tributaries of Drumcliff River), the design, construction and operation of the channel will require the provision of artificial geotextile membrane sheeting or rock armour, on the side and base of the temporary channel. This will minimise erosion and potential surface water runoff.

The new channels shall be constructed in dry conditions. Channels shall also be constructed in a fish friendly manner following IFI best practice (Shannon Regional Fisheries Board (2009) *Protection and Conservation of Fisheries Habitat with Particular Reference to Road Construction. Shannon Regional Fisheries Board, Clonmel* and *Guidelines on protection of fisheries during construction works in and adjacent to waters*, IFI 2016).

Newly created channels shall incorporate instream structures, features and meanders that will give rise to flow type variation as found in fish bearing waters. The channel base widths have been designed to match the width of the diverted channels.

Watercourse diversions will be subject to channel stabilization works, which consist of lining the new channel with rounded washed gravel to a maximum depth of 300mm below finished bed level and bank scour protection in the form of rock armour, along the channel. These works will be undertaken in consultation with IFI.

9.5.1.3.2 *Tree Felling and Hedgerow*

The removal of vegetation shall be undertaken in line with the provisions and exemptions described in the Wildlife Act 1976-2017.

The Landscape mitigation proposals associated with the *Proposed Road Development* is set out in Chapter 12 of this EIAR and will involve the planting of native hedgerow, treeline and woodland to mitigate for losses associated with the *Proposed Road Development*.

9.5.1.4 Flora and Fauna Mitigation

9.5.1.4.1 *Badger*

Pre-construction Badger survey

Prior to any works being carried out, a pre-construction Badger survey will be undertaken to ensure badger has not taken up residence within or close to the road footprint. Previously identified sett locations will be revisited to determine any changes in the intervening period between planning and construction.

9.5.1.4.2 *Otter*

Evidence of Otter was recorded along the Tully Stream and Willsborough Stream and suitable habitat was recorded at the additional watercourses within the study area. No breeding or resting sites were recorded and direct impact on the species is not anticipated.

Pre-construction Otter survey

Prior to any works being carried out, a pre-construction Otter survey will be undertaken to ensure that Otter has not taken up residence within or close to the road footprint.

9.5.1.4.3 *Bats*

Landscape Features

Mature tree-lines and hedgerows provide good potential for foraging and commuting and individual trees were considered to have potential to support smaller roosts (i.e. single Bats). The *Proposed Road Development* involves specific prescriptions for tree planting to ensure that habitat connectivity is not severed by the *Proposed Road Development*. Proposals include:

- Tree planting to provide commuting habitat along the *Proposed Road Development* and to guide Bats to other linking treelines/hedges, woodland, bridges, culverts or underpasses that may be used to cross the road. A network of vegetation will be created around the *Proposed Road Development* that in many sections of the study corridor will provide additional biodiversity within the landscape. Details of planting are provided in the landscape design. (See Figures 12.4.1 and 12.4.2 contained within Volume 3 of this EIAR);
- Planting of riparian trees to allow continued use of river corridors;
- Planting of tall (semi mature) trees on opposite sides of the road will be provided where connectivity is severed to provide Bat flyovers (or hop overs). This planting is done in association with strong guiding tree lines on both sides of the road to provide a safe crossing point for bats. These will be provided at *Castlegal*, where the *Proposed Road Development* severs tree lines in proximity to the identified roost site;
- Planting will utilise native species as these have a greater range of insects associated with them that provide an additional source of food for bat species.

A pre-construction Bat survey will be required by suitably qualified Bat ecologists prior to any felling being undertaken. If the presence of roosting Bats in a tree is suspected, a close up inspection by a suitably trained ecologist is required prior to felling.

Felling of mature broadleaved trees during winter months (November – March) should be avoided as this increases risk to hibernating Bats. If there is a requirement to fell trees in these sensitive areas during this period, any trees with significant roosting features will be subject to a detailed inspection undertaken by a suitably qualified professional.

Buildings

Identified roosting site at *Castlegal* House will not be directly impacted upon by the *Proposed Road Development*. The building to be demolished at *Lugatober* does not currently support roosting Bats. This building will be subject to pre-construction survey (as per TII/NRA, 2005b) prior to demolition to ensure Bats have not taken up residence. If bats are found to be present, exclusion measures will be followed under licence from the NPWS.

9.5.1.5 Mitigation through Best Practice

The following best practice control measures will be implemented in the prevention of ecological impacts. In addition, the measures outlined below will limit artificial lighting and noise emanation during the construction phase.

9.5.1.5.1 *Site Set Up*

- Prior to the outset of any excavation, the works area will be assessed and clearly delineated with boundary fencing. The minimum area necessary will be identified and there will be no access to works vehicles outside the fenced off areas;
- Adjacent to watercourses and identified Annex I habitat areas, a silt fence will be attached to the fencing and buried beneath the ground to filter any run-off that may occur as a result of the proposed works;
- All works will be located within the confines of these fences. No works will take place outside the fences to prevent damage to areas outside the necessary development footprint;
- The construction compound and storage area will be located within the land acquisition boundary and is located more than 30m away from watercourses. The storage of fuels, other hydrocarbons, and other chemicals within the construction compounds will take place on the south side of the compound, and will as a minimum not be within 100m of the Tully Stream .

9.5.1.5.2 *Disturbance Limitation Measures*

Full details of the disturbance limitation measures to be employed to minimise noise and vibration during the construction and operational phases are described in Chapter 7 of this EIAR. Measures relevant to biodiversity are outlined below

- The best means practical, 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 of the “sound reduced” 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.
- Machines which are used intermittently will be shut down or throttled back to a minimum during those periods when they are not in use.

- Any plant such as generators or pumps which are required to work outside of normal working hours will be surrounded by an acoustic enclosure.
- Throughout the contract the supervision of the works will include ensuring compliance with the limits using the methods set out in BS 5228.

9.5.1.6 Pollution Prevention Measures

This project has potential to cause pollution of the surrounding environment. Pollution could take a number of forms and could occur during a number of the operations involved in the construction process. Listed below are the activities during which pollution may arise and the type of pollution that may occur along with prescribed best practice construction measures. In addition, an Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent watercourses including various tributaries of the Drumcliff River.

9.5.1.7 Mitigation to Prevent the Spread of Invasive Species

Due to the legislative requirements to control the spread of noxious weeds and non-native invasive plant species, it is important that any activities associated with the planning, construction and operation of national road schemes comply with the requirements of the Wildlife Acts, 1976-2012. Regulations 49 and 50 of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011) include legislative measures to deal with the dispersal and introduction of Invasive Alien Species (IAS), which are listed in the Third Schedule of the regulations.

Regulation 49 deals with the Prohibition on introduction and dispersal of certain species while Regulation 50 relates to Prohibition on dealing in and keeping certain species (Regulation 50 has not yet been commenced). Invasive species are listed under the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011).

The introduction and/or spread of invasive species such as Himalayan Balsam, Giant Rhubarb or Rhododendron for example, could result in the establishment of invasive alien species and this may have negative impacts on the surrounding environs.

The non-native invasive species Japanese Knotweed (*Fallopia japonica*) was recorded on the *Proposed Road Development* in the townlands of *Lugatober* and *Lugnagall*. There was also signage present at the Southern tie-in (Grid Ref 571723, 839775) which indicated that Japanese knotweed had been recorded and treated in the past (as part of the TII IAPS eradication program). No evidence of Knotweed was recorded at this location during the 2017 and 2018 surveys.

A pre-construction survey for Knotweed will be conducted to determine if there has, or has not been an additional spread of Japanese knotweed/ or introduction of any other invasive species post the undertaking of this EIAR.

An IAS Management Plan has been prepared (included as an appendix contained with Volume 4 of this EIAR) in relation to the treatment of the identified stands of Japanese Knotweed (*Fallopia japonica*) pre-construction. General appropriate spread prevention measures are outlined below.

Control measures for the management of Invasive Species

The following measures address potential impacts associated with the construction phase of the project:

- Any plant or equipment that may have worked in environments where invasive species are present (including but not restricted to zebra mussel *Dreissena polymorpha*, Japanese knotweed *Fallopia japonica,* Indian balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, rhododendron *Rhododendron ponticum*), 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.

- All fill and material sourced or relocated within the site shall 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. 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.
- All planting and landscaping associated with the proposed development shall avoid the use on invasive shrubs such as Rhododendron;
- The treatment and control of invasive alien species will follow guidelines issued by the National Roads Authority – The Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads (NRA 2010).

9.5.1.8 Monitoring

The construction works will be monitored at several levels to ensure that the environmental best practice prescribed in this document is fully adhered to and is effective. The following system will be put in place to ensure compliance.

- The contractor will assign a member of the site staff as the environmental officer with the responsibility for ensuring the environmental measures prescribed in this document are adhered to. A checklist will be filled in on a weekly basis to show how the measures above have been complied with. Any environmental incidents or non-compliance issues will immediately be reported to the project team;
- The project managers (client representatives) will be continuously monitoring the works and will be fully briefed and aware of the environmental constraints and protection measures to be employed.

The works will be periodically monitored, as required by the Employers' Representative, during the construction phase by a suitably qualified ecologist. Following completion of the works, the ecologist will complete a final audit report to show how the works complied with the environmental provisions described in this Chapter.

9.5.2 **Operational Phase**

9.5.2.1 Emissions associated with the operation of the *Proposed Road Development*

Specific measures to offset potential impacts relating to surface water runoff, during the operation of the road, have been incorporated into the design of the *Proposed Road Development*. These include the use of penstocks, attenuation systems and hydrocarbon interceptors. Full details of the measures to be included are provided in Chapters 4 (Description of the *Proposed Road Development*) and Chapter 11 (Hydrology & Hydrogeology) of this EIAR.

It is noted that the *Proposed Road Development* will convey traffic diverted off the existing section of N16 road and, given the pollution prevention measures incorporated into the project design will result in a far greater level of ecological protection in relation to water pollution from such traffic during the operational phase of the *Proposed Road Development*.

9.5.2.2 Hydrologically Sensitive Habitats

The *Proposed Road Development* passes within proximity to a number of hydrologically sensitive habitats that are included as KERs and where potential indirect impacts were identified. Through consultation with the hydrology team on the project, it has been possible to prescribe mitigation to maintain a drainage neutral situation in these areas thereby not altering the existing hydrological situation. Full details of the measures to be included are provided in Chapter 11 (Hydrology & Hydrogeology) of this EIAR. The measures have removed the potential for significant hydrological or hydrogeological effects on Key Ecological Receptors outside the footprint of the *Proposed Road Development* during the operational phase.

9.5.2.3 Faunal Mortality, Habitat Fragmentation and Disturbance

9.5.2.3.1 *Mammal Resistant Fencing*

Fencing is required to prevent Badgers from crossing road points other than at underpasses. The fencing must extend sufficient distance to ensure that Badgers will not find an easy way around. Underpass entrances should be recessed in fence lines, thereby guiding animals to them.

The extent of fencing has been determined by the locations at which Badgers are likely to encounter it and the frequency with which they may attempt to cross the *Proposed Road Development*. It will be installed in all areas where Badger signs were recorded and will extend to cover the foraging habitats surrounding the recorded signs. Badger-proof fencing will not be installed asymmetrically and will be installed in parallel on both sides of the road and care will be taken to avoid any gaps or weaknesses even at awkward features such as undulating ground or streams in accordance with CC-SCD-00319.

Mammal proof fencing will be provided from Chainage 1,000m-1,400m in proximity to the Lugatober sett. In addition, a minimum of 25m of mammal proof fencing will be provided either side of the crossing points on the Tully Stream, Collinsford Stream and Lugnagall Stream.

Otters will often cross road some distance from watercourses. Therefore, mammal proof fencing will also be incorporated on either side of watercourses within potential to support the species (i.e. Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream). The fenced will stretch to 25m either side of the crossing point.

The locations of these fences are shown on the mitigation Maps Figures 9.4.1 and 9.4.2 contained within Volume 3 of this.

9.5.2.3.2 *Badger Underpasses*

Badger underpasses significantly reduce the number of Badger casualties and mortalities associated with *Proposed Road Development*s and should be installed where Badger pathways cross a *Proposed Road Development*. A number of trails and latrines have been recorded within the footprint of the *Proposed Road Development* and Badger/mammal underpasses are included in areas of identified badger activity. The underpasses will reduce impacts on Badger communities in the area as a result of the operational phase of the *Proposed Road Development*. The clear span structure over the Tully Stream will allow passage of Otter along the riverbank and no additional underpass/ledges will be necessary at that location.

Mammal underpasses will be provided either side of the crossing points on the Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream.

The locations of underpasses are shown on the mitigation maps Figures 9.3.1 and 9.3.2 contained within Volume 3 of this EIAR.

Badger underpasses will be constructed of 600mm concrete pipes but may form part of a watercourse culvert or bridge, where appropriate. They shall be constructed in accordance with TII Standard Construction Detail (SCD) CC-SCD-02504 and CC-SCD-02505. Mammals will be guided into the underpass by mesh fencing. This will prevent Badgers and other fauna from entering the road carriageway. The fencing design will correspond to CC-SCD-00319. The fencing shall be installed in such a manner as to prevent Badgers and other animals from digging under the fence. Underpasses have been sited as close as possible to existing Badger paths and follow existing wildlife corridors such as watercourses. The underpasses and fencing will be installed at the earliest stage possible during the construction phase so as to encourage Badger use. Where it is unfeasible to create a Badger underpass due to engineering constraints, it will be moved to a more suitable location not more than 250 metres from the original location and guide planting and fencing will be provided. As per SCDs the following measures, as per TII/NRA (2006) will be adhered to when constructing the prescribed Badger underpasses:

- Exit and Entrance to tunnels will be flush with badger-proof fencing;
- Drainage will be adequate to prevent waterlogging at entrances and within the underpass;
- Where stream culverts are being installed, structures greater than one metre diameter will be fitted with a raised mammal ledge. The ledge will be elevated above normal flood levels. Alternatively, a separate pipe culvert (600mm) can be set above flood level adjacent to stream culvert; and
- The entrances to the underpass will be planted with appropriate hedgerow planting to encourage Badger use though this will not obscure the entrances.

9.5.2.3.3 *Treatment of Otters at Watercourse Crossings*

The welfare of Otters will be ensured primarily through the provision of continued safe access for Otters to their ranges and foraging habitats. Adequate provision for Otters at affected watercourse crossings is required to allow the species to retain continued access to their foraging areas. Spanning large watercourses typically results in limited disruption to Otter activity. Smaller watercourse crossings require greater attention. The clear span structure over the Tully Stream will allow passage of Otter along the riverbank and no additional underpass/ledges will be necessary at that location.

Mammal underpasses will be provided either side of the crossing points on the Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream. The design of the underpasses will be as per that described above in relation to Badger.Ramps will be provided to ensure accessibility, if required. Underpasses have been designed to be as short as possible and daylight will as far as possible be visible through the tunnel. Drainage will prevent waterlogging at entrances and throughout the underpass. The tunnels have been sited as close as possible to watercourses and guiding features such as mammal-proof fencing, walls or natural features such as hedgerows will be installed to guide Otters and other fauna towards the underpass.

Otters may cross roads some distance from watercourses. Mammal resistant fencing has been incorporated in parallel on either side of the Tully Stream, Lugatober Stream, Collinsford Stream and *Lugnagall* Stream . This fencing will extend to a minimum of25 metres.

The locations of underpasses and mammal proof fencing are shown on Figures 9.4.1 and 9.4.2 contained within Volume 3 of this EIAR.

9.5.2.3.4 *Bats and Lighting*

It is proposed to provide external lighting installations at the location of the proposed roundabout on the southern tie in location. No additional lighting is proposed along the route of the *Proposed Road Development*.

The lighting location was not considered to be of significance for bat species and the species recorded in the area are not susceptible to disturbance from street lighting. However, taking a precautionary approach the proposed lighting has been designed to approve standards that minimise light spillage outside the intended target area. (See Chapter 4, Description of the *Proposed Road Development* for further details)

9.5.3 Residual Effects

The following habitats and species were identified as KERs and were subject to detailed impact assessment:

- KER 01 - Rich Fen and Flush (PF1) & Calcareous Springs (FP1) at *Lugnagall*;
- KER 02 - Calcareous springs (FP1) at *Lugatober* North;
- KER 03 - Flush Area (south of *Collinsford*);
- KER 04 - Flush Area (East of Drum);
- KER 05 -Calcareous springs FP1 at *Lugatober* (Reported as West of *Castlegal*);
- KER 06 - Woodland Habitats;
- KER 07 - Treelines and Hedgerows;
- KER 08 - Tully Stream and Additional Watercourses
- Bat Species;
- Otter;
- Badger;
- Fish and Aquatic Invertebrates

Taking into consideration the effect significance levels identified and the proposed best practice and mitigation; significant residual effects on KERs with regard to habitat loss/degradation, species displacement or collision mortality are not anticipated.

Table 9-35: Assessment of Residual Impact and Scale and Significance based on EPA (2017) and TII/NRA (2009)

Key Ecological Receptor	Pre Mitigation Effects	Post mitigation Effect
KER 01 -Rich Fen and Flush (PF1) & Calcareous Springs (FP1) at *Lugnagall*;	The impact associated with dust is assessed as a potential **Short-term Slight Negative effect**.	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
KER 02 -Calcareous springs (FP1) at Lugatober North	Deterioration of water quality is assessed as a potential **Short-term Slight Negative effect**. The impact associated with dust is assessed as a potential **Short-term Slight Negative effect**.	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**

Key Ecological Receptor	Pre Mitigation Effects	Post mitigation Effect
KER 03 -Flush Area (South of Collinsford)	During Construction, pollution of surface water is assessed as a **Short-term Slight-Moderate Negative effect.** The impact associated with dust is assessed as a potential **Short-term Slight Negative effect**. During operation, changes to recharge and drainage are assessed as a **Permanent Slight Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
KER 04 - Flush Area (East of Drum)	During Construction, pollution of surface water is assessed as a **Short-term Slight Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
KER 05 - Calcareous springs (FP1) at Lugatober (Reported as West of Castlegal);	During construction, pollution of surface water is assessed as a **Short-term Slight-Moderate Negative effect.** The impact associated with dust is assessed as a potential **Short-term Slight Negative effect**.	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
KER 06 - Woodland Habitats	Habitat loss is assessed as a **Permanent Slight Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
KER 07 - Treelines and Hedgerows	Habitat loss is assessed as a **Permanent Slight Negative effect at the local scale.**	
KER 08 -Tully Stream and Additional Watercourses	Habitat loss and degradation are assessed as a **Permanent Slight-Moderate Negative Impact.** Indirect water pollution effect during construction is assessed as **Short-term Moderate-significant negative effect.** Indirect effects during operation are assessed as a **Permanent slight to moderate negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
Bat Species	Habitat loss and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**

Key Ecological Receptor	Pre Mitigation Effects	Post mitigation Effect
	Displacement as a result of lighting proposals is assessed as a **Permanent Imperceptible Negative effect.**	
Otter	Habitat destruction and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect.** Indirect water pollution effect during construction is assessed as **Short-term Moderate-significant negative effect.** Indirect effects during operation are assessed as a **Permanent slight to moderate negative effect.** The potential for disturbance is considered to constitute a potential indirect **Short-term Slight Negative effect.** Death by collision is assessed as a **Permanent-Moderate-Significant Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
Badger	Habitat loss and fragmentation are assessed as a **Permanent Slight-Moderate Negative effect.** The potential for disturbance is considered to constitute a potential indirect **Short-term Slight Negative.** Death by collision is assessed as a **Permanent-Moderate-Significant Negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**
Fish and Aquatic Invertebrates	The potential for habitat loss is assessed as a potential **Permanent Moderate Negative Impact.** Indirect water pollution effect during construction is assessed as **Short-term Moderate-significant negative effect.**	With mitigation and best practice in place **no potential for significant residual effect on this KER is anticipated at any geographical scale.**

Key Ecological Receptor	Pre Mitigation Effects	Post mitigation Effect
	Indirect effects during operation are assessed as a **Permanent slight to moderate negative effect.** The potential for habitat fragmentation is assessed as a potential **Long-term Slight- Moderate Negative Impact**. The potential for habitat loss is assessed as a potential **Long-term Slight- Moderate Negative Impact.** The potential for accidental kills is assessed as a **Short-term-Moderate-Significant Negative.**	

9.5.4 Cumulative Impacts

As already outlined in section 5.4 of this EIAR, the following sources of information were consulted to establish if there are any *...existing and/or approved projects*[1]... in proximity to the *Proposed Road Development*, which are likely to result in cumulative effects:

- Sligo County Council Planning Register;
- Sligo County Council Water Services Department;
- Sligo County Development Plan, 2017 - 2023;
- An Bord Pleanála website;
- Coillte Website;
- Eirgrid Website;
- EU Biodiversity Strategy 2011;
- Irish National Biodiversity Action Plan 2017-2021

From a Biodiversity perspective, No potentially significant cumulative disturbance, displacement or habitat loss effects on any of the KERs has been identified regarding the current proposal.

The development proposal includes robust mitigation and best practice to ensure that there will be no significant adverse effects on surface water quality, watercourses, riparian habitat and associated flora and fauna.

Given that there a no existing plans or projects that could result in a cumulative effect and the predicted effects with the current proposal, no residual cumulative effects have been identified regarding any KER.

9.5.5 Conclusion

Following consideration of the residual effects (post-mitigation) it is noted that the *Proposed Road Development*, will not result in any significant effects on any of the identified KERs. No significant residual effects on receptors of International, National or County or Local Importance were identified.

The potential for effects on the European designated sites are fully described in the Natura Impact Statement that accompanies this application. Key findings of the assessment are summarised in section 9.4.2.2 of this EIAR. The NIS that the Proposed Development, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site.

No potential for significant effect on Nationally Designated Sites exists given that all identified pathways for impact are robustly blocked by the project design and mitigation contained in the EIAR.

The *Proposed Road Development* will be constructed and operated in strict accordance with the design, best practice and mitigation that is described within this EIAR and as such, significant effects on ecology are not anticipated at any geographical scale on any of the identified KERs.

9.1 Relevant Figures and Appendices

9.1.1 Figures contained in Volume 3

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

Fig. 9.1: Designated Sites and River Names;

[1] Terminology used in the amended EIA Directive.

Fig. 9.2.1: Habitat Mapping, Sheet 1 of 2;

Fig. 9.2.2: Habitat Mapping, Sheet 2 of 2;

Fig. 9.3.1: Key Ecological Receptors (KER's), Sheet 1 of 2;

Fig. 9.3.2: Key Ecological Receptors (KER's), Sheet 2 of 2;

Fig. 9.4.1: Volant and Non-Volant Mammals, Sheet 1 of 2;

Fig. 9.4.2: Volant and Non-Volant Mammals, Sheet 2 of 2;

9.1.2 Appendices contained in Volume 4

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 4.3: Chapter 4 (Main Report Reference); Outline Erosion and Sediment Control Plan

Appendix 9.1: Chapter 9 (Main Report Reference); Annex 1 Wetland Survey

Appendix 9.2: Chapter 9 (Main Report Reference); Whorl Snails Survey

Appendix 9.3: Chapter 9 (Main Report Reference); Invasive Alien Species Management Plan

10 Soils & Geology

10.1 Introduction

This Chapter describes the existing Land and Soils: Soils and Geology, it then considers and assesses the potential for likely significant effects on Land and Soils: Soils and geology (including natural soils, bedrock, imported fill, etc) from the construction and operational phases of the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*. Measures to mitigate any likely significant adverse effects of the *Proposed Road Development* on soils and geology near the *Proposed Road Development* are outlined within this Chapter along with predicted residual impacts.

The *Proposed Road Development* is situated in north Sligo, between the townlands of *Drumkilsellagh* and *Lugnagall*. The project comprises approximately 2.54kms of realignment to the existing N16 National Primary Route (c.790m online and c.1,750m offline).

A detailed description of the Project is provided in Chapter 4 - Description of the *Proposed Road Development* and is summarised in Section 10.3.2 of this chapter. As detailed in Chapter 1, Land & Soils from the perspective of existing agricultural landuse and landtake is assessed in Chapter 14 (Material Assets and Land – Agriculture), and Chapter 15 (Material Assets and Land – Non-Agriculture). Hydrogeology is addressed in Chapter 11 (Hydrology and Hydrogeology).

10.2 Methodology

The Soils and Geology assessment was prepared in accordance with the following guidelines

- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements by the Institute of Geologists of Ireland (IGI, 2013);
- Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports by the Environmental Protection Agency (EPA, 2017); and
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, National Road Authority (2008).

The main guidance document used in this chapter is the IGI (2013) guidelines which gives a recommended procedure containing 4 elements, it also gives guidance on the classification of impacts from the EPA guidelines and on criteria rating and impact significance from the NRA guidelines.

The assessment covers a study area of 250m beyond the landtake boundary for the proposed development in accordance with the NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, 2008 taking account potentially significant impacts which could arise at a greater distance away.

10.2.1 **IGI Guidelines**

The potential impact of the *Proposed Road Development* on Soils & Geology has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any impact on these attributes.

This impact assessment methodology is in accordance with the guidance outlined in Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements published by the Institute of Geologists of Ireland (IGI) in 2013.

This document outlines a 13 step methodology, which has four distinct elements, as follows:

- 1st Element: Initial Assessment (Steps 1 to 5);

- 2nd Element: Direct and Indirect Site investigations and Studies (Steps 6 to 9);
- 3rd Element: Mitigation Measures, Residual Impacts and Final Impact Assessment (Steps 10 to 12); and
- 4th Element: Completion of the Soils, Geological and Hydrogeological Sections of the EIS (Step 13).

The initial assessment as outlined in Section 10.3 describes the existing land and soil environment and presents a description of the past and present uses of the site and other neighbouring sites.

This section also describes the nature of the site based on both site specific and neighbouring site investigation data from publicly available sources.

Where specific features are identified, their importance is ranked in line with the IGI Guidelines in Section 10.3.3.

The outcome from examining this available data is the Conceptual Site Model (CSM) which is outlined in Section 10.4.3.

Section 10.5 lists the predicted impacts associated with the development of the site. Rating the importance of a geological feature was carried out using the guidelines on procedures for assessment and treatment of Geology Hydrology and Hydrogeology for National Road Schemes and reproduced in the IGI guidelines. The impact classification was carried out following the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft August 2017).

Following the assessment of impacts, specific mitigation measures have been developed to avoid, reduce and, if possible, remedy any negative impacts on the land and Soils: Soils & Geology. These are described in Section 10.6 below.

Residual impacts are described in Section 10.7. The magnitude and significance of these residual impacts have also been classified based on the IGI Guidelines.

10.2.2 Baseline Data Sources

The following sources of information were used in compiling this chapter.

- The Geology of Sligo Leitrim Sheet 7, Geological Survey of Ireland (GSI) Scale 1:100,000;
- Online mapping Geological Survey of Ireland (GSI);
- GSI Groundwater Vulnerability Map and Aquifer Classification Map (GSI, 2016c);
- Environmental Protection Agency (EPA) Soil and Subsoil Mapping-Outline Procedure Document (Version 1.2) (EPA, 2006);
- N16 Sligo to County Boundary Route Selection Report (July 2017) Section 5.3.4 Soils and Geology
- Priority Geotechnical Limited: N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) Road Project Ground Investigation Contract Factual Report No. P18008
- Site walkover;
- Aerial Photography; and
- Site Layout Plans.

10.3 Initial Assessment

10.3.1 **Existing Environment from Baseline Studies**

10.3.1.1 Site Location

The site is located in the townlands of *Drumkilsellagh, Doonally (ED Drumcliff East), Castlegal (ED Glencar), Drum East, Lugatober* (occurring predominately within), *Collinsford* and *Lugnagall.*

10.3.1.2 Geological Heritage

A review of the GSI's County Geological Sites of County Sligo (Geological Survey of Ireland, 2016e), indicated there are no County Geological Sites (CGS) identified within the study area. There are five County Geological Heritage sites within 10km of the *Proposed Road Development*, three of which have been recommended as a Geological National Heritage Area.

Table 10-1: Geological Heritage Sites

County Geological Heritage Site	**Details**	**Distance from Project**
Benbulben Plateau	The area described as the Benbulben Plateau which contains multi-interest geological features including: Benbulben Truskmore Kings Mountain Rift Swiss Valley Glencarbury Mine Gleniff Valley Diarmuid and Grainne's Cave IGH 1, 3 & 8. The Benbulben Plateau is recommended for Geological NHA.	1.8kms
Glencar Waterfall	Fluvial and Lacustrine Geomorphology. Waterfall IGH 14	3.7kms
The Doons	The Doons form the best examples in a group of isolated steep/vertical sided limestone hills (relict tower karst modified and truncated by glacial action). IGH 1. The Doons is recommended for Geological NHA.	7.4kms
Largy/Gorteenaguinnell	Upland karst plateau, dolines. Plateau karst with abundant dolines and vertical shafts developed in an area of upland limestone and bog. The area is considered to be the most extensive area of plateau doline field and contains the highest density of these features in Ireland. IGH 1. Largy/Gorteenaguinnell is recommended for Geological NHA.	8.1kms
Hill of Knocknarea	Isolated karstic hill. Blue/grey limestone of the Dartry Fm. Defines the Hill of Knocknarea. IGH 12, 7.	9.6kms
Note: The GSI produced a list of 16 Geological themes (IGH1-16) which assists in producing a list of sites for each theme. Themes are listed below: 1. Karst 2. Precambrian to Devonian Palaeontology 3. Carboniferous to Pliocene Palaeontology 4. Cambrian-Silurian 5. Precambrian 6. Mineralogy 7. Quaternary 8. Lower Carboniferous 9. Upper Carboniferous and Permian 10. Devonian 11. Igneous intrusions 12. Mesozoic and Cenozoic 13. Coastal geomorphology 14. Fluvial and lacustrine geomorphology 15. Economic geology 16. Hydrogeology		

There are no Geological Heritage Sites (CGS or Geological NHA's) within the study area. The Geological Heritage Sites outside the study area are not considered sensitive to the development due to their distance from the road footprint.

10.3.1.3 Hydrogeology

Aquifer classification and groundwater vulnerability classifications are sourced from the GSI Ground Water Protection Scheme (GWPS) mapping program (Geological Survey of Ireland, 2016c).

The site is underlain by three types of aquifers which are shown in Figure 11.2 contained within Volume 3, going from south to north, these are

- Regionally Important Aquifer (RKc) Karstified (conduit)
- Locally Important Aquifer (LM) Bedrock which is generally moderately productive
- Locally Important Aquifer (LI) Bedrock which is moderately productive only in local zones.

Note that groundwater vulnerability, groundwater quality, water wells in the vicinity of the *Proposed Road Development* and other hydrological and hydrogeological considerations are assessed in full in Chapter 11 of this EIAR; Hydrology and Hydrogeology.

10.3.1.4 History of Land Use

The site of the *Proposed Road Development* is comprised of land used for agriculture with no known other previous uses. A historical quarry is identified on the Geological Survey of Ireland drift maps at *Drum East*, east of the site, it is not identified in the 6 inch cassini mapping or in recent mapping.

Francis Scanlon And Sean Gilroy's Quarries have been identified in Figure 10.3, neither of these quarries are currently in operation.

10.3.1.5 Economic Geology

There are currently no registered quarries within the study area, the closest adjacent quarry is Scardon More Quarry, approximately 8km from the site.

10.3.1.6 Quaternary Geology

Information on the soils of the area has been obtained from examination of the Geological Services Ireland (GSI) Spatial Resource Mapping (Geological Survey of Ireland, 2016b).

The GSI mapping, reproduced in Figures 10.2.1 and 10.2.2 in Volume 3 of this EIAR, indicates that the majority of the site is underlain by glacial till primarily derived from Namurian siltstones and shales, there is a small proportion of Alluvium and some shallow rock.

10.3.1.7 Bedrock Geology

Information on the solid geology of this area has been obtained from maps and field guides published by the GSI (2004) and reproduced in Figures 10.3.1 and 10.3.2 in Volume 3 of this EIAR.

There are three major rock types, going from south to north the rock types are;

- Ballyshannon Limestone Formation comprising pale grey calcarenite Limestone, medium light grey massively bedded crinoidal calcarenite interspersed with very dark grey fine calcarenite with black chert nodules.
- Mullaghmore Sandstone Formation, a series of cyclic units of sandstones, siltstones and shales.
- Glencar Limestone Formation, cyclical units of calcareous shales and limestones which range from argillaceous calcisilitites to very fine calcarenites.

10.3.1.8 Aggregate Potential

The crushed rock aggregate potential is classified as high to very high due to the quality of the limestone rock as a crushed stone.

10.3.1.9 Karst

There are eighteen karst features situated within 10kms of the site, the site itself does not have any karst features identified in the GSI mapping. Three additional calc Tufa springs (See Table 10-2 - no.'s 14, 15, 16 & 17) were not identified in the GSI Mapping but highlighted in the N16 Sligo to County Boundary Route Selection Report (July 2017) in Section 5.3.4 Soils and Geology. These have been identified in Figure 10.1 contained within Volume 3 of this EIAR.

Table 10-2: Karst Features

No.	Karst Feature	Townland	Distance from site
1	Glencar Lake	Sracreeghan	2kms
2	Cave	Formoyle	3.9kms
3	Cave	Magheraghanrush or Deerpark	4kms
4	Swallow hole	Magheraghanrush or Deerpark	4.2kms
5	Cave	Magheraghanrush or Deerpark	4.4kms
6	Spring	Corglass	4.8kms
7	Spring	Corglass	5kms
8	Cave	Tully	5.3kms
9	Foxes Den Cave	Tonaphubble	5.5kms
10	Cave	Tormore	4kms
11	Cave	Glencarbury	4kms
12	Cave	Gleniff	4.6kms
13	Cave	Gleniff	5.5kms
14	Spring	*Lugatober*	Adjacent to existing road
15	Spring	*Lugatober*	Adjacent to existing road
16	Spring	*Lugnagall*	Adjacent to existing road
17	Spring	*Lugnagall*	Adjacent to the existing road
18	Swallow Hole	*Drumkilsellagh*	Directly adjacent to proposed road

10.3.1.10 Landslide Potential

Past landslides or potential landslide locations are identified on the GSI website. Three historic landslide slips have been identified outside of the study area. At 750m approximately from the site, a landslide slip near *Lugatober* (572528, 840871) has been identified as a concave slip in rock, the slip was 109.49m in length. At 600m from the site, a landslide slip near *Lugnagall* (573269, 841535) has been identified as a rotational slide, producing a concave slip in rock, the slip was 227m in length. To the north of the site, approximately 800m, a landslide slip near Gortnagrelly was identified as a concave slip, presenting as a cluster, the slip was 286m in length.

The *Proposed Road Development* avoids all areas of high susceptibility to landslides and is within areas of moderately low and low susceptibility, this is presented in Figure 10.5 of Volume 3 contained within Volume 3 of this EIAR. The historic slips are outside the study area are not considered sensitive to the development due to their distance from the road footprint. Furthermore, the 1,750m offline section of the *Proposed Road Development* is generally located further away from the high susceptibility areas than the existing N16.

10.3.1.11 Contaminated Land

There is no evidence of contaminated land from baseline data sources, ground investigation surveys or walkover surveys within the study area. There are two historic quarries to the south of the site at the foothills of Copes Mountain, identified in Figure 10.1 of Volume 3 as Francis Scanlon Quarry and Sean Gilroy Quarry, which have been previously used for the disposal of soil, stone and inert construction and demolition (C&D) waste as detailed below.

Glen Resources (Francis Scanlon) - Waste Facility Permit WPSO 03 09 for site at *Lugnagall*, Glencar, Co. Sligo for soil & stone and inert C&D waste (concrete, bricks, tiles & ceramics) is 390m from the *Proposed Road Development*. The permit was issued in November 2003. This site ceased accepting soil & stone and inert C&D waste material by 2008.

Sean Gilroy - Certificate of Registration at *Lugnagall*, Glencar applied for & operated by Sligo Co. Co., for soil & stone. This Certificate of Registration was applied for and granted in April 2008 and stopped accepting soil & stone material by 2012.

10.3.1.12 Organic Matter

No organic material is recorded within the study area of the *Proposed Road Development*. The *Proposed Road Development* crosses the Tully Stream at Ch. 610 where the GSI mapping indicates the presence of granular alluvium characteristic of high velocity rivers.

10.3.2 **Characteristics of the Proposed Road Development**

The *Proposed Road Development* passes through the townlands of *Drumkilsellagh, Doonally (ED Drumcliff East), Castlegal (ED Glencar), Drum East, Lugatober* (occurring predominately within), *Collinsford* and *Lugnagall.* The project comprises approximately 2.54kms of realignment to the existing N16 National Primary Route (c.790m online and c.1,750m offline) and contains one at grade roundabout and six T Junctions with approximately 1,500m of cycle tracks and one river/stream bridge.

The mainline alignment commences at a roundabout junction and initially commences at grade, it gradually increases to a fill section (3m high at Ch. 280), it then crosses the Tully Stream at c. Ch. 610m in fill (4.4m high at Ch. 620) between Ch. 530m and Ch. 720m.

From Ch. 750m the rock is un a cutting to Ch. 1150 (13m deep at Ch. 1,000m) before passing on a high fill section through a valley in the townland of *Lugatober* between Ch. 1,140m and 1,340m with a maximum fill depth of 5m. The alignment then passes through a cut section between Ch. 1,350m and 1,600m (3.4m deep at c. Ch. 1,400m), from Ch. 1,600 to 1,990 the *Proposed Road Development* is in fill with a maximum of 5.9m at Ch. 1940.

From Ch. 1,940m the alignment cuts through (4.5m deep at Ch. 2,080) a topographical high between Ch. 1,990m and Ch. 2,150m, before it continues through a slight cut and fill section and reconnects with the existing road at grade at Ch2,542m.

A Soil Repository/Borrow pit is proposed from Ch. 880 and Ch. 1045. The proposed layout of the soil repository/borrow pit is identified in Figure 4.10.1 contained within Volume 3 of this EIAR. It is proposed to excavate the soil repository/borrow pit to depths ranging from 8.4 to 16.5m below ground level. Approximately 59,000m^3 of material, both rock and overburden will be made available for re-use following excavation. The same volume of material, unsuitable for re-use due to its moisture content will be deposited in the repository.

A detailed description of the *Proposed Road Development* is provided in Chapter 4 - Description of the *Proposed Road Development*.

10.3.3 Initial Assessment and Impact Determination

The criteria for rating site importance of a geological feature is based on the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes published by the NRA (2009) which is reproduced in the IGI guidelines. Initial assessment is based on the findings of the information listed above. This rating was used to create *Table 10-3*.

Table 10-3: Initial Assessment and Impact Determination

Feature	Importance	Justification
Regionally Important Bedrock Aquifer (Karstified)	High	Attribute has a high quality, significance or value on a local scale.
Economic Geology	High	Loss of potential quarry reserves at the proposed Project.
Soils	Low	Attribute has a low quality, significance or value on a local scale.

10.3.4 Geological Environment

A review of the available information both from site works and information review of the site and the region, the site is classified as Type B geological environment. A Type B environment is identified as "Naturally dynamic hydrogeological environment', this has also been applied to the geological environment.

Assessments as required by the Activities/Environment Matrix in the Institute of Geologists of Ireland guidelines corresponding to the Proposed Project conditions (Type B) were undertaken for the following activities:

- Earthworks;
- Excavations of materials above and below the water table.

Table 10-4 outlines the investigations required by the IGI guidelines for a Type B Geological Environment which should be undertaken based on the environmental type and different activities which will be undertaken.

Table 10-4: Details of works required under the IGI Guidelines for a Type B Environment

Works required under the IGI Guidelines for a Type B Environment	Works Completed
Earthworks	
Invasive site works to characterise the nature, thickness, permeability and stratification of soils.	Site Investigations completed as presented in Section 10.4.1
Works to determine groundwater level, flow direction and gradient e.g. monitoring in standpipes, piezometers, or boreholes.	Works (e.g Standpipes installed long term monitoring) as detailed in Section 10.4.2.8 below and Refer to Chapter 11 – Hydrology & Hydrogeology
Works to determine groundwater – surface water interactions.	Refer to Chapter 11 – Hydrology and Hydrogeology

Works required under the IGI Guidelines for a Type B Environment	**Works Completed**
Excavation of materials above and below the water table	
Site works to characterise nature, thickness, permeability and stratification of soils and subsoils e.g. trial pits, augering.	Works as detailed in Section 10.4.1 outlining site investigation undertaken below and Refer to Chapter 11 - Hydrology and Hydrogeology
Site works to fully characterise the bedrock geology and in order to define the resource volume/weight according to the PERC Reporting Standard e.g. trenching, drilling, geophysics.	Bedrock geology for the *Proposed Road Development* has been characterised by extensive rotary coring, logging and Geophysical surveying as detailed in Section 10.4.2.5
Works to determine groundwater level, flow direction and gradient	Works as detailed in Section 10.4.2.8 below and Refer to Chapter 11 - Hydrology and Hydrogeology

10.4 Direct and Indirect Site Investigation and Studies

10.4.1 Ground Investigation

A ground investigation was carried out to establish subsurface conditions at the proposed project by Priority Geotechnical Limited in 2018. A summary of the ground investigation carried out is provided in Table 10-5.

Table 10-5: 2018 Ground Investigation Summary

Contractor	Description of Investigation	Details of Investigation
Priority Geotechnical Limited	N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) Road Project Ground Investigation Contract	20 Cable Percussion Boreholes 11 Rotary cored holes 23 trial pits 12 dynamic probes 4 Standpipes 3 soakaway tests 3 CBR tests Seismic Refraction Profiles 2D electrical resistivity tomography 5 falling head tests 5rising head tests
Priority Geotechnical Limited	N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) Road Project Ground Investigation Contract-Additional Exploratory Holes	2 Rotary cored holes 1 trial pit

Fieldwork for the geotechnical and geophysical investigation was carried out between February and September 2018 by Priority Geotechnical Ltd. Figures 10.4.1 and 10.4.2 contained within Volume 3 of this EIAR show the investigation locations.

10.4.1.1 Geophysical Survey

Priority Geotechnical Limited completed a geophysical investigation to determine rock head. Ground Profile 01 (GP01) using seismic refraction (seismic profile S1 to S5) was carried out from CH0+800 and CH1+110. Ground Profile 02 (GP02) using electrical resistivity and seismic refraction was carried out from CH2+020 and 2+330. GP01 indicated that depth to bedrock ranged from 3 to 4m below ground level. GP02 both seismic (seismic profile S6 to S8) and resistivity was carried out. The resistivity profile was split into two, due to the presence of a local road. R1 (Resistivity Profile 1) produced results did not achieve depth of penetration to rockhead. R2 (Resistivity Profile2) indicates rock is much deeper than in GP01 and is shallowest at 7.30m below ground level as encountered in BH216A.

The geophysical survey results generally align with the findings of the direct intrusive investigation.

10.4.2 Encountered Ground Conditions

10.4.2.1 Topsoil

Topsoil was found in all the trial pits ranging in thickness from 0.2 to 1.2m, with an average thickness of 0.3m.

10.4.2.2 Made Ground

Made Ground has been defined as soil which has been altered in some way by human activity (imported and placed in-situ) was encountered in TP120 from 0.2 to 0.65m bgl[73], in TP122 from 0.0 to 1.6m bgl and in BH202 from 0 to 1.6m bgl. It is described as dark grey brown, slightly sandy to sandy, gravelly CLAY with cobble and boulder fill. There is no evidence of contamination in the encountered made ground.

10.4.2.3 Cohesive Glacial Till

Cohesive glacial till was generally encountered directly beneath topsoil, interbedded with granular glacial till and/or above rockhead. It is generally described as soft at generally shallow depths to firm/stiff with depth, BH216 has 3.0m of soft silt (with minor localised soft areas), grey-brown, mottled, (slightly) sandy (slightly) gravelly CLAY/SILT with occasional cobbles and boulders. It is likely that the majority of this material will remain in-situ and where the footings or road boxes encroach into soft cohesive deposits, it shall be removed and replaced.

10.4.2.4 Granular Glacial Till

The glacial deposits encountered during the ground investigations comprise a highly variable, stratified mixture of cohesive and granular materials. The boundaries between these material types likely varying from sharp to gradational both laterally and vertically. A detailed review of the available ground investigation data for the site indicates that, although glacial deposits occur as either ‘cohesive’ or ‘granular’, they comprise a heterogeneous mixture of materials.

Where present, granular glacial till occurs as interbedded layers within cohesive glacial till and/or directly above (presumed) rockhead.

The granular glacial till is generally described as grey/brown, (slightly) silty, (very) gravelly SAND and silty, sandy, clayey GRAVEL. Sand is described as fine to coarse, gravel is described as fine to coarse, angular to sub-rounded of mixed lithologies.

10.4.2.5 Encountered Bedrock Geology

Limestone bedrock was encountered at depths ranging from 2.8 to 11.5m bgl. It is described as weak to strong, light to dark grey limestone. Weathering ranges from slightly with orange oxidisation to distinctly to completely weathered.

10.4.2.6 Contaminated Land

Laboratory test results do not indicate contamination in the samples tested.

10.4.2.7 Organic Matter

There is no organic material identified at the site.

10.4.2.8 Groundwater

Groundwater was encountered in the cable percussion boreholes, rotary coreholes and trial pits at depths ranging from 2.6 to 11.0m below ground level. Standpipes were installed in six rotary cores, RC206, 207, 216, 216a, 217 and 218. Groundwater level readings are identified below in *Table 10-6*.

[73] Denoting: below ground level

Table 10-6: Groundwater level readings[74]

RC No.	Groundwater Strike (metres below ground level)	Response Zone		Material	Groundwater reading range (metres below ground level)
		From	To		
RC206	3.5	4.0	12.0	Rock	8.88-11.03
RC207	4.5	12.0	15.5	Rock	15.36-15.47
RC216	10	8.0	14.8	Cohesive Overburden and Rock	6.71-8.94
RC216A	6	4.5	8.8	Cohesive Overburden	2.15-4.75
RC217	7.5	8.0	13.6	Rock	2.65-3.19
RC300	6	6.5	20	Rock	9.91-12.11
RC301	4	3	20	Rock and cohesive overburden	8.90-12.28

10.4.3 Conceptual Site Model

Using the subsurface information from the ground investigation and published data, a conceptual site model is presented on Figures 10.4.1 and 10.4.2 contained within Volume 3 of this EIAR and summarised in Table 10-7. The conceptual model plots the factual ground investigation data within the study area along the existing ground level against the proposed road level, earthworks areas, groundwater levels and chainage of the *Proposed Road Development.*

Table 10-7: Geotechnical Site Model

Unit	Material	Description	Depth to Top of Unit (m bgl)	Range of Unit Thickness (m) a)
1	Topsoil	Topsoil	0.0	0.2-1.2
2	Made Ground	Dark grey, slightly sandy to sandy, gravelly CLAY with cobble and boulder fill.	0.0	0.65-1.6
3	Cohesive Glacial Till	Typically comprising firm to stiff slightly sandy, slightly gravelly CLAY	0.2 to 1.6	1.05 to 11.5
4	Granular Glacial Till	Typically comprising slightly silty, very gravelly SAND and silty, sandy, clayey GRAVEL	2.0 to 5.0	0.2 to >2.0m
5	Bedrock	Typically weak to strong light to grey LIMESTONE, slightly to distinctly to completely weathered.	2.8 to 11.5	Unproven

Note: a) The depths and unit thicknesses are based on borehole locations and may not represent the maximum or minimum depths and thicknesses across the site.

10.4.4 Karst Features

As identified in Section 10.3.1.9 above, there are 18 karst features within a 10km radius which include those identified by the GSI and further sites identified as part of the environmental evaluation, all features are identified in Figure 10.1 contained within Volume 3 of this EIAR. There are five karst features within the study area, identified as numbers 14, 15, 16, 17 & 18. No.'s 14, 15, 16 and 17 are

[74] Further information in relation to ground water levels is provided in Chapter 11 (Hydrology & Hydrogeology) of this EIAR.

calcareous springs which are not identified in GSI mapping but were identified as part of the Route Selection and Design process associated with this project. No. 18 is a swallow hole (also discovered as part of the design process) which is at the roundabout at the start of the *Proposed Road Development*, a retaining wall is being proposed at this location.

Anomalies were encountered during the intrusive investigation, which may be karst related. These included BH218 which recorded no recovery from 11.0 to 12.0m bgl.

No surface karst features were identified underlying the *Proposed Road Development* itself, the risk of karst being present exists; however it is considered to be a low risk.

10.5Detailed Assessment and Impact Determination

Rating the importance of a geological feature was carried out using the guidelines on procedures for assessment and treatment of Geology Hydrology and Hydrogeology for National Road Schemes and reproduced in the IGI guidelines. The impact classification was carried out following the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft August 2017).

10.5.1 **Direct Impacts - Construction**

10.5.1.1 Earthworks: Excavation and Replacement

The earthworks balance for the *Proposed Road Development* has been designed to minimise the requirement for the importation of material and to maximise the reusability of materials within the site. The proposed soil repository/borrow pit will produce approximately 59,000m^3 of material suitable for use within the *Proposed Road Development*.

By excavating the soil repository/borrow pit, there will be a reduction in the need to import additional material, this will maintain the sustainability of existing quarries in the area, it also provides resource efficiency within the site. The material that cannot be used due to its moisture content will be used to restore ground at the soil repository to its original levels. The balance of the need for the project with the need to protect the environment is upheld. The use of the repository for material that is unsuitable as road construction material due to its moisture content is waste prevention as it does not need to go to a landfill which maintains the sustainability of the landfill.

This impact will involve sub soil and rock removal which are detailed in Section 10.5.1.2 and 10.5.1.3 below.

10.5.1.2 Importation of Road Construction Materials

All excavated material generated during the works will be reused within the project area as detailed in Section 10.3.2. 40,000m^3 of material will require importation onto site to achieve the proposed design levels. Figure 10.6 contained within Volume 3 of this EIAR identifies the location of quarries within the greater area which may be used to source road construction materials.

Materials required from quarries will only be sourced from quarries which are listed on the register maintained by the relevant Local Authority. All material reused on site will be subject to testing to ensure it is suitable for its proposed end use.

The importation of surplus clean and inert excavated material as a by-product from other sites would be subject to an Article 27 notification to the EPA in accordance with relevant waste legislation and taking account of the findings of the current EPA public consultation document *'Regulatory position on soil & stone by-products'* published in October 2018.

The importation of material will produce 5,000 additional truck movements, this impact is considered to be a neutral quality, of imperceptible significance and have a short term duration.

10.5.1.3 Sub soil removal

The removal of soil excavation works is a direct and permanent impact on the Soils and Geology of the proposed road. However, the soil is generally cohesive glacial till and of low commercial value. The magnitude of this potential impact is negligible (NRA 2008) and would be classified under the EPA guidelines as having a neutral effect, of imperceptible significance and permanent duration.

10.5.1.4 Bedrock Removal

The removal of bedrock during excavation works is a direct and permanent impact on the soils and geology of the *Proposed Road Development*. However, the site itself is not a County Geological Site (CGS).

Rock excavation will be required from circa Ch. Ch. 880m to Ch. 1,120m and in the proposed soil repository/borrow pit from Ch. 880 to Ch. 1045. Given the localised nature of the excavation, the bedrock encountered is likely to be ripped or blasted. Blasting (if required) shall be carried out in accordance with the mitigation measures outlined in Chapter 7(Noise and Vibration).

The exposure of rock faces along roads is considered to have a positive impact for geology as it allows the public to see rock normally hidden underground. The re-use of rock from the *Proposed Road Development* and from the proposed borrow pit and the subsequent reduction of the need to import road construction materials is also a positive impact. The overall magnitude of this potential impact is minor beneficial (NRA 2008) and would be classified under the EPA guidelines as having positive effect, not significant and of permanent duration.

10.5.1.5 Karst Features

As detailed in Section 10.4.4 above, karst features were identified in the surrounding area, however, karst features were not identified underlying the proposed road itself. A non-intact section or potential void was encountered in BH218 which is located adjacent to an on line section. Given the nature of the proposed works, this potential void will not be encountered during construction and will not give rise to an environmental impact.

There does, however, remain a possibility of localised karst features that may be encountered during construction, with the implementation of the design, the proposed road is expected to have minimal impact on these karst features. Hydrogeology is assessed in Chapter 11 (Hydrology and Hydrogeology) The magnitude of this potential impact is negligible (NRA 2008) and would be classified under the EPA guidelines as having neutral effect, of imperceptible significance and temporary duration.

10.5.1.6 Economic Geology

The *Proposed Road Development* is located in an area of high to very high crushed rock potential. The removal of a proportion of a future quarry or reserve is considered a direct and permanent impact on the economic geology, however as the rock is not shallow under a large proportion of the site, this potential impact is negligible (NRA 2008) and would be classified under the EPA guidelines as having a neutral effect, of imperceptible significance and permanent duration.

10.5.1.7 Erosion, Storage and Stockpiles

Earthworks surfaces will be exposed during the excavation of cuttings. These earthworks surfaces are subject to erosion if left exposed over a long period of time. The impact is classified as having a negative quality, moderate significance and temporary duration.

The removal of topsoil, overburden material and rock and the treatment of those materials shall require its temporary storage, handling and reuse on site. The impact is classified as having a negative quality, slight significance and temporary duration.

10.5.1.8 Sealing of overburden material

During construction, vehicles and plant will track over areas of topsoil and overburden. The vehicle and plant movements have the potential to compact the subsoil (following topsoil removal). The magnitude of this potential impact is a negative effect, of imperceptible significance and of permanent duration.

10.5.1.9 Contaminated Land

Contaminated land was not encountered during the site investigation and will not present an impact.

10.5.1.10 Organic Matter

Organic material was not encountered during the site investigation and will not present an impact.

10.5.1.11 Soil Pollution

During the construction phase, localised accidental spillages of fuel or chemicals on the site have the potential to contaminate the underlying soils by exposure, dewatering or construction related spillages resulting in a Permanent Negative Impact on Soils. In the case of soils, the magnitude of this impact is small adverse as it may result in the requirement to excavate/remediate a small proportion of contamination or result in a low risk of pollution to soils. As a result, its significance is Moderate / Slight for soil features.

Groundwater Pollution is assessed in Chapter 11 (Hydrology and Hydrogeology).

10.5.2 **Potential Impacts-Operational**

10.5.2.1 Soil Pollution

During the operational phase, there is a low risk of spillages of chemicals and fuels/lubricants (from an accident for example). The impact is neutral, of imperceptible significance and of permanent duration. All mainline runoff will be treated in attenuation/wetland facilities as identified in Chapter 4 (Description of the *Proposed Road Development*).

10.5.2.2 Groundwater Pollution

This potential impact is discussed in Chapter 11 (Hydrology and Hydrogeology).

10.5.3 **Do Nothing Scenario Impact**

In the event that the *Proposed Road Development* is not constructed there will be no impacts on soils and geology, except due to future engineering works which would be controlled under the relevant planning process.

10.5.4 **Worst Case Scenario Impact**

If the *Proposed Road Development* is operated under worst case traffic conditions there would be no additional negative impacts on soils and geology, provided that the mitigation measures described are fully implemented.

10.6 Mitigation Measures

10.6.1 Mitigation of Construction Impacts

10.6.1.1 Subsoil and Bedrock Removal

To achieve the proposed design levels, approximately 158,000m^3 of material, including soil, starter layers drainage blankets etc. will be required. The earthworks balance for the *Proposed Road Development* has been designed to minimise the requirement for the importation of material and to maximise the reusability of materials within the site. The proposed soil repository/borrow pit will produce approximately 59,000m^3 of material suitable for use within the *Proposed Road Development*, this will reduce the projects fill deficit from 99,000m^3 down to circa 40,000m^3.

10.6.1.2 Soil Repository / Borrow Pit

Importation of materials from outside the site will be minimised, in-so-far as possible, by ensuring that materials arising within the site area are used to the greatest extent possible. Where necessary, naturally occurring materials will be processed to reduce moisture content and/or improve grading in order to maximise suitability for use. Inevitably, materials will be encountered which cannot be processed into suitable fill material. Approximately 59,000m^3 of material that cannot be used due to its moisture content will be used to restore ground at the soil repository/borrow pit to its original levels.

The proposed soil repository/borrow pit will allow for the deposition of 59,00m^3 of material, any additional surplus material will be used to construct landscaping bunds within the site area. Any surplus material remaining which cannot be incorporated within the works will be disposed of off-site at suitably licenced facilities. Licenced facilities are identified in Figure 10.6 contained within Volume 3 of this EIAR.

Soil Repository/Borrow Pit sites will be enclosed within double erosion control fencing (silt fence) and erosion control features will be installed at the drainage outfalls of the sites prior to works being undertaken. Where required, an access road will then be constructed within the restoration area together with wheel wash facilities.

In the unlikely event that contaminated material is encountered on site, it shall be disposed of in accordance with all relevant legislation including the Waste Management Act, 1996 (as amended) and associated regulations and with regard to Best Practice Guidelines on Preparation of Waste Management Plans for Construction and Demolition Projects (DoEHLG., June 2006) and TII guidelines including The Management of Waste from National Road Construction Projects (GE-ENV-01101) December 2017.

10.6.1.3 Karst Features

The following construction karst mitigation measures are proposed if karst is encountered during construction:

Exposed rockhead will allow careful treatment of any karst features exposed. A suitably qualified geotechnical engineer/engineering geologist will investigate the exposed surface of the excavation for any possible karst features, investigate these and break out additional rock where required.

Where rock head is not exposed, the ground will be inspected by a suitably qualified geotechnical engineer/engineering geologist for the appearance of karst features such as unusually soft ground/disturbed soil.

Karst features encountered will be backfilled using a fining up sequence with large clean rock at the base to choke the opening/void, this will be overlain by progressively finer stone and sand to return the site to its original hydraulic conductivity whilst removing the risk of collapse.

Following the implementation of these mitigation measures the residual impact is predicted to be imperceptible and neutral.

10.6.1.4 Economic Geology

No mitigation measures are proposed.

10.6.1.5 Erosion, Storage and Stockpiles

The principal avoidance measures shall include the following; topsoil stripping and earthworks removal will not be carried out over large areas in advance resulting in these areas being exposed for long periods of time. Similarly, when the design cut level has been achieved, the slopes shall be battered back to a safe angle of repose and topsoiled immediately, the underlying material shall be protected by covering with construction materials or topsoil, as required, and shall not be left exposed.

Control measures will involve the immediate use of topsoil wherever practicable after its stripping, if this is not possible, stockpiles of topsoil shall be limited to heights not exceeding 2m. Topsoil shall be battered to a stable slope and shall not be unnecessarily trafficked either before stripping or when in a stockpile.

Overburden, where required to be stockpiled prior to use, shall be limited to heights not exceeding 4m, shall be battered to a stable slope and shall not be unnecessarily trafficked either before stripping or when in a stockpile. Other control measures include the protection of these stockpiled materials from erosion, the provision of adequate drainage to limit and control surface water runoff.

Following the implementation of these mitigation measures the residual impact is predicted to be imperceptible and neutral.

10.6.1.6 Sealing of topsoil/overburden material

The principal avoidance measures shall include the following; topsoil and overburden shall not be unnecessarily trafficked either before stripping or when in a stockpile. When the design cut level has been achieved, the underlying overburden shall be covered with construction materials or topsoil, as required, and shall not be left exposed.

Following the implementation of these mitigation measures the residual impact is predicted to be neutral Imperceptible.

10.6.1.7 Contaminated Land

No mitigation measures are proposed.

10.6.1.8 Organic Matter

No mitigation measures are proposed.

10.6.1.9 Soil Pollution

No further mitigation measures are proposed.

10.6.2 **Mitigation of Operational Impacts**

10.6.2.1 Soil Pollution

Mitigation measures proposed for soil pollution are consistent with the mitigation measures outlined in Chapter 11 Hydrology and Hydrogeology for the protection of groundwater, as potential contaminants could travel through soil before entering the groundwater system and as such, measures to protect the groundwater also protect the soils from contamination.

10.7 Residual Impact of the *Proposed Road Development*

An overall analysis of the impacts in light of the proposed mitigation measures concludes that all of the potential impacts (both construction and operational impacts) are predicted to be reduced to neutral quality, imperceptible significance.

10.8Cumulative Impacts

There are no projects or plans identified in proximity that have the potential to result in cumulative impacts with regard to Land & Soils: Soils and Geology.

10.9Relevant Figures and Appendices

10.9.1 **Figures contained in Volume 3**

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

Fig. 10.1: Geological Heritage, Karst Features & Quarries

Fig. 10.2.1: Subsoil Geology Map (Sheet 1 of 2)

Fig. 10.2.2: Subsoil Geology Map (Sheet 2 of 2)

Fig. 10.3.1: Bedrock Geology Map (including structural and karst features) (Sheet 1 of 2)

Fig. 10.3.2: Bedrock Geology Map (including structural and karst features) (Sheet 2 of 2)

Fig. 10.4.1: Geotechnical Overview; Ch. 0m to Ch. 1,460m - Sheet 1 of 2

Fig. 10.4.2: Geotechnical Overview; Ch. 1,460m to Ch. 2,540m - Sheet 2 of 2

Fig. 10.5: Landslides & Landslides Susceptibility

Fig. 10.6: Waste Facilities and Regional Quarries

10.9.2 **Appendices contained in Volume 4**

There are no appendices associated with this Chapter contained within Volume 4 of the EIAR.

11 Hydrology and Hydrogeology

11.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) presents the hydrological and hydrogeological assessment of the P*roposed Road Development*. The chapter sets out the methodology used in the assessment (Section 11.2), describes the existing hydrological and hydrogeological environment (Section 11.3), details the likely significant hydrological impacts associated with the construction and operational phase of the *Proposed Road Development*, (Section 11.4), describes measures to mitigate identified significant impacts (Section 11.5) and details residual impacts post mitigation (Section 11.6).

The *Proposed Road Development* is approximately 2.54km in length located between the townlands of *Drumkilsellagh* and *Lugnagall* and commencing circa 3km north of Sligo Town.

This section of the Environmental Impact Assessment Report seeks to assess and evaluate the *Proposed Road Development* in relation to hydrology and hydrogeology. It has been prepared by expanding the desk study work carried out for the wider N16 Sligo to County Boundary Route Selection Report which includes the constraints study. This report section was prepared in accordance with the Transport Infrastructure Ireland (TII) / National Roads Authority (NRA) publication '*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (2008)*'.

The study entails an assessment of published literature available from various sources including a web based search for relevant material. Available geological and geotechnical intrusive and geophysical investigation work carried out for the early EIAR stage have been used to identify areas of subsurface karstification and to ascertain the depth and type of subsoil underlying the *Proposed Road Development*, thus enabling an assessment of groundwater vulnerability. Site specific aerial photography, detailed Digital Terrain Modelling and LiDAR data has been reviewed to locate potential features of hydrological interest, and these have been investigated on the ground by walkover surveys in order to assess their significance and the likelihood of environmental impacts on them associated with this project.

This assessment includes liaison with the agricultural and ecological specialists to obtain relevant information on the private wells and water supplies and sites of ecological importance along the proposed route.

The scope of the study entails:

- Description of the hydrological and hydrogeological setting underlying the *Proposed Road Development*;
- Description and evaluation of the likely impacts of the development in terms of construction and operational phases including the character, magnitude and duration of such impacts;
- Description and development of proposed mitigation measures to minimise any potential impacts;
- Description of the residual impacts after mitigation;
- Description of impact interactions and cumulative impacts.

The principal potential hydrological impacts to the character of the receiving waters are associated with the proposed road crossing points and the potential for sediment loading and associated road drainage pollutants entering such watercourses during both construction and operational phases.

The principal potential hydrogeological impacts associated with the road development are the potential interception of groundwater flow and recharge by the road construction, particularly at the deeper road cuttings and the potential pollution of the underlying groundwater body from road drainage and construction works.

11.2Methodology

The Hydrological Impact Assessment Methodology is in general agreement with the guidance outlined in Section 5.6 of the TII/NRA Guidelines pertaining to the treatment of Hydrology & Hydrogeology. The Impact category, duration and nature of impact have been taken into account in this assessment as per the guidelines. The range criteria for assessing the importance of hydrological features within the study area and the criteria for quantifying the magnitude of impacts follow the TII/NRA guidelines.

The hydrological assessment has been prepared by expanding and updating the desk study work carried out for the wider N16 Sligo to County Boundary Route Selection Report. It includes an assessment of published literature available from various sources including a web based search for relevant material. Site specific topographical information and aerial photography has been reviewed to locate any potential features of hydrological interest, and these have been investigated on the ground by walkover surveys in order to assess the significance of any likely environmental impacts on them.

Available topographical and hydrometric information (field and desk based) has been used to perform hydrological impact assessments of all culvert crossings and proposed outfall locations. All watercourses and water bodies which could be affected directly (i.e. crossed or realigned/ diverted) or indirectly (i.e. generally lie within 250m of the road development boundary or would receive storm runoff from the *Proposed Road Development*) were assessed through a series of initial walkover visits followed up by a more detailed survey and hydrological assessment. Due to the nature of the hydrological environment it is necessary to consider the larger river catchment environments that the *Proposed Road Development* traverses.

11.2.1 **Data Sources**

The following list of data sources were reviewed as part of this assessment of the impacts on hydrology:

Ordnance Survey Ireland (OSi)

- Discovery Series Mapping (1:50,000)
- Six Inch Raster Maps (1:10,560)
- Six inch and 25inch OS Vector mapping
- Orthographic Aerial Mapping

Environmental Protection Agency (EPA)

- Teagasc Subsoil Classification Mapping
- Water Quality Monitoring Database and Reports
- Water Framework Directive Classification
- EPA Hydrometric Data System
- EPA Hydrometric Data System

Office of Public Works (OPW)

- Arterial Drainage scheme land benefitting Mapping for Ireland
- OPW and Drainage District arterial Drainage Channels and maintained channels
- OPW hydrometric Data WEB Site
- Floodmaps Site
- OPW FSU (Flood Studies Update) Web Portal Site for Flood flow Estimation
- OPW Preliminary Flood Risk Assessment Mapping (pFRA).

Sligo County Council

- Sligo County Development Plan 2017 – 2023
- Planning Register
- Water Services – Abstractions, Discharges & Supply Schemes

National Parks and Wildlife Service (NPWS)

- Designated Areas Mapping
- Site Synopsis Reports

Geological Survey of Ireland (GSI)

- Bedrock Geology Mapping
- Aquifer Mapping
- Groundwater Vulnerability Mapping
- Groundwater Source Protection Mapping
- Teagasc Subsoil Classification Mapping
- Well Database
- Karst Features Database
- Unpublished Turlough Database
- Groundwater Protection Schemes (1999). Department of the Environment, Heritage and Local Government (DoEHLG), Environment Protection Agency (EPA) and Geological Survey of Ireland (GSI)
- Geology of Sligo-Leitrim: A geological description to accompany the bedrock geology 1:100,000 scale map series, Sheet 7 GSI 1996.
- The GSI Groundwater Newsletters

Other sources

- LIDAR and ground survey topographical data;
- Aerial survey photography;
- Geological Survey of Ireland (GSI) Web Mapping;
- Priority Drilling Limited, Ground Investigation Factual Report;
- Geophysical Surveys along alignment, June 2018.

11.2.2 Legislation and Guidelines

In addition to various aspects of legislation already quoted in The following legislation was taken into account during this assessment

- The European Communities (Environmental Impact Assessment) Regulations (as amended);
- The European Union (Environmental Impact Assessment and Habitats) Regulations;
- The Planning and Development Act (as amended);
- The Planning and Development Regulations (as amended);
- European Communities Environmental Objectives (Groundwater) Regulations 2010-2012;
- S.I. No. 122 of 2014 European Union (Drinking water) Regulations;
- Directive 2011/92/EU (as amended by Directive 2014/52/EU).

This assessment was carried out in accordance with the following guidelines:

- DoEHLG, 2010. Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Environmental Protection Agency, 2002. Guidelines on the information to be contained in Environmental Impact Statements;
- Environmental Protection Agency, 2003. Advice Notes on current practice (in the preparation of Environmental Impact Statements);
- Institute of Geologists of Ireland, 2002. Geology in Environmental Impact Statements, A Guide;
- Institute of Geologists of Ireland, 2013. Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- National Roads Authority, 2008. Environmental Impact Assessment of National Road Schemes – A Practical Guide;
- National Roads Authority, 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

The following Draft Guidance documents have also been consulted:

- EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Draft May 2017; and
- EPA Advice Notes for Preparing Environmental Impact Statements, Draft September 2015.

11.2.3 Consultation with Regulatory and Other Bodies

Consultation took place with all relevant regulatory bodies including various departments of Sligo County Council, the OPW, GSI and Inland Fisheries Ireland.

11.2.4 Field Surveys and inspections

Field surveys and walkover assessments were carried out to assess the hydrological impacts of the *Proposed Road Development*. Detailed stream surveys (including topographical surveys where required) were carried out at areas where hydrological impacts were likely to occur without appropriate mitigation. Specifically, all proposed culvert / bridge crossing locations, proposed outfall locations and ecologically sensitive areas were visited and field measurements carried out along with reconnaissance of potential flood risk areas.

Field surveys were carried out to assess the hydrogeological aspects of the *Proposed Road Development*. Detailed site walkovers were made at any key areas of concern. At sensitive locations, water supply springs, wells and boreholes were visited and assessed in respect to use, well characteristics, yield and recharge area. Water quality sampling was carried out of both groundwater and surface waters along with water table level monitoring of selected boreholes.

11.3 Existing Environment

11.3.1 **Surface Hydrology**

11.3.1.1 Hydrological Overview of Study Area

Within the Study Area there are three relatively small river/stream basins which discharge westwards to the coast and into Sligo Harbour. The topography can be split into steep hillslope lands off Cope's and Keelogyboy Mountains to the east and northeast of the existing N16. These steep sloping lands continue northwest and north towards Glencar Lough and the Drumcliff River valley. To the west and south west of the existing N16, moderate to gentle sloping lands are present which become more gentle in gradient towards the coast. The ground levels along the proposed 2.54km road alignment are variable ranging from a low of 77m OD to a high of 113m OD and typically at 80 to 90m OD. The road alignment runs along the southwest, west and northwest slopes of Cope's Mountain.

The rainfall increases with altitude west to east with typical annual average rainfall amounts of 1200 to 1300mm along the coastline area and increasing to 1300 to 1500mm in the vicinity of the existing N16, reaching levels of 1800 to 1900mm towards the summit of Copes Mountain and Crockauns. The catchment average annual rainfall is 1790mm for the Drumcliff River (FSU web portal), 1570mm for the *Lugnagall*, 1560mm for the *Collinsford* Stream and 1465mm for the Tully Stream using the MET Eireann 20km by 20km SAAR data (1990 to 2010). Evapotranspiration rates are approximately 450 to 500mm per annum and annual groundwater recharge rates are estimated to be c. 60% (GSI Groundwater database).

The proposed N16 *Lugatober* road development crosses several watercourses which are part of the Sligo Bay and Drowse Hydrometric Area No. 35 (Sligo Bay and Drowse Catchment representing a total basin area of 1974km^2). The total upstream drainage catchment to the road Development is only 2.7km^2 draining the western and north-western upper slopes of Copes Mountain.

The *Proposed Road Development* is located within three river catchments, the Willsborough Stream[75] catchment to the South, the Tully Stream[76] and the Drumcliff River[77] (outflow from Glencar Lough). The Willsborough Stream catchment outfalls into the Garvogue Estuary having a catchment area of 17.4km^2, the Tully Stream and the Drumcliff River both outfall into the Drumcliff Estuary having respective catchment areas of 6.6 and 61.3km^2 respectively to their sea outfalls.

The catchment Winter Rainfall Acceptance Potential (WRAP) for these catchments is predominantly SOIL index 5 and to a lesser extent index 4 representing the classifications of "Very Low" and "Low" WRAP or conversely very high and high flood runoff classifications. The WRAP Soil Index score is based on the depth to an impermeable horizon, permeability class of the soil, and the topographical slope

[75] Described as 'Willsborough (Stream)' on EPA Maps (https://gis.epa.ie/EPAMaps/);

[76] Described as labelled as 'Drumcliff_Glebe' on EPA Maps (https://gis.epa.ie/EPAMaps/);

[77] Described as labelled as 'Drumcliff 35' on EPA Maps (https://gis.epa.ie/EPAMaps/);

and has five index classes 1 to 5 representing very high, high, moderate, low and very low WRAPS. With the steep slopes and clayey nature of the soils the flood runoff rate will be very high representing a WRAP Soil index of 5 based on the definition of the soil groups (FSR 1975 and ADAS 1980).

11.3.1.2 Watercourses Crossings

There are 5 small surface drainage/stream channels to be crossed by the *Proposed Road Development* which are summarised as follows:

1. Tully Stream[78] at Ch 600 Castlegal - Catchment Area 1.53km^2
2. Lugatober Stream[79] at Ch. 1,230 Lugatober – Catchment Area 0.214km^2
3. Lugatober drain at Ch 1,500 – Catchment Area 0.071km^2
4. Collinsford Stream[80] at Ch 1,925 – Catchment Area 0.166km^2
5. Lugnagall Stream[81] at Ch. 2,210 – Catchment Area 0.397km^2

The only stream crossing of a moderate catchment size is the Tully Stream crossing with an upstream catchment area of 1.53km^2 to the proposed crossing and 1.64km^2 to the existing N16 road culvert. All of the other drains/streams to be crossed have very small catchments of c. 7 to 40ha in area.

Table 11-1: Details of Existing N16 Stream Culvert Crossings

Culvert	WC Ref	Chainage (m)	Area (Km2)	EPA Stream name	Existing N16 Culvert Size
1	SC02	600	1.530	Tully Stream	u/s & d/s concrete rectangular 3.1m by 2.6mhigh Middle section 3 m by 2.5m high Arch
2	SC03	1,295	0.214	Lugatober Stream	Twin 300mm pipe culverts To be diverted from Ch. 1,230 to Ch. 1295
3	SC04	1,500	0.071	Lugatober Drain - Collinsford tributary	300mm diameter pipe under existing N16
4	SC05	1,925	0.166	Collinsford Stream	u/s 1m by 1m high Masonry Arch d/s concrete rectangular 1.2m wide by 1.25m high
5	SC06	2,210	0.229	Lugnagall Stream	u/s 1.2m by 0.8 high Masonry Arch d/s concrete rectangular 1.3m wide by 1m high

The design of stream culverts that meet the OPW Section 50 design standards and the TII drainage requirements require a 100 year return period flood flow (this is generally 2 times the annual flood)

78 Alternatively labelled as 'Drumcliff_Glebe' on EPA Maps (https://gis.epa.ie/EPAMaps/);

79 Alternatively labelled as 'Drum_East' on EPA Maps (https://gis.epa.ie/EPAMaps/);

80 Alternatively labelled as 'Collinsford' on EPA Maps (https://gis.epa.ie/EPAMaps/);

81 Alternatively labelled as 'Lugnagall' on EPA Maps (https://gis.epa.ie/EPAMaps/);

plus the inclusion of the statistical error for the estimation method used (IH124 method has factorial error of 1.65) plus Climate Change allowance (mid-range allowance is 1.2). This can represent a combined factor of 3.96 which is almost 4 times the mean annual flood flow.

For smaller catchments less than 0.4km^2 the TII drainage guidelines suggest the use of the ADAS(1980) method which for high SAAR combined with high runoff soils provides a very high estimate of the Flood Flow rates. The recommended design flow for these smaller catchments, (i.e. Collinsford and Lugatober Streams) is to use the mean of the IH124 and ADAS design flow estimates.

Table 11-2: Design Flows using the IH124 flood estimation equation for Proposed Crossings

Culvert	WC Ref	Ch.	Area (km^2)	Annual Rainfall SAAR (mm)	FSR SOIL Index	Annual Flood flow Qbar (cumec)	Design Flood Flow (cumec)
1	SC02	600	1.53	1465	0. 5	3.51	6.88
2	SC03	1295	0.214	1560	0.5	0.66	1.29
3	SC04	1500	0.071	1560	0.5	0.25	0.49
4	SC05	1925	0.166	1570	0.5	0.53	1.03
5	SC06	2210	0.40	1570	0.5	1.15	2.25

Note: 100year growth factor 1.96, Statistical Factorial Error 1.65 and Climate change allowance factor 1.2 have been included in the design flood flows rates above

Table 11-3: Design Flows using the ADAS(1980) flood estimation equation

Culvert	WC Ref	Ch.	Area (km^2)	Annual Rainfall SAAR (mm)	FSR SOIL Index	Time of Conc (hrs)	Median Flood flow Qbar (cumec)	Design Flood Flow (cumec)
1	SC02	600	1.53					
2	SC03	1295	0.214	1560	0.5	3.45	0.86	2.26
3	SC04	1500	0.071	1570	0.5	4.12	0.25	0.66
4	SC05	1925	0.166	1570	0.5	2.59	0.79	2.13
5	SC06	2110	0.40					

Notes: Met Eireann predicted depth-duration-Frequency storm rainfall was used (FSU Web Portal)
Climate change allowance of 1.2 included

Table 11-4: Recommended Design Flow and Minimum culvert Size

Culvert	**WC Ref**	**Ch.**	**Design Flood Flow (cumec)**	**Recommended minimum hydraulic Culvert Size**	**Proposed Culvert Size**
1	SC02	600	6.88	3.3m by 3m buried by 0.5m	IFI requirement Clear Span Crossing.
2	SC03	1295	1.77	1.2m by 1.8m high Box buried by 0.3m	1.2m by 1.8m high Box buried by 0.3m
3	SC04	1500	0.57	1.2m diameter	1.2m diameter
4	SC05	1925	1.58	1.2m by 1.8m high Box buried by 0.3m	1.2m by 1.8m high Box buried by 0.3m
5	SC06	2110	2.25	1.2m by 1.8m high Box buried by 0.5m	1.2m by 1.8m high Box buried by 0.5m

All box culverts are required to achieve a freeboard clearance form culvert soffit to design flood level of at least 0.3m.

11.3.1.3 Watercourses Road Drainage Outfalls

There are 4 proposed road pavement drainage outfalls discharging to watercourses, refer to Table 11-5 for details. The drainage characteristics in terms of low, mean and flood flow are presented in Table 11-6 below. The flood flow is estimated without inclusion of any of the statistical factors (i.e. factorial error of 1.65 and climate change of 1.2) as it is to be used to estimate and set the green field flood runoff rates for the storm water discharges to receiving watercourses.

Table 11-5: Proposed Road Drainage Receiving Watercourses

Outfall	**outfall Chainage (m)**	**WC Ref**	**Stream name**	**Mainline Road Chainage**	**Total Impervious area (ha)**	**Attenuation Provided**
1	0	SC01	Willsborough Stream	0 – 600 M.L. 0 – 70 (SR 02)	0.533	Attenuation Pond
2	600	SC03	Tully Stream	600 – 850 (ML[82])	0.337	Attenuation Pond
3	1925	SC05	Collinsford Stream	845 – 2290 (ML) 0 – 168 (SR 08)	1.451	Attenuation Pond
4	2250	SC07	Lugnagall Stream	2290 – 2525 (ML)	0.183	Attenuation Pond

[82] ML is proposed N16 Mainline

Table 11-6: Flow characteristics of Receiving Watercourses

Outfall	WC Ref	Area (Km^2)	Annual Rainfall (mm)	Mean Flow (l/s)	95-percentile low flow (l/s)	Mean annual flood flow (cumec)	Catchment Greenfield Runoff Rate (l/s per ha)
1	SC01	11.75	1500	372.6	11.8	10.88	9.5
2	SC02	1.53	1465	46.8	1.5	1.77	11.6
3	SC03	0.27	1545	8.9	0.3	0.41	13.9
4	SC06/SC07	0.40	1570	13.6	0.4	0.58	14.2

The Willsborough Stream and Tully Stream are considered to be fishery sensitive both locally at the proposed crossing point and in their upstream and particularly downstream reaches. The smaller drainage channels of the Lugatober, Collinsford and Lugnagall Streams are considered to be fishery sensitive in their downstream reach (refer to Biodiversity Chapter of the EIAR) but less sensitive locally.

The Willsborough Stream Discharges into the Garvogue Estuary which is a designated SAC (Cummeen Strand/Drumcliff SAC) and SPA (Cummeen Strand SPA). The Garvogue Estuary is also a Shellfish Waterbody (EPA Geohieve, 2018). The Willsborough stream is not crossed or encroached directly by the Proposed Road Development but is to be a receiving watercourse for a proposed road storm drainage outfall draining the mainline section from Ch. 0m to Ch. 600m.

The two more northerly catchments of the Tully Stream and the Drumcliff River with its associated tributaries that include the Lugatober, Collinsford and Lugnagall streams discharge into Drumcliff Estuary c. 5km to the west of the Proposed Road Development. The Drumcliff Estuary is a designated European site being part of the Cummeen Strand/Drumcliff SAC and the Drumcliff Bay SPA. It is also a designated Shellfish Waterbody (EPA Geohieve, 2018).

Table 11-7: Proposed Storm water attenuation storage volume, permissible flood discharge rate and for attenuation ponds

Outfall	Location	Required Attenuation Storage (m3) with 20% CC allowance	Water Quality Retention Storage (m3)	Permissible Greenfield Discharge (l/s)
1	Willsborough Stream	203	153	6.9
2	Tully Stream	130	98	4.5
3	Collinsford Stream	535	418	20.4
4	Lugnagall Stream	66	52	2.6

11.3.1.4 Flood Risk Assessment

A flood risk assessment has been undertaken for the *Proposed Road Development*. All proposed culvert structures will be designed with a capacity to pass the estimated 100 year flood flow with appropriate allowances for statistical error and climate change. A minimum freeboard allowance of greater than 0.3m between its soffit level and the design Flood level will be provided at all culverts. Consideration of the following flood flows and flood levels were calculated using a number of methods including IH124, the OPW FSU Web Portal method and the ADAS method and the appropriate design flows adopted. For all of the proposed stream crossings hydraulic flood modelling was carried out to estimate the design flood level and potential impact of the *Proposed Road Development*, details of which are summarised in Table 11-8 below.

To inform the Flood Risk Assessment (FRA) the website floodmaps.ie and the pFRA and CFRAM flood mapping were consulted as initial screening. The CFRAM detailed Flood Risk Assessment Studies carried out for the Sligo AFA does not cover the Road Development Study area and the pFRA mapping which is a coarse flood risk screening resource shows only a narrow band of fluvial Flood risk along the Tully Stream and Willsborough Stream coinciding with its narrow valley and a small pluvial flood risk area downstream of existing N16 road at *Lugnagall*.

Existing flood risk within the study area has fluvial flood risk along the existing N16 road at Lugatober Stream culvert crossing, Collinsford tributary crossing and Lugnagall stream crossing. Significant existing flood risk exists downstream of the N16 road on the Glencar local road (L3404-0) occurring from the Lugnagall Stream due to insufficient culvert sizes at field crossings and at the local Glencar road (L3404-0) crossing. Historical flooding of properties and a dwelling as a result of this stream has been reported in the recent past. Potential for overland sheet flood flow crossing the existing N16 road for the section from *Lugatober* to *Lugnagall* has been identified. The *Proposed Road Development* must not exacerbate flooding at this vulnerable location.

Table 11-8: Predicted Flood Levels and Flood Flows at Each of the Major River Crossings (0.1% Annual Exceedance Probability (1000year return period flood event)

River Name	Chainage (m)	0.1% AEP Flood Flow (m^3/s)	0.1% AEP Flood Level upstream (mOD)
Tully Stream	600	7.48	95.45mOD
Lugtober	1295	1.92	83.71mOD
Lugtober drain	1500	0.62	85.67mOD 92.64mOD upstream of drop manhole
Collinsford	1925	1.72	79.50mOD
Lugnagall	2210	2.45	85.44m OD

0.1%AEP represents the 1000year return period flood event

The *Proposed Road Development* has a beneficial impact on flood risk over the existing section of N16 minimising flood risk to the road without increasing flood Risk elsewhere. This is achieved by providing a modern drainage system including interceptor and toe drains and road pavement drainage with Storm water attenuation and all road culverts design to meet OPW Section 50 capacity requirements which is to accommodate the 100year return period flood plus statistical error and climate change allowance.

11.3.1.5 Surface Water Quality

The EPA carries out water quality assessments of rivers as part of a nationwide monitoring programme. Data is collected from physio-chemical and biological surveys, sampling both river water and the benthic substrate (sediment) in contact with the water.

Water sampling is carried out throughout the year and the main parameters analysed include: conductivity, pH, colour, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand (BOD), ammonia, chloride, ortho-phosphate, oxidised nitrogen and temperature.

Biological surveys are normally carried out between the months of June and October. These examine the relationship between water quality and the relative abundance and composition of the macro-invertebrate communities in the sediment of rivers and streams. The macro-invertebrates include the aquatic stages of insects, shrimps, snails and bivalves, worms and leeches. It is generally found that the greater the diversity of species recorded, the better the water quality is.

The collated information relating the water quality and macro-invertebrate community composition is condensed to a numerical scale of Q-values or Biotic Index. The indices are grouped into four classes based on a river's suitability for beneficial uses such as water abstraction, fishery potential, amenity value, etc. (refer to Table 11-9 below).

Table 11-9: Biological River Water Quality Classification System

Biotic Index (Q value)	Quality Status	Quality Class	Condition
Q5, Q4-5, Q4	Unpolluted	Class A	Satisfactory
Q3-4	Slightly Polluted / Eutrophic	Class B	Transitional
Q3, Q2-3	Moderately Polluted	Class C	Unsatisfactory
Q2, Q1-2, Q1	Seriously Polluted	Class D	Unsatisfactory

The monitored rivers that traverse the *Proposed Road Development* vary in quality from being slightly polluted (Q3-4) to moderately unpolluted (Q2-3).

The EPA river water quality status for the Drumcliff River catchment (Drumcliff_SC_010) is "Good" based on the 2010 to 2015 monitoring period. The Q-rating is measured by the EPA at reference station RS35D040250 (571017, 842018) at *Collinsford* Bridge and at station RS35D040400 (567871, 842190) in the lower reach 500m upstream of the Drumcliff Bridge. For the 2015 sampling result both sites achieved a Q-rating of 4 (unpolluted) and for the previous 2012 sampling 3-4 (slightly polluted) for the upper station and 4 (unpolluted) for the lower station. Both sites assessed are now in satisfactory condition for the first time since 2000. The water quality risk status for Drumcliff catchment is classed as "not at Risk".

The Tully Stream (Cregg_35_010) system is not monitored and is classed as "unassigned" and the risk status is also unassigned. No Q-Rating assessment has been carried out for this small catchment.

The EPA river water quality status for the Willsborough Stream catchment (Willsborough_35_010) is "Good" based on the 2010 to 2015 monitoring period. The Q-rating is measured by the EPA at three reference stations within the catchment located at station RS35W010060 (574378, 839459) in the upper reaches at the bridge south of Glackbaun, and at RS35W010150 (571165, 838311) in the middle reach at the road bridge west of *Willsborough* and at RS35W010300 (569216,837380) in the lower reach at the Sligo-Bundoran (N15) road bridge. All three sites have good status (a Q-rating of 4) for 2015 assessment with slight decline in the upper station near Glackbaun from high to good quality. The water quality risk status for Willsborough catchment is classed as "not at Risk".

The water quality status of the downstream transitional waters of the Drumcliff Estuary and the Garvogue Estuary are classified as unassigned and good respectively. The risk status for these transitional waterbodies is "not at Risk" and "Review" respectively.

11.3.1.6 Surface and groundwater Water Quality Results

Water quality testing of the surface and groundwater quality was carried out on two dates that included 2 surface watercourses, 1 spring, 1 domestic/agricultural supply well and 4 borehole locations as outlined in the following tables.

Table 11-10: Location Water Quality Sampling Points

Reference	**Chainage**	Easting	Northing
Stuart's Well	0	571560	841172
BH206	1040	571780	840771
Tully Stream	580	571469	841132
Collinsford Stream	1960	571750	839980
BH 216	2060	572305	841572
BH 216A	2105	572343	841596
BH 216B	2105	572342	841600
BH 216C	2105	572334	841603
BH 217	2162	572388	841634
Lugnagall spring	2200	572444	841601

Table 11-11: Water Quality laboratory Results of N16 Groundwater and surface water samples

Date	Location	pH	Conductivity µS @20º	suspended solids mg/l	total hardness mg/l CaCO3	sulphate mg/l	zinc mg/l	copper mg/l	iron mg/l	manganese mg/l	DROs mg/l
28-Mar-18	BH206	7.63	411	112	246	<20	0.032	0.008	6.54	0.185	440
28-Mar-18	Tully R	8.28	284	3.4	137	<20	<0.005	<0.001	0.235	0.005	143
28-Mar-18	BH 216A	6.81	731	56.6	401	<20	0.019	0.004	33.3	0.589	45
28-Mar-18	BH 217	7.21	949	36.0	388	<20	0.010	0.002	1.36	0.035	291
28-Mar-18	Lugnagall Sp	7.81	309	4.8	153	<20	<0.005	<0.001	0.119	0.007	57
28-Mar-18	Collinsford St.	8.32	365	5.4	210	<20	<0.005	<0.001	0.028	<0.005	78
06-Jun-18	BH206	7.49	529	66.6	332	34.300	0.011	0.001	1.350	0.202	721
06-Jun-18	Tully R	8.21	269	11.2	142	<20	0.007	<0.001	0.761	0.016	102
06-Jun-18	BH 216A	6.78	710	55	426	<20	0.013	<0.001	15.5	0.657	104
06-Jun-18	BH 217	7.47	637	25.6	316	13.2	0.023	0.005	0.127	0.009	146
06-Jun-18	Lugnagall spring	7.74	316	1.2	169	10.9	<0.005	<0.001	0.016	<0.005	58
06-Jun-18	Collinsford St.	8.49	337	3.4	180	<20	<0.005	<0.001	0.016	<0.005	161
06-Jun-18	Stuart's Well	7.61	105	14	65.1	<20	0.022	0.002	3.71	0.249	187
06-Jun-18	BH216	6.88	810	5.8	467	<20	0.015	<0.001	1.700	1.04	475
06-Jun-18	BH216B	6.81	1033	62.5	686	10.6	0.006	<0.001	19.4	0.944	170
06-Jun-18	BH216C	7.05	859	67.8	520	10.2	0.011	<0.001	0.906	0.055	330

Table 11-12: Water Quality laboratory Results of N16 Groundwater and surface water samples

Date	Location	COD mg/l	BOD mg/l	Ammonia mg/l N	Nitrate mg/l N	Nitrite mg/l N	Total N mg/l N	Phosphate mg/l P	Total P mg/l P
28-Mar-18	BH206	<10	2.5	0.010	0.135	0.003	0.449	0.006	0.012
28-Mar-18	Tully R	34	2.7	<0.010	0.449	0.003	0.504	0.018	0.028
28-Mar-18	BH 216A	11	6.7	0.099	0.011	0.015	1.064	0.004	0.006
28-Mar-18	BH 217	<10	<2.0	<0.010	0.274	0.001	0.413	0.003	0.009
28-Mar-18	Lugnagall Sp	12	2.3	<0.010	0.392	<0.001	0.495	0.004	0.015
28-Mar-18	Scanlans Well	14	2.4	<0.010	0.303	0.001	0.327	0.005	0.007
06-Jun-18	BH206	6.0	<2.0	0.033	0.057	0.003	0.131	0.008	0.120
06-Jun-18	Tully R	70	<2.0	<0.01	0.409	0.009	0.705	0.044	0.071
06-Jun-18	BH 216A	43	3.1	0.937	0.007	0.013	1.072	<0.003	0.010
06-Jun-18	BH 217	29	2.3	0.067	0.346	<0.003	0.535	0.003	0.088
06-Jun-18	Lugnagall spring	12	<2.0	0.019	0.361	<0.003	0.482	<0.003	0.034
06-Jun-18	Scanlans Well	23	<2.0	0.012	0.234	<0.003	0.287	0.005	0.009
06-Jun-18	Collinsford St.	60	2.8	0.138	0.047	0.005	0.862	0.016	0.079
06-Jun-18	BH216	8	<2.0	0.031	0.011	<0.003	0.145	<0.003	0.018
06-Jun-18	BH216B	42	2.4	0.607	<0.001	0.017	0.684	<0.003	0.010
06-Jun-18	BH216C	26	<2.0	0.036	0.014	<0.003	0.274	<0.003	0.007

11.3.2 Hydrogeology

11.3.2.1 Bedrock Geology

Geological maps from the GSI were reviewed to obtain an overview of the bedrock geology traversed by the *Proposed Road Development*. The alignment predominantly transverses over Carboniferous rocks with three rock formations identified which are summarised below in the following table.

Table 11-13: Bedrock Geology Encountered Along Proposed Road

Chainage	Bedrock type	Formation	
0m – 1,050,	Pale grey calcarenite Limestone - Massively bedded	BS	Ballyshannon Limestone Dinantian Pure Bedded Limestones
1,050– 1,120	Sandstone, Siltstone and Shale	MU	Mullaghmore Sandstone Dinantian Sandstoness
1,120 – 2,540	Dark fine grained limestone and calcareous shale range from argillaceous calcisiltites to very fine calcarenites.	GC	Glencar Limestone Dinantian Upper Impure Limestones

11.3.2.2 Aquifer Classification Geology

The GSI has classified geological strata for hydrogeological purposes based on the value of the groundwater resource and the hydrogeological characteristics. There are 3 principal types of aquifer, corresponding to whether they are major, minor or unproductive groundwater resources. These are further subdivided into 10 aquifer categories (DELG/EPA/GSI, 1999) (Table 11-14).

Table 11-14: Aquifer Types

Aquifer Type	Description	Code
Regionally Important (R)	Karstified bedrock dominated by diffuse flow	(Rkd)
	Karstified bedrock dominated by conduit flow	(Rkc)
	Fissured bedrock	(Rf)
	Extensive sand & gravel	(Rg)
Locally Important (L)	Sand and gravel	(Lg)
	Bedrock which is Generally Moderately Productive	(Lm)
	Bedrock which is Moderately Productive only in Local Zones	(Ll)
	Locally important karstified bedrock	(Lk)
Poor (P)	Bedrock which is Generally Unproductive except for Local Zones	(Pl)
	Bedrock which is Generally Unproductive	(Pu)

There are 3 aquifer classes traversed by the *Proposed Road Development* with the majority of the mainline road either lying within a Regionally important karstified conduit flow aquifer to the south within the Rosses Point GWB (Groundwater body), or a Locally Important bedrock aquifer which is moderately productive only in local zones (LI) within the Drumcliff-Strandhill GWB. A very small portion (c. 70m) of the alignment is identified as lying with the Locally Important (LM) bedrock aquifer of the Mullaghmore Sandstones. The aquifer types that are encountered from south to north along the proposed road are summarised in Table 11-15 and Table 11-16.

Table 11-15: Aquifer Types underlain by proposed road alignment

Aquifer Type	**Description**	**Code**
Regionally Important	Karstified bedrock dominated by conduit flow	Rkc
Locally Important	Bedrock which is generally moderately productive Bedrock which is moderately productive only in local zones	Lm Ll

Table 11-16: Location of Aquifer Types along proposed road alignment

Approximate Chainage	Length	Aquifer Type
0m – 1,050	1.05 km	RKc
1,050 – 1,120	0.07 km	LM
1,120 – 2,540	1.32 km	Ll

A summary of the main characteristics is provided by the GSI in its aquifer classification process and this is detailed below in Table 11-17.

Table 11-17: Typical Characteristics for Aquifers in the Study Area

Aquifer property	**Aquifer Type**		
	Rkc	**Lm**	**Ll**
Groundwater Body	Rosses Point GWB located south of Lugotober/Castelgal Ballyshannon Limestones	Rosses Point GWB located south of Lugotober/Castelgal Mullaghmore Sandstones	Drumcliff-Strandhill GWB - Glencar Limestones
Transmissivity	Variable; can range from 1 - 2000m^2/d. Storativity is likely to be in the range of 1 to 2%. Transmissivity are most likely to be higher in the vicinity of fault lines.	Transmissivity is in the order of 100 to 150 m2/d in the sandstones. Transmissivity are most likely to be higher in the vicinity of fault lines. Storativity up to 2% in sandstones.	Variable: expected to be low at 2 to 15 m^2/d in limestones; enhanced zones occurring locally and particularly along fault lines. Storativity low at < 0.5% in limestones.
Productivity	High to moderate	Moderately productivity.	Moderate to low.
Borehole yields	One moderate yielding spring within the GWB at Ballinear House 107m^3/d	High yielding springs or wells None identified.	High yielding springs or wells None identified.
Large springs	None identified	None identified	None identified Small Spring at *Lugnagall* supplying number of households – yield not available
Lithology	Dinantian Pure Bedded Limestones and abundant karst features	Dinantian Sandstones	Dinantian mixed sandstones, Shales, & limestones

Aquifer property	**Aquifer Type**		
	Rkc	**Lm**	**Ll**
Structural geology	Mapped fault line near Castelgal to south of *Lugatober* running SE-NW separating the sandstone from the pure bedded limestone formation	Two fault lines converge near *Castlegal*, to south of *Lugatober*, running SE-NW and E-W separating the sandstone from the pure bedded limestone and impure limestone formations	Mapped E-W fault line separating the sandstone from the impure limestone formation to the north at Castelgal
Surface water groundwater interaction	High degree of interconnection between surface and groundwater. However very few karst features have been identified within the Rosses Point GWB	Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps.	Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the Low permeability of this aquifer it is unlikely that any major surface – ground water interaction occurs and that baseflow to watercourses is likely to be low
Recharge mechanisms	Diffuse recharge from rainfall percolating through permeable subsoil and exposed bedrock. No evidence of significant point source recharge. Minor swallow hole feature identified at *Drumkilsellagh*	Diffuse recharge from rainfall percolating through permeable subsoil and exposed bedrock. Large portion of rainfall on steep hillslopes will runoff as overland flow.	Diffuse recharge from rainfall percolating through permeable subsoil and exposed bedrock. Large portion of rainfall will runoff rather than percolate due to hill slope and poor permeability.
Groundwater Flow/aquifer thickness	Most GW flow in upper epikarst weathered zone typical <3m and the zone of interconnected solutionally enlarged fissures/conduits; generally not extending below 30m	GW within the weathered zone of less than 3m and upper interconnected zone extending to 40m	Most GW flow within upper weathered zone of less than 3m and the zone of interconnected fissures not likely to extend more than 15m
Hydro-chemical Signature	The groundwater has a CaHCO3 signature, with high alkalinity (254, 304 as CaCo3)	The groundwater has a CaHCO3 signature with alkalinity range 186 – 222 as CaCO3 and hardness range 194-232 (moderately hard)	The groundwater has a CaHCO3 signature with alkalinity range 116 – 136 as CaCO3 and hardness range 118-168 (slightly hard)

11.3.2.3 Groundwater Bodies Encountered

Under the Water Framework Directive, the GSI have delineated a number of groundwater bodies (GWB) in Ireland. The Water Framework Directive (WFD) provides for the protection, improvement and sustainable use of waters, including rivers, lakes, coastal waters, estuaries and groundwater within the EU Member States. It aims to prevent deterioration of these water bodies and enhance the status of aquatic ecosystems; promote sustainable water use; reduce pollution; and contribute to the mitigation of floods and droughts. Under the Water Framework Directive large geographical areas of aquifer have been subdivided into smaller groundwater bodies (GWB) in order for them to be effectively managed. There are 2 hydrogeologically defined GWB traversed by the *Proposed Road Development* namely the Rosses Point and Drumcliff-Strandhill GWB's.

According to classification work carried out as part of the Water Framework Directive, the Rosses Point and Drumcliff-Strandhill GWB's are classified as having good groundwater status in terms of quality based on the currently available monitoring period 2010 to 2015. The overall risk status from the Water Framework Basin study is *"Not at Risk"* for the Rosses Point GWB and "*Review*" for the Drumcliff-Strandhill GWB. The objective for these GWB's is to *Maintain* their good status and the

"Review" classification for Drumcliff-Strandhill GWB may indicate potential for future risks to the GWB quality.

For the purpose of this assessment, aquifer characteristics have been considered for each GWB traversed by the *Proposed Road Development*. The descriptions have been taken from the GSI 'Summary of Initial Characterisation' draft reports for each hydrogeologically defined groundwater body. Site specific data including depth to bedrock and subsoil type, collated during the work for this road development has been used to supplement and validate the general information.

11.3.2.4 Groundwater Aquifer Vulnerability

The risk to groundwater is defined through assessments of groundwater vulnerability, aquifer potential and source protection areas. Groundwater vulnerability represents the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. It depends on the travel time of infiltrating water (and contaminants), the amount of contaminants that can reach groundwater and the contaminant attenuating capacity of the geological materials through which the water and contaminants infiltrate. The final groundwater vulnerability rating is determined by both the thickness of the unsaturated subsoil which the contaminants move through and the attributes of the overlying subsoil and more specifically the subsoil permeability (DELG/EPA/GSI, 1999). The nature of groundwater recharge (point or diffuse) and how readily water is received also influences the final vulnerably rating of an area. Areas where water (and contaminants) can quickly move from the land surface to groundwater are deemed to be more vulnerable and in that regard groundwater vulnerability is primarily dependant on the permeability and depth of the overburden.

The GSI guidelines given in their Groundwater Protection Schemes (DELG/EPA/GSI, 1999) can be combined with site investigation data (geological and hydrogeological characteristics) to obtain appropriate vulnerability ratings for the ground along the *Proposed Road Development*. Four groundwater vulnerability categories are defined: extreme (E), high (H), moderate (M) and low (L). A subset of the 'extreme' category is termed the 'X – extreme' category, and relates to areas of bedrock outcrop or subcrop (<1m), or within 30m of a location of point recharge (i.e. karst feature). Table 11-18 outlines the geological and hydrogeological characteristics which determine the vulnerability of an area.

Table 11-18: Groundwater Vulnerability Mapping Guidelines

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(< 30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	n/a
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
n/a = not applicable. Precise permeability values cannot be given at present. Release point of contaminants is assumed to be 1-2m below ground surface.					

The GSI mapping indicates the vulnerability of the groundwater closest to the ground surface from contaminants assumed to be released 1m to 2m below the ground surface. Vulnerability mapping is used for guidance only and should be supported by site investigation data and contaminant specific assessments where appropriate. In this regard a detailed programme of ground investigations has been undertaken along the *Proposed Road Development* allowing the site specific vulnerability to be determined. In unsaturated bedrock aquifers the target for protection is the groundwater table within the bedrock unit, and for saturated aquifers it is the top of the bedrock.

In karst areas groundwater is particularly vulnerable to contamination with an extreme rating as:

- Water ingress can be rapid through solution enlarged fissures;
- Sinking streams enable direct entry of water with little or no attenuation of contaminants;
- Karst features such as dolines can provide direct water entry routes through vertical shafts;
- Soil cover over karst limestone tends to be minimal or absent and so provides little or no protection (GSI, 2002).

The vulnerability mapping for Sligo is available from the GSI website and GIS datasets. Based on this mapping the *Proposed Road Development* traverses the vulnerability ratings of extreme over its entire 2.54km length.

The ground investigation survey completed to date allows a site specific assessment of groundwater vulnerability to be undertaken along the *Proposed Road Development* in accordance with Table 11-18 above. The resulting vulnerabilities are presented in Table 11-19.

The Trial pit information only confirms that bedrock was not encountered above the base depth of the trial pit. The Shell and auger bore-holes were carried out to a set depth or refusal by an obstruction. This obstruction may indicate bedrock or a boulder within the overburden. Only the rotary cores confirm the depth to Bedrock and degree of weathering / fissuring within the bedrock to a specified depth.

Table 11-19: Vulnerability Mapping Along the Proposed Road Development[83]

Chainage (m)	GI Reference	depth to bedrock (m)	Ground level (m aOD)	Vulnerability (Rating)
0	TP101	>2.65	79.72	Extreme
190	TP103	>3.7	85.15	High
280	TP104	>4.3	87.06	High
390	BH202	4	92.61	High
490	TP105	>4.4	95.39	High
590	BH203	3.5	95.53	High
615	TP106	>3.9	94.98	High
680	TP107	>3.8	97.76	High

[83] Note TP is trial pit, BH is shell and auger and RC is Rotary Core through bedrock. Shell and auger holes which stop at refusal may not necessarily reflect the rock head as it may be a small boulder in the overburden and therefore the vulnerability rating is provisional / potential.

Chainage (m)	GI Reference	depth to bedrock (m)	Ground level (m aOD)	Vulnerability (Rating)
840	BH204	3	103.66	Extreme
880	TP110	>3.6	103.1	High
935	BH205 / RC205	4.25	107.63	High
960	BH207/RC207	3.8	107.9	High
1040	BH206 / RC206	2.8	116.4	Extreme
1184	TP121	>3.3	90.68	High
1200	BH209	6.4	80.74	Moderate
1250	TP111	>4.5	79.3	Moderate-High
1305	BH210	5.3	86.94	Moderate
1425	TP112	>4.25	92.18	High
1505	BH211	3.5	88.79	High
1615	BH212	4	85.09	High
1715	TP116	>4.2	83.54	High
1822	TP117	>4.5	79.58	High
1950	BH215	4	84.36	High
2060	BH216/RC216	11.5	90.87	Low
2080	TP118	>4.4	78.9	Moderate-High
2105	BH216A/RC216A	7.3	89.77	Moderate
2162	BH217/RC217	8.6	83.73	Moderate
2200	BH208	3.55	80.44	High
2240	BH219B	4.7	82.82	High
2270	BH218/RC218	9	86.54	Moderate
2360	TP114	>4.5	86.7	Moderate-High

Generally the road alignment passes through a till of low permeability

11.3.2.5 Groundwater Levels at Proposed deep Road Cut Sections

During the GI, water strikes and presence of groundwater in the Boreholes and trial holes at the time of excavation were recorded included in the GI Logs (reference). These are presented in Table 11-20 for the Mainline.

Table 11-20: Summary of GI Findings in respect to groundwater strike and level[84]

Chainage	GI Reference	Ground Level (m OD)	depth to bedrock m	Depth to Groundwater (m)	GSI Aquifer
0	TP101	79.72	>2.65	dry	Rkc
190	TP103	85.15	>3.7	dry	Rkc
280	TP104	87.06	>4.3	W.S.3.2 to 3.8	Rkc
390	BH202	92.61	4	dry	Rkc
490	TP105	95.39	>4.4	W.S. 4.1	Rkc
590	BH203	95.53	3.5	dry	Rkc
615	TP106	94.98	>3.9	W.S. 3.2	Rkc
680	TP107	97.76	>3.8	W.S. 3.65	Rkc
840	BH204	103.66	3	dry	Rkc
880	TP110	103.1	>3.6	none	Rkc
935	BH205 / RC205	107.63	4.25	dry	Rkc
960	BH207/RC207	107.9	3.8	4 to 4.25	Rkc
1040	BH206 / RC206	116.4	2.8	dry	Rkc
950	BH/RC300 to 20m	117.20	>4.5	Water Table at 10.4m	Ll
1025	BH/RC301 to 20m	122.0	>4.4	Water Table at 10.6m	Ll
1184	TP121	90.68	>3.3	W.S. at 1.1 & 2.2	Ll
1200	BH209	80.74	6.4	dry	Ll
1250	TP111	79.3	>4.5	W.S. 2.2	Ll
1305	BH210	86.94	5.3	dry	Ll
1425	TP112	92.18	>4.25	W.S. 3.3	Ll
1505	BH211	88.79	3.5	dry	Ll
1615	BH212	85.09	4	dry	Ll
1715	TP116	83.54	>4.2	none	Ll
1822	TP117	79.58	>4.5	none	Ll
1950	BH215	84.36	4	dry	Ll
2059	BH216	90.87	11.5	GW 6 to 7	Ll
2080	TP118	78.9	>4.4	none	Ll
2105	BH216A/RC216A	89.77	7.3	W.S. 6	Ll
2162	BH217/RC217	83.73	8.6	W.S. 3 & GW 7.6	Ll

[84] W.S. -water strike, G.W. groundwater level

Chainage	GI Reference	Ground Level (m OD)	depth to bedrock m	Depth to Groundwater (m)	GSI Aquifer
2200	BH208	80.44	3.55	dry	LI
2240	BH219B	82.82	4.7	dry	LI
2270	BH218/RC218	86.54	9	W.S. 2.6 & 11	LI
2360	TP114	86.7	>4.5	none	LI

At the two deeper cut sections standpipes and piezometers were installed and monitoring of water levels carried out, refer to Table 11-21 below.

Table 11-21: Groundwater monitoring at the two deep cut sections

Identifier	BH206	BH207	BH216	BH216A	BH216B	BH216C	BH217	BH300	BH301
Coordinates (ITM)	*571778* *840770*	*571703* *840691*	*572303* *841571*	*572342* *841596*	*572334* *841603*	*572341* *841599*	*572387* *841633*	*572334* *841603*	*572387* *841633*
Elevation (m aOD)	*116.515*	*107.999*	*90.782*	*89.816*	*90.115*	*89.631*	*83.774*	*117.2*	*121.5*
Date	Readings (metres below ground level)								
Thu, 22 March, 2018			8.93	4.63			3.15		
Fri, 23 March, 2018	10.00	15.38	8.87	4.65			3.04		
Mon, 26 March, 2018	10.06	15.41	8.94	4.50			3.10		
Tue, 27 March, 2018	9.84	15.45	8.86	4.39			2.98		
Thu, 29 March, 2018	10.06	15.36	8.79	4.14			2.97		
Tue, 03 April, 2018	9.93	15.43	8.74	4.30			3.05		
Tue, 10 April, 2018	9.61	15.41	8.81	3.57			2.78		
Thu, 12 April, 2018			8.79	3.60			2.93		
Wed, 18 April, 2018	9.38	15.47	8.79	3.52			2.65		
Thu, 26 April, 2018			8.69	3.50			2.77		
Thu, 03 May, 2018			8.48	3.38			2.66		
Tue, 15 May, 2018			8.67	4.00	1.14	1.71	3.00		
Mon, 28 May, 2018				4.14	1.74	2.10			
Tues, 29 May, 2018				4.19	2.00	2.00			
Thurs, 7 June, 2018				4.48	2.48	2.37			
Friday, 16th June 2018	10.92	15.41	8.69	4.75	3.07	2.67	3.19		
Tuesday, 24th July 2018	11.03	15.43	8.90	3.95	2.50	2.35	3.14		
Tuesday, 25th September	10.47	15.44	7.72	2.65	1.10	1.35	2.99		
Thursday, 11th October 2018				2.34	0.61	1.04			

Identifier	BH206	BH207	BH216	BH216A	BH216B	BH216C	BH217	BH300	BH301
Monday, 15th October 2018				2.20	0.68	0.93		10.41	10.40
Tuesday, 16th October 2018								10.27	10.74
Wednesay, 17th October 2018								11.22	10.61
Thursday, 18th October 2018	9.74	15.44							
Mon, 05 November, 2018	8.88	15.46	6.71	2.15	0.57	0.85	2.72	9.91	8.90
Fri, 07 December, 2018	10.11	15.45	7.03	2.16	0.67	0.82	2.79	11.10	10.32
Wed, 09 January, 2019	10.62	15.46	7.43	2.36	1.05	1.21	2.94	12.11	12.28
Median	10.03	15.44	8.77	3.95	1.12	1.53	2.98	10.76	10.51
Max Depth	11.03	15.47	8.94	4.75	3.07	2.67	3.19	12.11	12.28
Min Depth	8.88	15.36	6.71	2.15	0.57	0.82	2.65	9.91	8.90
Depth Range	2.15	0.11	2.23	2.60	2.50	1.85	0.54	2.21	3.38

11.3.2.6 Karst features

A review of the GSI National Karst Database system shows no identified karst features within the Study Area. This karst database is not very extensive and many areas of karst features are not included in the database. Karst Features are indicated to north and east of Glencar Lough, which include a Turlough and a number of springs and a number of caves and swallow hole between the R278 and the R286 to the north of Lough Gill. The bedrock formation for this area particularly the pure limestones in the south and up-gradient to the east, but also the impure muddy formations, have a potential for karstification and the development of conduit flow preferential groundwater pathways to develop. Outcrop and sub-crop areas have been identified in the *Carncash* td area and the hillslopes near *Lugatober* and *Lugnagall*. The OSI historical mapping shows the location of a number of small springs/risings and supply wells throughout the Study area which have been mapped and defined as hydrogeological Features. A walkover visit and the OSI historical mapping reveal little evidence of significant surface karst features present within the Study area except for a local zone of karstification near *Carncash*. There are no major springs, Turlough, swallow-hole or Cave features present. There are a number of small doline features evident from the aerial photography of the area which may represent possible collapse features in the *Doonally* to *Carncash* townlands. A limestone Rock outcropping is identified to the West of *Doonally* townland and some depression features are present there also.

A small Swallow hole depression feature was identified immediately to the north the N16 road at Ch 0m. This feature only drains locally the surrounding land (less than 1 ha). The *Proposed Road Development* involves inclusion of a low retaining wall to avoid the proposed road embankment encroaching this feature.

Plate 11-1: Swallow Hole Feature near intersection of Drum Road and the N16 – north of Ch 0m

The group supply spring source at *Lugnagall* townland are considered to represent potential karst spring features.

11.3.2.7 Groundwater Resources

As previously outlined in this Section 11.3.2.2 the aquifer to Chainage 0 to 1,050m is classified as a regionally Important Karst conduit Flow aquifer Rkc and north of Chainage 1,050m is classified as a Local Important (LM,LI) bedrock aquifer. These aquifers have an importance of Low (local high) in respect to the (LM,LI) aquifer and High (county importance) in respect to the Rkc aquifer.

11.3.2.8 Water abstractions / Groundwater supplies

There are two main sources of water supplying the Sligo City and Environs area, namely Kilsellagh Reservoir and Lough Gill which are surface water abstractions and source protection applies to their immediate upstream catchment and such source protection areas will not be encroached by the *Proposed Road Development*. The Kilsellagh Reservoir is supplied by mountain runoff from the southern slopes of Copes Mountain and the Eastern Slopes of Keelogyboy Mountain and baseflow from groundwater. The Lough Gill Public supply source is remote from the *Proposed Road Development* and is located in a separate catchment and not hydrologically linked to the study area. There is a water treatment plant at Kilsellagh and two plants treating water from Lough Gill, recently upgraded Foxes Den) and the Cairns Hill.

There are no large group water schemes and sources protection areas within proximity to the *Proposed Road Development.* The National Federation of Group Water Schemes database of group water sources identifies the following sources:

- Castletown Group scheme – Spring and Mountain Stream Source (569256, 844308)
- Benbulben Group Scheme – Spring (568278, 844497 and 568256, 844427)
- *Drum East* Group Scheme – Springs (570552, 843244 and 570358, 843089)
- Keelogyboy Group Scheme spring/ Mountain Stream source (577419, 838110) on the south slopes of the Keelogyboy Mountain which drain into Lough Gill

All of these sources are not hydrologically linked to and are located remote from the *Proposed Road Development*. The Castletown, Benbulben and *Drum East* Sources are to the North of the Drumcliff River and supplied from the slopes off the King's Mountain.

Small local household borehole supplies and wells are used to supply a number of individual or locally grouped households and agricultural supplies within the Study Area. Generally, boreholes and sunk wells were found supplying households and small springs and dug wells supplying agriculture supply connections. The importance rating varies from Low for single household supply boreholes / well to Medium for Large Group Water supply. Regional Supply and large commercial abstractions would get an importance rating of High.

11.3.2.9 Groundwater Protection Response for permeable road drainage

The risk to groundwater from road runoff is influenced by a number of factors, namely

- The topsoil and subsoils unsaturated thickness and infiltration rates
- The thickness ,permeability and porosity of the saturated subsoil zone
- The presence of karst and weatered bedrock
- Groundwater Flow mechanism – intergranular or fracture flow.
- Presence of abstraction zones and source protection zones

A Groundwater Protection Response Matrix for use of permeable drains in road schemes is set out in Table A.4 of the TII DN-DNG-03065 standards and the response is based on vulnerability rating, presence of a source protection area and the aquifer category. The proposed N16 road development is not located within a groundwater source protection area. The first 1.05km of road is underlain by Rk Regionally important karst limestone bedrock aquifer of high vulnerability giving a response class of R2(2). The remainder of the road is underlain by a locally Important aquifer of high and moderate vulnerability giving a response class of R2(2) for high vulnerability and R2(1) for moderate vulnerability.

Table 11-22: Groundwater Protection Response Matrix

R2(1)	Acceptable subject to minimum design standards in the TII Publications and to meeting the following requirements : 1. There is a consistent minimum thickness of 1 m unsaturated subsoil, or 2 m in areas of karstified rock (Rk & Lk), beneath the invert level of the drainage system (Note 1). 2. During all stages of design particular attention must be paid to the presence of karst features and additional assessments undertaken if required. If karst features are identified response R2 (3) must be applied as a minimum. 3. During all stages of design particular attention must be paid to receptors (such as; public wells, group schemes, industrial water supply sources and springs) and additional assessments undertaken if required.
R2(2)	Acceptable subject to minimum design standards in the TII Publications, meeting requirements 1, 2 and 3 of above and the following additional requirements: 4. Where the subsoil is classed using BS5930 as; SAND, GRAVEL or SILT (in circumstances where the clay content is <10%) AND/OR is underlain by limestone bedrock, there is a consistent minimum thickness of 2 m unsaturated subsoil beneath the invert level of the drainage system; OR There is a minimum consistent unsaturated thickness 1m of "appropriate material" (Note 3) either natural or man-made beneath the invert level of the point of discharge. 5. Where a gravel aquifer is present, a consistent minimum thickness of 3 m unsaturated subsoil beneath the invert level of the drainage system must be present.
R2(3)	Acceptable subject to minimum design standards in TII Publications, meeting requirements 1, 2, 3, 4 and 5 above and the following additional requirements: 6. The drainage system shall be at least 15m away from karst features that indicate enhanced zones of high bedrock permeability (e.g. swallow holes and dolines (collapse features)).

	7. The site investigation shall pay particular attention to the possibility of instability in these karst areas.

Table 11-23: Identified Local Water supplies within the study area

REF	Source	Location	Townland	Easting/ Northing	Ground elevation m aOD	Comment
GWS_1	Private well Bore Hole Supply	100m SE of Ch. 0m 50m from N16 Tie-in	*Drumkilsellagh*	571568, 841172	80.5	Well located adjacent to existing N16 on northern side and 50m down gradient of the proposed tie in.
GWS_2	Private well. Bore Hole Supply	280m W of Ch. 850m	*Castlegal*	571400, 840590	95	BH 280m supply down gradient of road and 300m down gradient of cutting given the ground investigation information and the distance
GWS_3	Hill slope supply serving multiple properties	350m east of Ch. 1,250m	*Castlegal*	572130, 841010	150	Embankment at existing elevation of 80m
GWS_4	Private well	100m east of Ch. 1,550m	*Lugatober*	572035, 841357	105	Well up-gradient on foot hill to Copes Mountain
GWS_5	Private well	60m east at Ch. 1,710m	*Lugatober*	572065, 841360	95	Well up-gradient on foot hill to Copes Mountain
GWS_6	Small hill slope spring/rising supplying two households	100m southeast of Ch. 2,200m	*Lugnagall*	572410, 841450	115	Small hill slope spring/rising supplying two to three properties on the L34041-0
GWS_7	*Lugnagall* spring supplying multiple properties	25m southeast of Ch. 2,180m	*Lugnagall*	572444, 841604	86m	small spring discharging into a concrete chamber supplying at least 9 properties along the L3404-0

11.3.3 Relevant Designated Sites

The various designated sites in proximity to the Study area are listed as follows:

- Lough Gill SAC and pNHA (001976) to the southeast;
- Crochauns/Keelogyboy Bogs NHA (002435) to the southeast and upstream of the existing and proposed N16 road;
- Sligo Leitrim Uplands SPA (004187);
- Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623) to the North of the study area on the opposite side of the Drumcliff River valley;
- Cummeen Strand / Drumcliff Bay SAC and pNHA (000627) in the coastal and estuarine waters and shoreline area to the west and downstream of the Road;
- Cummeen Strand SPA (004035) to the west;
- Drumcliff Bay SPA (004013) to the west;
- Shellfish Waters within the transitional and coastal zones of Drumcliff Bay and Garvogue Estuary/ Cummeen Strand.

11.3.4 Surface and Groundwater Dependent Habitats

A number of groundwater dependant wetland habitat sites have been identified within the study area which have the potential of being impacted by the *Proposed Road Development*. A summary of the key groundwater dependant wetland habitat identified within the study area are presented in Table 11.23 below.

There are three wetland sites located in close proximity to the *Proposed Road Development* which support the priority Annex I habitats '*Petrifying springs with tufa formation*' [7220] and '*Alkaline fens'* [7230]:

- 'Lugnagall Flush'[85] (Grid Ref. G725416) - Annex I alkaline fen and petrifying spring habitats.
- 'Lugatober North'[86] (KER 02 as per Figure 9.3.2 (Biodiversity) of Volume 3) (Grid Ref: G 722414) – Annex I petrifying springs within wet grassland and woodland.
- 'West of Castlegal'[87] (Lugatober) (KER 05 as per Figure 9.3.1 (Biodiversity) of Volume 3) (Grid Ref. G718409) – Annex I petrifying springs within woodland.

Other sites identified during the Route Selection process and more remote from the Road are the sites at 'South of Collinsford' and ' East of Drum'.

Table 11-24: Summary Description Groundwater Dependent Wetland Sites

Site name	Annex I habitats	Ecological evaluation
Lugnagall Flush – south of road	Small remnants of alkaline fen and petrifying springs	County Ecological Importance and supports two Annex I habitats, the spring area corresponds with the Annex I priority habitat 'Petrifying springs' and the fen area corresponds to the Annex I habitat 'Alkaline fen'. The site also overlaps with Crockaun/ Keelogbuy Bogs NHA.
Town	A main spring on the NE of the site and six additional drainage channels (presumed man-made) which support tufa formation and petrifying spring vegetation.	National Ecological Importance as the main spring is of high quality and the area of petrifying springs/ seepage is relatively extensive.
West of Castlegal	Three petrifying spring/seepage area with small amount of tufa formation within semi-natural woodland	County Ecological Importance as springs are small but are examples of an Annex I priority habitat.
South of Collinsford[88]	Small areas of tufa formation and vegetation with affinity to petrifying springs	County Ecological Importance as has some affinity to the Annex I priority habitat and is associated with a small area of mature wet woodland.
East of Drum[89]	Rich fen and flush vegetation with some affinity to alkaline fen. No petrifying spring vegetation or tufa recorded.	Local (higher value) ecological importance as vegetation has a slight affinity to the Annex I habitat alkaline fen but is not considered to be a good example.

[85] This is Key Ecological Receptor (KER) 01 as defined in Chapter 9 of this EIAR. Location is depicted on Figure 9.3.2 contained within Volume 3 of this EIAR.

[86] This is Key Ecological Receptor (KER) 02 as defined in Chapter 9 of this EIAR. Location is depicted on Figure 9.3.2 contained within Volume 3 of this EIAR.

[87] This is Key Ecological Receptor (KER) 05 as defined in Chapter 9 of this EIAR. Location is depicted on Figure 9.3.1 contained within Volume 3 of this EIAR.

[88] This is Key Ecological Receptor (KER) 03 as defined in Chapter 9 of this EIAR. Location is depicted on Figure 9.3.2 contained within Volume 3 of this EIAR.

[89] This is Key Ecological Receptor (KER) 04 as defined in Chapter 9 of this EIAR. Location is depicted on Figure 9.3.1 contained within Volume 3 of this EIAR.

11.4 Potential Impact Assessment

11.4.1 Introduction

Road projects given their scale and nature have significant potential for causing impact to the surface and groundwater environments both during their construction and during their on-going operation and consequently require careful planning and detailed assessment to ensure the best solution is attained.

The assessment of hydrological impacts from the *Proposed Road Development* has been based on the analysis and interpretation of the data acquired during the wider N16 Sligo to County Boundary Constraints Study and Route Corridor Selection phases, as well as site specific investigations undertaken as part of the Design, EIAR and NIS, including the ecological study, intrusive site investigation, agricultural survey and hydrological investigations.

The procedure follows guidelines established by the TII/NRA in its '*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes'* and the '*TII/NRA DN-DNG-03065 Road Drainage and the Water Environmen*t'.

11.4.2 Rating of Key Hydrological and hydrogeological Features

Key hydrological attributes identified along the *Proposed Road Development* include:

- European Designated Sites that include Cummeen Strand / Drumcliff Bay SAC and pNHA (000627), Cummeen Strand SPA (004035) and Drumcliff Bay SPA (004013) in the coastal and estuarine waters and shoreline area to the west and downstream of the Road.
- Shellfish Waters within the transitional and coastal zones of Drumcliff Bay and Cummeen Strand/ Garavoge Estuary.
- Crochauns/Keelogyboy Bogs NHA (002435) to the southeast and upstream of the existing and proposed N16 road;
- Ecologically sensitive surface water features and catchment systems including fishery streams either locally or downstream, Fens, flushes and wetlands including petrifying springs and tufa habitat.

Key hydrogeological attributes that have been considered along the *Proposed Road Development* include:

- High yielding springs and wells used for groundwater supply and their surrounding Source Protection Zones (SPZs);
- Low-yielding wells used mainly for domestic and farm water supply; and
- Any significant natural hydrogeological features (including large springs or groundwater dependent habitats);
- The dominant hydrogeological characteristics (aquifer classification) of the underlying strata;
- Sensitive karst features and groundwater systems.

The individual importance of these attributes has been then assessed with respect to their quality, extent / scale and rarity (Table 11-25).

Table 11-25: Criteria for Rating Site Attributes

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale

Importance	Criteria
Very High	Attribute has a high quality or value on a regional or national scale
High	Attribute has a high quality or value on a local scale
Medium	Attribute has a medium quality or value on a local scale
Low	Attribute has a low quality or value on a local scale

For the purposes of this assessment and particularly with reference to the identified Key Ecological Receptor's and how their importance was rated from the ecological perspective (see the Biodiversity Chapter of this EIAR), the following rating criteria were used in respect to the attribute values :

- Local Importance Lower value - Low;
- Local Importance Higher value – Medium;
- County/ Regionally Important – High;
- National Importance – Very High;
- European Importance – Extremely High.

11.4.3 Rating of Impact Significance

Impacts are categorised as one of 3 types:

- Direct Impact – where the existing hydrological and hydrogeological environments along or in close proximity to the *Proposed Road Development* is altered, in whole or in part, as a consequence of road construction and / or operation.
- Indirect Impact – where the hydrological and hydrogeological environments beyond the proposed road corridor is altered by activities related to road construction and / or operation.
- No Predicted Impact – where the *Proposed Road Development* has neither a negative nor a positive impact on the hydrogeological environment.

The EPA document 'Advice Notes on Current Practice (in the Preparation of Environmental Impact Statements)' further expands the type of the impact with respect to the following criteria:

- Cumulative Impact – where the combination of many minor impacts creates one, larger, more significant impact.
- Potential Impact – the impact of the proposed development before mitigation measures are fully established.
- Worst-case Impact – the impact of the proposed development should mitigation measures substantially fail to fulfil their intended function.
- Residual Impact – the final or designed impact which results after the proposed mitigation measures have fully established.

An appraisal on the duration of the impact can be made over the construction and operation phases of the road development:

- Temporary – construction-related and lasting less than one year
- Short-term – lasting 1 to 7 years
- Medium-term – lasting between 7 to 15 years
- Long-term – lasting 15 to 60 years
- Permanent – lasting over 60 years

The TII/NRA guidelines also define the impact significance level relative to the attribute importance (Table 11-26).

Table 11-26: Criteria for Rating Impact Significance

Impact Level	Attribute Importance				
	Extremely High	**Very High**	**High**	**Medium**	**Low**
Profound	Any permanent impact on attribute	Permanent impact on significant proportion of attribute			
Significant	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute		
Moderate	Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute	
Slight		Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute
Imperceptible			Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute

The magnitude of impacts is defined in accordance with the criteria provided in the EPA publication '*Guidelines on the information to be contained in Environmental Impact Assessment Reports*' (Table 11-27).

Table 11-27: Rating of Significant Environmental Impacts

Importance of Attribute	Magnitude of Impact			
	Negligible	**Small**	**Moderate**	**Large**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
High	Imperceptible	Moderate / Slight	Significant / Moderate	Severe /Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

The TII/NRA criteria for rating impact significance have been used to assess actual and potential changes to hydrological and hydrogeological criteria (Table 9.26 and 9.27).

Table 11-28: Estimation of Magnitude of Impact on Hydrological Attributes

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and / or quality and integrity of attribute	Loss or extensive change to a waterbody or water dependent habitat Impact on Flood magnitude (e.g. >100mm) and frequency causing significant increase in flood risk to lands and property Extensive Loss of Fishery or extensive reduction in amenity area Potential high risk of serious pollution to Sensitive Watercourses from routine road run-off Calculated risk of serious pollution incident >2% annually
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Moderate Loss or change to a waterbody or water dependent habitat Impact on Flood magnitude of > 50mm and frequency causing moderate increase in flood risk to lands and property Partial Loss of Fishery or partial reduction in amenity area Potential medium risk of pollution to Sensitive Watercourses from routine road run-off Calculated risk of serious pollution incident >1% annually
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	minor Loss or change to a waterbody or water dependent habitat Impact on Flood magnitude of > 10mm and frequency causing moderate increase in flood risk to lands and property Minor Loss of Fishery or slight reduction in amenity area Potential low risk of pollution to Sensitive Watercourses from routine road run-off Calculated risk of serious pollution incident >0.5% annually
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually No perceptible Impact on Flood magnitude No perceptible impact to fishery or amenity

Table 11-29: Estimation of Magnitude of Impact on Hydrogeology Attributes

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and / or quality and integrity of attribute	Removal of large proportion of aquifer / GWB Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >2% annually
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >1% annually

Magnitude of Impact	Criteria	Typical Examples
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems Potential low risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >0.5% annually
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually

11.4.4 Hydrological Impacts

11.4.4.1 General

Hydrological impacts are impacts to the surface water features, that include overland flow, watercourses, lakes, estuaries and coastal waters, in terms of quantity (flow regime changes) and quality (water quality changes) from both the construction and operational phases of the road project.

The operational and constructional impacts are discussed below:

Operational Impacts

- Permanent interference with river, streams and floodplains at bridge and culvert road crossing points. These structures can, if not appropriately designed create an obstacle to flow, particularly under flood conditions resulting in increased flood risk and damage as a result of afflux by such structures. Such structures can locally alter bed levels and channel dimension resulting in changes in flow velocity and water depth which can during low flow periods represent a barrier to fish passage. These structures can result in localised bed and bank erosion resulting in changes to the morphology of the stream channel and downstream deposition.
- Removal of flood storage as a result of the road footprint encroaching on the floodplain area. This can result in slight to moderate reduction in the flood attenuating function of a floodplain. No significant floodplains are encroached by the *Proposed Road Development*.
- Potential diversion of water between drainage catchments and sub-catchments as a result of the road alignment and associated road drainage design (cut-off and interceptor drains) and outfalls. At some locations, the creation of the proposed road perpendicular to the natural drainage path may lead to the interception of overland flow into the road drainage system (surface drainage or toe drainage / cut off drains) that will convey it to the nearest associated outfall. This may lead in some cases to permanent diversion of flow resulting in an increase in the rate and volume of flow in one watercourse and a corresponding reduction in the other, with potential implications for flood risk and water quality/ dilution.
- Interference with local drainage, relocation, discontinuation and combination of existing land drains as a result of the road footprint and its associated drainage system including toe drains and attenuation/detention drainage ponds. This can lead to local changes in the hydrological regime and can lead to a concentration of flows where a number of smaller drains are discontinued / diverted. This can lead potentially to a deterioration of the hydraulic capacity and exacerbation of flood risk. In the event of realignment of watercourses this will effectively remove a section of channel reach including its channel and bank-side ecology.
- Increased runoff to watercourses at proposed storm outfalls due to the road pavement (impervious area), reduced transmission time and increased point loading associated with the

road and drainage system. This can, particularly in the smaller receiving watercourses/drains, lead to increased flood flow magnitudes and increased frequency of flooding.

- Water quality impact on receiving watercourses at storm outfalls from routine road runoff (generally sediment associated contaminants, heavy metals, hydrocarbons and suspended solids, de-icing agents (salt and grit) and to a lesser extent nutrients, organics, and coliforms). A wide range of heavy metals are known to occur in road drainage waters, the primary metals of concern are cadmium (Cb), Lead (Pb), copper (Cu) and Zinc(ZU). All of these metals are included in the EU substances Directive (76/464/EEC), the EU Directive on Pollution Caused by Certain Dangerous Substances (2006/11/EC), the EU Water Framework Directive (2000/60/EC) and the proposed EU priority Contaminating Substances Directive.
- The road drainage and associated storm outfalls provide a direct pathway for contaminant from accidental spillages associated with HGV's (agricultural, oil/chemical spillages, bulk liquid, cement, etc.) to gain rapid un-attenuated access to receiving watercourses.
- Salt and grit applications to road surfaces to mitigate icy conditions, will result in an increased salinity, pH, conductivity and total dissolved solids concentrations to receiving aquatic system. Increased salinity of watercourses can alter the ecological balance of the aquatic system and increase the bioavailability of chemical contaminants.

Constructional Impacts

- Construction activities pose a significant risk to watercourses particularly contaminated surface water runoff from construction activities entering nearby watercourses.
- Construction activities within and alongside surface waters associated with bridge and culvert construction, outfalls and channel diversions can contribute to the deterioration of water quality and can physically alter the stream/river bed and bank morphology with the potential to alter erosion and deposition rates locally and downstream. Activities within or close to the watercourse channels can lead to increased turbidity through re-suspension of bed sediments and release of new sediments from earthworks. Consequently instream works can potentially represent a severe disruption to aquatic ecology.

The main contaminants arising from construction runoff include:

- Elevated silt/sediment loading in the construction site runoff. Elevated silt loading can lead to long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish. Increased silt load in receiving watercourses stunts aquatic plant growth, limits dissolved oxygen capacity and overall reduces the ecological quality with the most critical period associated with low stream flow conditions. Chemical contaminants in the watercourse can bind to silt which can lead to increased bioavailability of these contaminants.
- Spillage of concrete, grout and other cement based products. These cement based products are highly alkaline (releasing fine highly alkaline silt) and extremely corrosive and can result in significant impact to watercourses altering the pH, smothering the stream bed and physically damaging fish through burning and clogging by the fine silt of gills.
- Accidental Spillage of hydrocarbons from construction plant and at Storage depots / construction compounds.

11.4.4.2 Do Nothing Impacts

In the event of the *Proposed Road Development* not being constructed there would be no resulting impacts on the hydrology along the route of the *Proposed Road Development*. The traffic will remain on the existing N16 road network, which is generally over the edge drainage and does not include a sustainable urban drainage system to protect surface and groundwater bodies from pollution and flood runoff.

11.4.4.3 Road Drainage Design Objectives

The proposed road Drainage design is to separate and collect in a sealed drainage system road runoff from the pavement of the 2.65km of N16 road development and discharge to receiving watercourses at four outfall locations. There is no proposed discharge of road drainage to groundwater. The principal objective of the proposed road drainage system is the speedy removal of surface water from the road pavement, provision of effective sub-surface drainage to maximise pavement longevity and associated earthworks and minimise the impact of runoff discharges on the receiving water environment in terms of flooding and water quality. This is achieved by:

- the maintenance of existing surface drainage catchments through provision of interceptor drains and culverting under the road footprint, insofar as is reasonably practicable;
- the separation of intercepted land drainage water from the road pavement waters;
- Provision on storm water attenuation and water quality treatment facilities upstream of all proposed road drainage outfalls.

The water treatment facilities provided upstream of the proposed road drainage outfalls include a petrol/oil Interceptor and a retention pond designed to capture the first flush rainfall event in accordance with TII DN-DNG03066 standard and CIRIA C697 treatment volume calculation approach.

The storm attenuation is included in the same Pond and is designed to provide 100year attenuation storage plus 20% climate change and the outflow controlled by a flow control device discharging to the estimated greenfield flood runoff rate, refer to Table 11-7.

11.4.4.4 Road Culvert Crossings

Table 11-4 as already outlined, presents a summary of the five proposed culvert crossings including upstream contributing catchment area including the proposed culvert sizes. All of the streams intercepted are minor having small upland catchment areas and the recommended barrel dimension size provided is generally an increase over existing structures and stream channel dimensions and will not result in any significant contraction of the stream flow velocity or creation of upstream afflux. The OPW Section 50 assessment shows that all proposed culverts provided are suitably sized to prevent any potential flood impacts both under present day statistics and in the short to medium term climate change conditions both locally upstream and downstream.

These structures can also have a negative impact on the flow regime in watercourses particularly those with fishery potential as often the wider dimension or increased channel gradients can locally result in insufficient water depth during mean and low flow conditions and such structures if not appropriately designed can lead to undesirable changes in channel morphology and thus potentially impact fish migration and sedimentation. The construction of these structures in watercourses, if not carefully managed, can lead to pollution of the watercourse both locally and in its downstream reaches through the potential for spillages from construction plant and equipment and potential release of cement based products, wood preservative from roadway timber fencing and the disturbance of bed and channel banks resulting in suspended sediment releases.

Without appropriate design measures the potential operational impact on hydrology and channel morphology is classified as slight for Local Low fishery watercourses and moderate for Local High watercourses. This is based on the fact that most of the streams to be culverted are classified as locally higher value for fish in their downstream reaches. It is noted that all of the watercourses are valued as having Local High ecological value.

The potential constructional impacts without mitigation through potential release of sediments by disturbance of the channel bed and bank represent a short term local moderate to significant impact on water quality and bed sediment deposition rates that could impact fishery habitat potential of the downstream reach. As a result all construction works are to be carried out in accordance with OPW, EPA and IFI guidelines at appropriate times of the year and are to implement all necessary measures to limit the potential impact of the works on all stream/river ecology.

11.4.4.5 Diversions and Realignments

The construction of watercourse crossings for the *Proposed Road Development* will necessitate in some cases the localised diversion/realignment of the existing watercourse/drain. The proposed diversion/realignment are often associated with reducing the required length of culvert so as to align almost perpendicular to the road alignment, avoiding culvert crossings at proposed cut-sections of road or rationalising the number of drainage runs and culvert crossings required.

Where feasible, these minor watercourse diversions/realignments will be carried out in the dry and only when the channel has been established, the watercourse will be diverted into them. The principal impact on a watercourse by a diversion is the change in the watercourse morphology. The general potential impacts can be:

- Slacker gradients: Slower flow velocities with resulting increased flow area and deposition, siltation promoting vegetation and weeds to grow in channels during periods of low flow;
- Steeper gradients: Faster flow velocities, increased local bed erosion, shallower low flow depth;
- Sharp bends and change in direction: Erosion and deposition with subsequent changes to the river channel morphology;
- Lack of natural flood plains: Increase in upstream flood levels;
- Other potential impacts of watercourse diversions include:
    - Change to natural low flow channels: Impact on fisheries and other animals
    - Change to existing foliage and vegetation: Impact on fisheries and other species (otters, badgers etc.)

No regrading or diversion on the Tully Stream is proposed which is the only watercourse that is fishery sensitive locally, whereas all the other crossings are of minor streams and drains that discharge to fishery sensitive watercourse reaches downstream. The Tully Stream will involve the provision of a wide clear span structure (in accordance with IFI requirements) to avoid realignment of the channel at the crossing. All of the other small watercourses crossed by the *Proposed Road Development* will involve some realignment. None of these realignments/diversions represent a transfer of stream flow between basins and are only local realignments to facilitate the *Proposed Road Development*.

The largest diversion will take place on the Lugatober Stream where the crossing will be diverted northwards from Ch 1225 to 1,295 to avoid a high embankment section requiring a large culvert length. The diverted stream will be returned southwest along the embankment toe to the existing drainage channel downstream of the road. This represents a localised impact only within the land-take of the road development and has little effect on the hydrological regime either upstream or downstream of the road development.

The principal impact of these channel realignments is associated with the construction stage and the potential for soil erosion associated with the initial excavation works and the initial establishment of the flow channel. This soil erosion may give rise to potential water quality impacts and sedimentation downstream in the receiving waters, most of which are salmonid and of a local higher ecological value in their lower reaches. Therefore, in the unmitigated case, the potential impact of the constructional phase on the salmonid potential downstream reaches with locally higher ecological value will represent a temporary moderate water quality impact with potential for temporary elevated suspended solids concentrations and potential for short-term sediment deposition.

The operational impact of the proposed watercourse realignments/diversions will be very localised to morphology changes in the stream/drain channel during large floods and which will quickly stabilise over time. The potential impact is rated to be a locally minor impact which can be further minimised through engineering design (trapezoidal channel with 45degree side slopes of the channel and transitions including provision of culvert headwalls and armoured bed and channel banks at such transitions.

11.4.4.6 Road Drainage Outfalls

Flow regime impacts

The proposed drainage outfall discharges to surface watercourses represent point discharges. Therefore, locally, the discharges will change the flow rate, the flow depth and velocity in the receiving watercourse and generally cause an increase locally. There will be no significant transfer of drainage runoff between streams/drains due to the *Proposed Road Development* whose drainage design is sympathetic to the natural topography and catchment areas. The road pavement drainage can increase the rate and volume of flood runoff and cause potential flooding and scouring of the receiving watercourse locally. The design includes the provision of attenuation ponds and flow control to restrict the outfall discharge to a more natural greenfield flood runoff rate, thereby avoiding potential moderate to significant impacts to channel morphology and flow regime at the local scale.

Water quality impacts

The proposed road drainage system and outfalls provides a pathway for pollution from the road development to enter a watercourse at the proposed drainage outfall either as first flush drainage discharges or routine road runoff or from a serious accidental spillage by a HGV.

Accidental Spillages

During the operational phase of the *Proposed Road Development*, the risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV is an issue to be considered. Trying to predict the occurrence of a spill with any degree of certainty is difficult. The risk is influenced by the type of roadway, length of road, the traffic volume, and proportion and type of heavy goods vehicles (HGV's), design speed and visibility. A spillage risk assessment of the *Proposed Road Development* has been carried out in accordance with the TII publications document DN-DNG-03065 (HD45) – see Table 11-30.

The spillage assessment shows the *Proposed Road Development* will have a very low magnitude of risk for individual outfalls or grouped catchment outfalls, and as such specific mitigation measures to lower this risk are not required under the TII publications road design standards.

The overall combined probability of a serious HGV spillage entering a watercourse from the *Proposed Road Development* is low at 0.016%. This spillage risk analysis was based on the medium growth AADT Traffic figures, presented in Chapter 4 of this EIAR, which indicates that HGV numbers are only 6% of the AADT number. The design year AADT number used in the analysis is obtained from Table 4-5 and vary for the mainline from circa 3,500 to circa 4,400 in a forecast year of 2051.

Notwithstanding the very low spillage risk for this *Proposed Road Development*, all storm outfalls will include pollution control facilities at their outfalls. All of the mainline drainage network outflows will pass through a suitably sized oil and petrol interceptor and then through a constructed wetland with a permanent pond volume and the attenuation volume provided above the permanent pond level prior to discharging through its outfall to the receiving watercourse. A penstock or similar online control restriction will be installed upstream of the petrol interceptor. In the event of a serious spill these controls can be put in place to block the outflow of contaminants allowing time for clean up to take place.

Table 11-30: Serious Spillage Pollution Risk Assessment at Proposed Outfalls to Surface Watercourses

Drainage Reference	Approx. Chainage	Watercourse	Outfall Risk (%)
S1	0m - 0,600	Willsborough Stream	0.0066
S2	600 - 1,000	Tully Stream	0.0013
S3	1,000 - 1,475	Collinsford Stream	0.0073
S4	1,475 - 1,900	Lugnagall Stream	0.0008

Routine Road Runoff

Research has found that a broad band of potential pollutants are associated with routine runoff from road schemes arising from road traffic and road maintenance. These contaminants are generally associated with the particulate phase and are principally heavy metals, hydrocarbons and suspended solids and de-icing agents (salt and grit) and to a lesser extent nutrients, organics and faecal contamination. In terms of the potential impact to receiving watercourses research has found the first flush runoff (10 to 15mm rainfall runoff following an extended dry period) can produce elevated concentrations locally in the receiving waters. The impact of contaminants within routine road runoff depends on the loading (associated with traffic numbers) and the available dilution in the receiving watercourse.

The high density of outfall discharge points along the mainline of the *Proposed Road Development*, disperses and reduces the potential pollutant point load from the proposed road drainage system. The design traffic volume in conjunction with the relatively small contributing road areas will not give rise to any potential significant hydraulic or pollutant loads on the receiving waters. The potential impact of routine runoff in the absence of storm drainage pollutant removal represents a localised impact on water quality of the receiving environment. The overall loading of heavy metals, sediments, hydrocarbons and other waste products on the receiving waters will be significantly reduced through the provision of various drainage design elements such as, petrol and oils interceptors, filter drains, grassed surface water channels, wetlands, infiltration area and storm attenuation ponds upstream of the outfalls designed to capture and treat the first flush rainfall runoff events.A HAWRAT assessment was carried out to investigate the impact on the receiving water environment from routine road drainage runoff of the proposed N16 road development using the Highways Agency Water Risk Assessment Tool (HAWRAT). HAWRAT was developed using UK datasets and research showed that pollution impacts from routine road runoff is broadly correlated with Annual Daily Traffic numbers. The lowest AADT Road used in the research was 11,000 and the tool provides three AADT bands of 10,000 to 50,000, 50,000 to 100,000 and > 100,000. It should be noted for the subject road the projected design AADT is only 4,400 which represents a lightly trafficked road and well below the thresholds AADTs provided for in HAWRAT. Therefore the loading used in the HAWRAT of 10,000 to 50,000AADTs is on average 7 times higher in terms of AADT's than the N16 design AADT.

The meteorological conditions for N16 Lugotober road section give a SAAR (mean annual rainfall) of approximately 1500mm. The wettest UK site available in HAWRAT is Ardtalnaig with SAAR of 1344mm and climate classification of cold-wet. The majority of the UK sites in HAWRAT have SAARs well lower than 1000mm. The higher annual rainfall reduces the pollutant build up and thus the pollutant concentrations of the first flush events on the receiving waters. The full HAWRAT Assessment is presented in Appendix 10.1 contained within Volume 3 of this EIAR.

The conclusion from the HAWRAT analysis is that the proposed outfall discharges at the four outfalls pass the Method A assessment in respect to the acute and chronic pollutant impact of routine road drainage on the receiving watercourses. Method B assessment of the annual average loading of road drainage pollutants using dissolved copper and zinc as the indicator pollutants predict low concentrations in the receiving streams, indicating that long term impacts of such pollutants on the receiving waters will be minor to insignificant.

The water quality status of the receiving stream, both locally and downstream, will not be impacted negatively as a result of the road drainage discharges. Pre-treatment is provided upstream of each outfall which reduces further any potential impacts during the operational phase of the *Proposed Road Development*.

11.4.4.7 Soil Repository/Borrow Pit

A Borrow Pit to win limestone rock for the road construction is proposed adjacent to the road at Ch 880 to 1,050. This Soil Repository/Borrow Pit is almost 1ha in area, located on upgradient eastern side of the road and will provide approximately 59,000m^3 of road construction material.

The base of the Borrow pit will be excavated to c. 15m and a maximum depth of 17m below existing ground level. Typically the overburden cover is 3 to 5m overlying weathered limestone and a medium to strong bedded limestone at approximately 8- 10m depth below the ground. Water Table levels in two recently cored boreholes (BH300 to BH301) indicate a groundwater table in the bedrock of 10 to 11m below Ground level. Therefore the excavation of 15m to 17m depth will encounter the bedrock groundwater table by as much as 5 to 7m. The GI indicates that the water table level observed is at the base of the weathered bedrock zone and possibly unable to drain due to the more competent less permeable bedrock. Dewatering requirement is unlikely to be significant and drawdown effect is predicted to be very localised to within 15 to 20m of the excavation site. Dewatering may involve pumping out and the dewatered volume will discharged through a settlement ponds prior to discharge overland or to an adjacent drainage/stream channel.

This borrow pit will on completion of excavation be used as a material deposit area to accommodate excess unsuitable road construction material. Its confinement cut walls will contain within the excavation pit any soiled waters from the deposited material until they percolate away to the groundwater table. This avoids the requirement for direct discharge of soiled runoff from the pit to a surface watercourse. On completion this repository will be capped with natural glacial material to depth of 3 to 4m and grassed so that it will, when established behave as a natural grassed greenfield surface.

The material to be deposited in the soil repository/borrow pit will be unsuitable road construction material generated locally with the construction footprint area. This material is a native material, generally comprising the silt and clay and is not considered to represent a contaminated soil. The borrow pit will be excavated into competent limestone bedrock and based on the borehole logs and this competent bedrock will provide good containment for this material with relatively low permeability.

11.4.4.8 Compounds

A single constructional compound area has been identified and included within the landtake for the development . This is located on the western side of the proposed road between ch 460 and 500. The identified area is 0.5ha, and sandwiched between the *Proposed Road Development* and the Existing N16 road which provides a degree of protection to the natural environment.

The compuound site is located on dry land and well setback from watercourses (>70m from the Tully River) and from any local groundwater supplies. It is located outside of any potential high or medium risk flood zone. The lands are sloping southwestward at 5degrees and will require some levelling on the site. The use of this compound site in accordance to the Outline Erosion and Sediment Control Plan will have limited ability to impact on hydrology and hydrogeology.

11.4.5 Hydrogeological Impacts

Hydrogeological impacts are impacts to the groundwater in terms of quantity (flow regime changes) and quality (water quality changes) from both the construction and operational phases of the road project.

11.4.5.1 Road Cut Sections

Cut sections along a road section have the potential to lower the level of the groundwater table in the immediate surrounding area as well as to cause a deterioration in aquifer water quality. The main impact targets will be water supply springs, wells and boreholes as well as any nearby groundwater dependent habitats and karst related features. Typically the impact increases:

- With increased depth of road cutting below groundwater table;
- With increase interception depth of a productive bedrock aquifer or productive sand and gravel layer;
- With increased permeability of the soil and / or bedrock strata between the road cutting and groundwater feature;
- In the absence of any hydrogeological boundaries such as watercourses, between the road cutting and water supply well or groundwater feature.

Road cuttings will increase the vulnerability of the underlying aquifer to pollution through either a complete loss of overburden where cuttings are into the bedrock or by reducing the protective overburden depth and thus increasing the vulnerability for contaminated road drainage if not transmitted in a sealed drainage system to infiltrate to and potentially contaminate the groundwater. Deep cuttings can locally change the GSI risk classification for groundwater resources/aquifers.

A summary of the main cut sections along the proposed development together with the aquifer vulnerability is given in see Table 11-31.

Extensive road cuttings can if not mitigated significantly increase the runoff volume to be conveyed within the road drainage system and the volume to be ultimately discharged to receiving waters at road drainage outfalls. This can have an adverse effect on the receiving waters in terms of chemistry and water balance. Groundwater quality can be indirectly impacted if drainage systems are not adequately designed and maintained, to ensure conveyance of potentially contaminated surface run-off through these areas in sealed drains / channels where fissured/weathered bedrock is exposed and the aquifer is a regionally important karst bedrock aquifer.

Cut sections can impact potential groundwater recharge and cause dewatering of the intercepted aquifer. There is also the potential to intercept and truncate high yielding groundwater flows within the karst aquifer. It is assumed that where deep cut sections are located along the *Proposed Road Development*, there will always be a direct potential temporary impact to the quality of the underlying aquifer during the construction phase and until appropriate measures are in place to prevent infiltration of contaminated site run-off and construction drainage waters. However in terms of the flow regime, there is the potential for a permanent impact on the underlying aquifer which will remain during the operational phase.

Cut sections will reduce the depth of subsoil from particular areas along the *Proposed Road Development*. This will have a localised effect on the groundwater vulnerability rating, as the pathway for potential contaminants to migrate into the underlying aquifer is shortened. Areas where bedrock is at or close to surface will be particularly sensitive.

An assessment in relation to hydrogeological aspects at all significant proposed cut sections as outlined in Table 11-31 is given in Table 11-32.

Table 11-31: Cut Sections along Mainline

Chainage			Average cut depth m	Chainage	Max cut Depth m	Comment
20	to	120	-0.3	80	-0.5	minor cutting within glacial till
500	to	540	-0.8	520	-1.3	minor cutting within glacial till
580	to	1140	-5.5	1040	-12.8	Deep cutting into limestone bedrock
1360	to	1580	-2.0	1400	-3.5	within glacial till
2000	to	2150	-3.1	2070	-4.5	within glacial till
2310	to	2440	-0.8	2340	-1.4	minor cutting within glacial till

Rock Cutting Ch. 580m to Ch 1,100m

At RC206 (Ch 1,040) the groundwater table was typically found to lie at10m below ground level and fluctuated by only 1.65m from March to September 2019. The response zone monitored was from 4 to 12m bgl. The log indicates a slightly weathered medium strong to strong grey limestone. At Borehole RC207 (Ch 960) the depth to the Limestone is 3.8m OD and the driller's log indicates a water strike at a depth of 4.5m. A standpipe was installed for a response zone in the bedrock at 12 to 15m depth and the monitoring indicates that the standpipe readings are the base of the borehole indicating that the groundwater table in the bedrock at this location was not encountered. The log indicates a slightly weathered medium strong to strong grey limestone.

Two rotary cores located in the proposed borrow pit immediately adjacent to this cutting (BH 300 and BH 301) have shown that the groundwater table is at a depth of c. 10 to 12m below ground level and located within the competent moderately strong to strong bedrock zone. This zone is likely to have low transmissivity and storativity properties and thus the potential intercepted groundwater flow / yield from this bedrock cutting and borrow pit will not be significant.

At this road cutting the bedrock will be encountered from approximately Ch 930 to Ch 1,100 and typically the glacial till overburden depth is 3 to 4m such that the proposed cutting will increase the aquifer vulnerability to extreme and the potential dewatering effect will be minor and very localised to the cut face (within 50m worst case).

The other cuttings are superficial and remain in the relatively low permeability glacial till overburden and therefore will have no impact on the underlying regionally or locally important bedrock aquifers and GWBs. Given the low permeability of the soil perched groundwater is located within the overburden and the dewatering effect on these soils by the road cuttings will be very localised and of low yield and easily accommodated in the receiving surface drain.

11.4.5.2 Impact on Aquifer Characteristics

There will be a very limited impact on the nature of the underlying aquifers as the road will normally only cover a very small fraction of a groundwater body. The majority of the *Proposed Road Development* is underlain by a Regionally Important Aquifer (89%) which has an attribute rating of

High importance (County importance). The remaining 59% is underlain by Locally Important Aquifers of medium importance (local high).

A generalised assessment has been made for each aquifer type along the *Proposed Road Development*, based on potential characteristic changes caused by cut and fill sections (Table 11-32).

Table 11-32: Rating of Significant Environmental Impacts on Aquifer Characteristics

Attribute		**Impact**		
Site Name	**Importance**	**Description**	**Magnitude of Impact**	**Impact Rating**
Regionally Important Aquifer Ch 0m to 1,050	High	Localised changes to groundwater levels in aquifer and / or overlying subsoil caused by dewatering at cut sections	Small Adverse	Slight
		Localised changes to down-gradient hydrochemistry in aquifer or overlying subsoil caused by routine surface runoff and spillages	Small Adverse	Slight
		Localised changes to up-gradient groundwater levels and hydrochemistry caused by flow restriction	Small Adverse	Slight
Locally Important Aquifer Ch 1,050 to 2,540	Medium	Localised changes to up-gradient groundwater levels and hydrochemistry caused by flow restriction	Small Adverse	Imperceptible
		Localised changes to groundwater levels in aquifer and / or overlying subsoil caused by dewatering at cut sections	Small Adverse	Imperceptible
		Localised changes to down-gradient hydrochemistry in aquifer or overlying subsoil caused by routine surface runoff and spillages	Small Adverse	Imperceptible

11.4.5.3 Impact on Hydrogeological Features

Very few karst features are encountered along the proposed alignment with a single Swallow-hole feature identified adjacent to the road alignment near Ch. 0m and high weathering and artesian type groundwater conditions at Ch. 2,200. The swallow hole feature will not be encroached and drainage to and from this feature will not be affected.

The small private groundwater sources within 250m of the proposed development have also been summarised in Table 11-33 below. Beyond this distance the impacts of the *Proposed Road Development* are unlikely to be perceptible. The ratings of significant impacts on groundwater resources are given below in Table 11-33. The locations of these supplies are shown in Figure 11.1, contained within volume 3 of this EIAR.

Table 11-33: Rating of Significant Environmental Impacts on Groundwater Resources (See Figure 11.1 contained with volume 3 of this EIAR)

Attribute		**Impact**		
Site	**Importance**	**Description**	**Magnitude**	**Significance**
GWS_1 Private well Bore Hole Supply100m SE of Ch 0m 50m from N16 Tie-in	Low	Well located adjacent to existing N16 on northern side and 50m downgradient of the proposed tie potential construction pollution impact - unmitigated case	moderate adverse	Slight
GWS_2 Private well Bore Hole Supply 280m W of Ch 850m	Low	BH 280m supply downgradient of road and 300m down gradient of cutting given the ground investigation information and the distance	Small adverse	imperceptible
GWS_3 Hill slope supply serving multiple properties 350m east of CH 1,250	Medium	Embankment at existing elevation of 80m	Negligible	imperceptible
GWS_4 Private well 100m east of Ch 1,550	Low	Well up gradient on foot hill to Copes Mountain	Negligible	imperceptible
GWS_5 Private well 60m east at CH 1,710	Low	Well up gradient on foot hill to Copes Mountain	Negligible	imperceptible
GWS_6 Small hill slope spring/rising supplying two households100m southeast of CH 2,200	Low	Small hill slope spring/rising supplying two to three properties on the L34041-0	Negligible	imperceptible
GWS_7 Lugnagall spring supplying multiple properties25m southeast of CH 2,180	Medium	Small spring discharging into a concrete chamber supplying at least 9 properties along the L3404-0- road development located down gradient no predicted impact	Negligible	Imperceptible

11.4.5.4 Impact on Designated Sites

Table 11-34: Impact Rating on Designated Sites

Site	**Description**	**Impact magnitude**	**Impact Significance**
Lough Gill SAC and pNHA (001976)	This SAC is not hydrologically linked to the Road Development	No Impact	Neutral
Cummeen Strand / Drumcliff Bay SAC and pNHA (000627) Drumcliff Bay SPA (004013) and Cummeen Strand SPA (004035)	This European Site is located down-gradient in the coastal and estuarine waters. The Proposed Road Development has potential to cause an indirect impact to these sites from construction and operation phase pollution.	The scale of the road development of a 2.54km length relative to the overall drainage catchment supplying these sites is very minor and further buffered by the separation distance of 4 to 5km. Given that construction works are short term the unmitigated potential impact represents a Small adverse impact magnitude Operation Phase: The separation distance downstream and the proposed drainage treatment of the road development over the existing “do nothing Scenario” represents a small positive impact magnitude	Slight adverse Slight beneficial
Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623)	This SAC is not hydrologically linked to the Road Development	No Impact	Neutral

Site	Description	Impact magnitude	Impact Significance
Sligo Leitrim Uplands SPA (004187)	This SAC is not hydrologically linked to the Road Development	No Impact	Neutral
Crochauns/Keelogyboy Bogs NHA (002435) to the southeast and upstream of the existing and proposed N16 road	The road development is down gradient and only at Lugnagall is the development immediately adjacent to the NHA.	The road development and its drainage treatment will have a negligible impact magnitude on this NHA.	imperceptible

11.4.5.5 Impact on Annex I wetland habitats

Table 11-35: Potential impacts to Lugnagall Flush from Proposed Road Development

Potential impact	Impact details	Design measures to avoid impacts	impact Significance
The Lugnagall Flush ecological site represents a petrifying spring with small area of tufa formation and a small area of alkaline Fen both located slightly up-gradient of the existing and Proposed Road Development on lands that have significantly been interfered with by filling, a group water supply and land reclamation works at Ch. 2,200.			
Construction impacts			
Hydrological regime Impacts (Flows and water levels)	Construction works will involve the replacement of the existing N16 culvert and the provision of an open drain along the toe of the road embankment on the southeast side of the road. This interceptor open drain replaces and extends the existing drainage channel.	The proposed road alignment is in embankment adjacent to this site and the flush and spring habitat is sufficiently up-gradient of the works not to be impacted in term of the hydrological flow regime during the construction works provided a drainage pathway is provided under the road during the construction	No significant impact
Water quality Impacts	Contaminated surface water from construction area could enter fen and spring areas leading to pollution and nutrient enrichment	The Fen and Tufa habitat at Lugnagall Flush area is to be fenced and protected during construction with silt fencing erected. Appropriate surface water control measures to be employed in this area during construction as outline in the CESCP. However, the feature is up gradient from the Proposed Road Development and therefore construction site runoff will not impact this habitat.	No significant impact

Potential impact	Impact details	Design measures to avoid impacts	impact Significance
Operational impacts			
Hydrological regime Impact - Changes to recharge	A road cut section is proposed in the vicinity of Lugnagall Flush (Ch. 2,070m) to the west. This could potentially lead to dewatering of the recharge area of the springs at Lugnagall Flush	The Proposed Road Development avoids the recharge zone of this spring (which is from upland area to the southeast). The adjacent cutting is of 3 to 4.5m is completely within the overburden boulder clay layer and avoids any potential localised impact on the underlying bedrock aquifer. Topographically this cutting is not within the catchment area feeding the spring and flush which is supplied off the hillslopes to the southeast.	No significant impact
Hydrological regime Impact - Changes to drainage	Change in the culvert draining the spring/ fen area e.g. either an increase of drainage leading to drying out, or a decrease leading to flooding	A drainage neutral solution is proposed at this location with the existing culvert replaced by a similar sized box culvert and installed at similar invert levels to the existing drain. The existing drain on the southeast side is to be replaced by reformed drainage channel at similar invert levels. The features are sufficiently up gradient and unlikely to be drained.	No significant impact
Water quality Impact - Surface water run-off	Contaminated surface water from the road could enter fen and spring areas leading to pollution and nutrient enrichment.	Surface water from the road pavement in the vicinity of the ecological site will be collected in a sealed drainage system passing through a petrol/ oil interceptors and attenuation ponds and discharge to the Lugnagall Stream downstream, northwest of the Lugnagall habitat.	No significant impact
Water quality Impact - Accidental spillage	e.g. risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV	All storm outfalls will include pollution control facilities at their outfalls. The potential risk of a road traffic spillage event is extremely low and an improvement over the existing N16 road.	No significant impact

Table 11-36: Potential impacts to Lugatober North Ecological Site of National importance

Potential impact	Impact details	Design measures to avoid impacts	impact Significance
The Lugatober North ecological site represents a petrifying spring and seepages giving rise to an extensive area of tufa formation within a series of dug land drainage channels on the north-western slopes immediately downstream of the existing N16 Road. This site is up gradient of the Proposed Road Development at Ch 1,800 to 1,900 and comes to within 10m of the road embankment. The recharge area to this habitat is groundwater flow from the southeast under the existing N16 Road. and a small area of alkaline Fen both located slightly up-gradient of the Existing and Proposed road			
Construction impacts			
Surface water run-off Pollution	Contaminated surface water from construction area could enter this site leading to pollution by sediment laden runoff waters. The habitat is upgradient and can be protected from impact of soiled site waters.	Appropriate surface water control measures to be employed in this area during construction including Silt fencing along the habitat boundary between Ch 1800 and 1900 and the collection and discharge of site runoff water through settlement ponds and released over undisturbed vegetated to the Collinsford stream.	No significant impact
Hydrological regime Impacts (Flows and water levels)	The habitat is upgradient and all construction waters will be discharged downgradient of the habitat. At this location no deep excavations involving dewatering will be required.	Construction drainage and discharges affecting this habitat will be avoided as the road development is downgradient and will discharge naturally northwest to the Collinsford stream.	No significant impact
Operational impacts			
Change to groundwater Recharge leading to drying of the habitat	The road development is located downgradient and is in embankment adjacent to this habitat and therefore any potential dewatering and impact to recharge is avoided. There are no proposed works associated with the Road Development within the recharge zone of this petrifying spring and Tufa habitat	Road alignment and proposed drainage pond located down gradient and in embankment at this site.	No significant impact
Change to drainage regime	The Proposed Road Development will involve a shallow toe drain at the edge of the road embankment to collect overland flows and convey them to the Collinsford Stream. This drain is shallow at an invert of 1m below existing ground level and will not exert a drainage effect up the steep sloping land (at 10degrees) on the tufa habitat The provision of a toe drain will collect and convey overland runoff to the Collinsford Stream and will avoid the road embankment acting as a barrier causing increased upstream flooding of lands including the Habitat site. The road pavement itself will be collected in sealed drainage system and discharged to the Collinsford Stream at proposed outfall Ch. 1,940. Downgradient and northwest of the habitat.	The drainage solution avoids any drainage effect on the site and avoids direct discharges and flooding of the site.	No Significant impact

Potential impact	**Impact details**	**Design measures to avoid impacts**	**impact Significance**
Surface water run-off	Potentially contaminated surface water from the road will be collected in a sealed drainage system undergo treatment and discharge to the Collinsford Stream at Ch.1,940. The drainage design protects the groundwater aquifer from pollution and the proposed road is sufficiently down gradient and will not impact the habitat even in flood conditions.	The road alignment and drainage solution avoids any direct or indirect discharge to the ecological site.	No significant impact
Accidental spillage	e.g. risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV	All storm outfalls will include pollution control facilities at their outfalls. In any event the road drainage outfalls discharge downgradient of the habitat.	No significant impact

Table 11-37: Potential impacts to West of Castlegal' Ecological Site of County importance

Potential impact	**Impact details**	**Design measures to avoid impacts**	**impact Significance**
This ecological site representing three seepage zones with small areas of tufa formation within a semi natural Woodland is located on sloping lands 20 to 30m downgradient of the existing N16 Road and well upstream of the proposed Road development landtake at Ch.1,200			
Construction impacts			
Surface water run-off	The proposed Road Alignment is located downgradient to the west/northwest of the site boundary by c 40 to 50m to the edge of the road embankment. Some widening and realignment works are proposed for the existing N16 and extend up to adjacent to this site. Contaminated surface water from construction area could enter this site leading to pollution by sediment laden runoff waters.	Appropriate surface water control measures to be employed in this area during construction including Silt fencing along the upper habitat boundary between the existing N16 road and the habitat. Construction discharges must be diverted westward away from this habitat.	No significant impact
Hydrological regime Impacts (Flows and water levels)	All construction site runoff waters will be discharged away from this site westward. Some excavation works will be required into the hillslope to the south of the existing N16 in order to widen the road. These excavation works are unlikely to encounter groundwater nor will they involve dewatering.	Construction drainage and discharges will be collected and discharged westward away from the site and no excavation dewatering is required at this location	No significant impact

Potential impact	**Impact details**	**Design measures to avoid impacts**	**impact Significance**
Operational impacts			
Change to groundwater Recharge leading to drying of the habitat	The proposed road alignment is located downgradient of the site and will not affect the Recharge zone of this habitat. The only works potentially that could impact on this habitat are the realignment and widening works proposed for the Existing N16. These works will involve widening into the hillslope for a section and superficial excavation of the existing road pavement for relaying purposes The majority of the widening works into the hillslope are to the west of the Recharge zone of the tufa sites and will not affect the recharge as the excavation will be confined to the hill slope above the existing road alignment and unlikely to encounter groundwater.	Road alignment and proposed drainage pond located down gradient and in embankment in the vicinity of this site. The proposed works to the Existing N16 road within the recharge catchment of the habitat are superficial and related to road pavement restoration	No significant impact
Change to drainage regime	The mainline road drainage is downgradient and will not affect this site. The realigned and widened N16 Road adjacent to the site will incorporated a sealed road pavement drainage which will discharge to the Mainline drainage system west of the site with no direct discharges to the site. The potential loss of road pavement drainage from the existing N16 on the site is miniscule and will not affect the groundwater petrifying seepages necessary to support the tufa habitat. Given the elevated nature of the existing N16 road above the groundwater table a filter drain at the toe of the widened cut is not proposed.	The drainage solution avoids any drainage effect on the site and avoids direct discharges and flooding of the site.	No Significant impact
Surface water run-off	Potentially contaminated surface water from the existing realigned and widened N16 road will be collected in a sealed drainage system and discharged westward away from the ecological site to the mainline drainage system.	The road alignment and drainage solution avoids any direct or indirect discharge to the ecological site.	No significant impact
Accidental spillage	e.g. risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV	All storm outfalls will include pollution control facilities at their outfalls. In any event the road drainage outfalls discharge downgradient of the habitat.	No significant impact

Table 11-38: Potential impacts to 'South of Collinsford' Ecological Site of County importance

Potential impact	**Impact details**	**Design measures to avoid impacts**	**Impact Significance**
This ecological site representing small areas of tufa formation and vegetation with affinity to petrifying springs within a small area of wet Woodland is located 70m northwest of Road development landtake at Ch.1,600.			
Construction impacts			

Potential impact	Impact details	Design measures to avoid impacts	Impact Significance
Hydrological regime Impacts (Flows and water levels)	All construction site runoff waters will be discharged to the Collinsford stream and to direct discharge to this habitat will be permitted Some excavation works will be required into the hillslope to the southeast of will be required but such excavation is unlikely to encounter groundwater table. There is no construction excavation dewatering required for this section of road works.	As set out in the Outline Erosion and Sediment Control Plan, construction drainage and discharges will be collected and discharged to the Collinsford Stream after construction water treatment and no direct discharge to this site or dewatering effects on this site will occur.	No significant impact
Surface water run-off pollution	Contaminated surface water from construction area could enter this site as it is located c. 70m downgradient from the site leading to pollution by sediment laden runoff waters	As set out in the Outline Erosion and Sediment Control Plan, appropriate surface water control measures to be employed in this area during construction including Silt fencing along the downstream site boundary between Ch 1500 and 1650 and the collection and discharge of site runoff water through settlement ponds and release over undisturbed vegetated, refer to outline ESCP.	No significant impact
Operational impacts			
Change to groundwater yield	The southeast side of the main line road is in cut into the hillslope between Ch1500 and 1650 and the northwestern side of the road alignment is in embankment. Interception of the permanent bedrock aquifer at this section will not occur and therefore the road development will avoid any permanent dewatering effects on the Locally important bedrock aquifer and on the downstream ecological site.	The Proposed Road Development cutting into the upper slope is completely within the overburden boulder clay layer and avoids any potential localised impact on the underlying bedrock aquifer and thus on groundwater supply to the downstream receptor.	No significant impact
Change to drainage and recharge	The base of the cut-slope would generally be drained by a filter drain that outfalls to the Lugatober drain at Ch. 1500. An interceptor drain along the upper cut slope will collect and divert overland sheet flow away from the cutting to the Lugatober drain at Ch 1500. These measures have the potential to intercept recharge to the aquifer and the wetland habitat site. The road pavement itself will be collected in sealed drainage system and discharged to the Collinsford Stream at proposed outfall Ch. 1,940 The diversion of natural overland flow, interflow and groundwater seepage flows and the loss of recharge from the road pavement and cut-slope area has the potential to moderately impact the local downstream hydrological regime which has the potential to impact the habitat impact the	Specific Mitigation measures will be required in order tomaintain the seepage flows locally where encountered by the cutting and avoid being diverted away from the habitat site to Ch 1500 via the proposed road filter drain. Such diversion of seepage flows could represent a potential moderate significance impact on the hydrological regime of the habitat.	Moderate Potential impact
Surface water run-off Pollution	Potentially contaminated surface water from the road will be collected in a sealed drainage system undergo treatment and discharge to the Collinsford Stream at Ch.1,940. The drainage design protects the groundwater aquifer from pollution and therefore the impact magnitude on the habitat will be imperceptible.		No significant impact

Potential impact	Impact details	Design measures to avoid impacts	Impact Significance
Accidental spillage	e.g. risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV	Sealed drainage and all storm outfalls will include pollution control facilities at their outfalls.	No significant impact

Table 11-39: Potential impacts to 'East of Drum' Ecological Site of Local Higher importance

Potential impact	Impact details	Design measures to avoid impacts	impact Significance
This ecological site is located over 320m downgradient to the northwest of Road development at Ch. 1200. It represents a Rich fen and flush vegetation with some affinity to alkaline fen.			
Construction impacts			
Hydrological regime Impacts (Flows and water levels)	All construction site runoff waters will be discharged to the Lugotober stream and to direct discharge from the construction site to this habitat will be permitted The proposed road alignment at this location is in embankment and no impact from excavation dewatering or construction drainage will affect the hydrological regime of this site.	As set out in the Outline Erosion and Sediment Control Plan, no construction drainage effects on the ecological site by ensuring that site runoff water is collected and discharged to the local drainage network after treatment.	No significant impact
Surface water run-off Pollution	Contaminated surface water from construction area could if not controlled reach the site being 320m downgradient of the works.	As set out in the Outline Erosion and Sediment Control Plan, appropriate surface water control measures to be employed in this area during construction including Silt fencing and the collection and discharge of site runoff water through settlement ponds and release over undisturbed vegetated.	No significant impact
Operational impacts			
Change to groundwater yield	The site is located downgradient and well over 320m from the road alignment. The proposed road alignment is in embankment through its recharge catchment and therefore will not intercept the groundwater table.	There will be no impact on groundwater flows supplying this habitat with the habitat reasonably buffered from the road development being over 320m away	No significant impact
Change to drainage and recharge	Shallow Toe drains will be provided along the base of the proposed road embankments will capture overland flow and discharge to the Lugatober stream. This area is drained by the Lugatober stream and the proposed land drainage treatment is to maintain the status-quo and ensure that road embankment does not represent an obstacle to flow. The road pavement itself will be collected in sealed drainage system and discharged to the Collinsford Stream at proposed outfall Ch 1,940.	No direct impact on drainage at this ecological site.	No significant impact

Potential impact	Impact details	Design measures to avoid impacts	impact Significance
Surface water run-off	Road drainage waters causing pollution of this downstream habitat.	Potentially contaminated surface water from the road will be collected in a sealed drainage system undergo treatment and discharge to the Collinsford Stream at Ch.1,940. The drainage design protects the groundwater aquifer from pollution and therefore the impact magnitude on the habitat will be imperceptible.	No significant impact
Accidental spillage	e.g. risk of pollution from accidental spillage of chemical / hydrocarbons by an accident involving a HGV	Sealed drainage and all storm outfalls will include pollution control facilities at their outfalls.	No significant impact

11.5Mitigation Measures

11.5.1 Introduction

Mitigation measures follow the principles of avoidance, reduction and remedy. The most effective measure of avoidance is dealt with during the route selection and design stage, by moving the *Proposed Road Development* either laterally or vertically within the Emerging Preferred Route Corridor, to ensure that it does not traverse or pass near to sensitive hydrological and hydrogeological attributes. Appropriate measures have been incorporated into the design of the *Proposed Road Development* in terms of drainage design so as to avoid impact or minimise impacts where possible.

Where avoidance of the feature has not been possible, consideration has been given to locally modifying the *Proposed Road Development* so as to reduce / minimise the extent of the impact.

11.5.2 Construction Phase

As is normal practice the Contractor will be required to prepare an Operating Environmental Management Plan in advance of the commencement of construction and the following measures will be included as part this plan:

- An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks;
- A Sediment Erosion and Pollution Control Plan (Refer to Outline Erosion and Sediment Control Plan (CESCP) contained within Volume 4 of this EIAR). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988);
- All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent will be obtained prior to construction for all culverts and bridges proposed in the EIA Report;
- Continue to Inform and consult with Inland Fisheries Ireland (IFI);
- Continue to Inform and consult with National Parks and Wildlife Service (NPWS);
- Construction activities will be required to take cognisance of the following guidance documents for construction work on, over or near water:
    - Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016);
    - Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction;

- Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board);
- Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers;
- CIRIA C793 The SUDS Manual;
- CIRIA C624 Development and Flood Risk – guidance for the construction industry;
- CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors;
- CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance;
- CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide;
- Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006);
- Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015);
- Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015)

Based on the above guidance documents concerning control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:

- Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate;
- Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses;
- Where construction works are carried out adjacent to wetlands, fens, stream and drainage channels, karst features, springs and wells, protection of such aquatic bodies from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses;
- Use of settlement ponds, silt traps and bunds and minimising construction activities within watercourses. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap or sedi-mat;
- All drains that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound site does not discharge directly to the watercourse.;
- Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses;
- Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution;
- The construction discharge will be treated such that it will not reduce the environmental quality standards of the receiving watercourses;

- Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone for its protection to a minimum distance of 5m except for proposed crossing points;
- The use and management of concrete (which has a deleterious effect on water chemistry and aquatic habitats and species) in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such mixing plants will be carried out only in a designated contained impermeable area;
- The Soil Repository/Borrow Pit must be adequately controlled and compartmentalised such that the rainwater outflow from this facility is adequately treated through settlement prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the Outline Erosion and Sediment Control Plan (refer Appendix 4.3 contained within Volume 4 of this EIAR).

The potential for constructional phase impacts on water quality in receiving watercourses and groundwater bodies will be reduced to slight / imperceptible through the implementation of the outline Erosion and Sediment Control Plan.

The potential for constructional phase impacts on hydrological regime on the identified sensitive aquatic ecological habitats and on the downstream European site (Cummeen Strand / Drumcliff Bay SAC, SPA and pNHA (000627) has been reduced to imperceptible through the implementation of a Sediment Erosion and Pollution Control Management Plan.

11.5.3 Operational Phase

There are generally no operational Phase Mitigation measures required for this road development as the road design has avoided any significant hydrological / hydrogeological impacts through the engineering design of the road horizontal and vertical alignment and the drainage design that includes sealed drainage system, water quality and stormwater attenuation pond facilities, petrol interceptors and suitable sized and designed outfalls and culverts. A specific mitigation measure to protect a county importance ecological site at the south of *Collinsford* (Site 4) from potential hydrological changes due to possible upstream interception of groundwater and interflow seepages by the upslope cutting between circa Ch. 1,500m and c. Ch. 1,600m is proposed.

The southeast side of the main line road is in cut into the hillslope between Ch1500 and 1650 and the northwestern side of the road alignment is in embankment. The base of the cut-slope would generally be drained by a filter drain that outfalls to the *Lugatober* drain at Ch. 1500. An interceptor drain along the upper cut slope will collect and divert overland sheet flow away from the cutting to the *Lugatober* drain at Ch 1500. These measures have the potential to intercept recharge to the aquifer and the wetland habitat site giving rise to a potential impact to the hydrological regime within the ecological site. In order to maintain the seepage flows where encountered by the cut slope the capping layer should be extended to the base of the cut slope and an additional Class 6C crushed rock granular layer shall be provided underneath the capping layer and will extend from the face of the cutting on the east side to the toe of the fill at the west side. This will facilitate seepage flows off the cut face flowing under the road, thereby maintaining flow paths for seepage flows from the up-gradient cut face to travel northwest towards the south of *Collinsford* wetland Site.

This mitigation will maintain groundwater seepage flows from the cut slope discharging in a northwest direction towards the habitat. The proposed drainage treatment including the above mitigation will still result in a potential loss of recharge to the immediate downstream area including the habitat site. However this loss of potential recharge is surface water and not the groundwater petrifying seepage flows necessary to maintain Tufa habitat. The impact magnitude on the hydrological regime is rated as a slight impact.

11.6Cumulative Impacts

11.6.1 **Introduction**

There are no *existing and/or approved projects*[1].. in proximity to the project which are likely to result in an accumulation of effects. A Preferred Route Corridor has been established for the N16, extending from Sligo to the townland of *Diffreen* in County Leitrim. However, other sections of the route in this area are not *'approved'* and are unlikely, to be progressed in the next 5 to 15 years[2].

In respect to cumulative impact there are no projects within the study area that have been approved or within the planning process that could overlap with the proposed *Lugatober* road development that would generate a cumulative impact on hydrology and hydrogeology.]

11.7Residual Impacts

11.7.1 **Introduction**

The residual impacts are those impacts that would occur with the proposed mitigation measures applied.

11.7.2 **Impacts**

There will be no significant negative residual impacts from the *Proposed Road Development* on the surface water and groundwater hydrology, with no predicted residual impacts to the hydrological regime (both quantity and quality) within the salmonid watercourses, water dependent habitats and on the any designated European site. There are no significant residual impacts to water resources including water supplies as a result of the *Proposed Road Development*.

[1] Terminology used in the amended EIA Directive.

[2] The Sligo section of the N16 lends itself to improvement in a number of sections over the long term (20 to 25 years). However, based on current knowledge, it is likely that only one developement will occur in the short to medium term.

Table 11-40: Residual Impacts

No.	Sites	Importance		Residual Impact		
			Attribute Value	**Impact description**	**Impact Magnitude**	**Significance of Impact**
1 Designated Sites						
1.1	Cummeen Strand and Drumcliff Bay cSAC	European Coastal and Estuarine SAC and NHA Site	Extremely High	All drainage discharges to surface waters eventually drain into the SAC undergo treatment and have accidental spillage containment provided.	Negligible	imperceptible
1.2	Cummeen Strand SPA (004035)	Coastal and Estuarine European SPA Site	Extremely High	All drainage discharges to surface waters eventually drain into the SPA undergo treatment and have accidental spillage containment provided.	Negligible	imperceptible
1.3	Drumcliff Bay SPA (004013)	Coastal and Estuarine European SPA Site	Extremely High	All drainage discharges to surface waters eventually drain into the SPA undergo treatment and have accidental spillage containment provided.	Negligible	imperceptible
1.4	Lough Gill SAC and pNHA (001976)	European SAC Site	Extremely High	European site not hydrologically linked to the proposed road development	None	neutral
1.5	Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623)	European SAC Site	Extremely High	European site not hydrologically linked to the road development	None	neutral
1.6	Sligo Leitrim Uplands SPA (004187)	European SPA Site	Extremely High	European site not hydrologically linked to the road development	None	neutral
1.7	Crochauns/Keelogyboy Bogs NHA (002435)	National Heritage area with upland blanket Bog, heathand grassland habitats of National Significance	very High	Road development downgradient of the raised bog habitat with no impact on hydrological regime or water quality both during operation and construction phases. No wetland habitat located within the hydrological zone of influence of the road development at its proposed cuttings	Negligible	imperceptible

No.	Sites	Importance		Residual Impact		
			Attribute Value	Impact description	Impact Magnitude	Significance of Impact
2 Salmonid Watercourses						
2.1	Willsborough Stream	Salmonid locally and downstream	local higher	Treated road drainage outfall discharge, and associated Constructional impacts	Slight	imperceptible
2.2	Tully Stream	Salmonid locally and downstream	local higher	Full span bridge crossing and treated road drainage outfall discharge, inclusion of interceptor and toe drains and associated constructional impacts	Slight	imperceptible
2.3	Lugatober Stream	Salmonid downstream	local lower	Proposed culvert crossing and significant channel realignment, inclusion of interceptor and toe drains discharging to stream and associated Constructional impacts	moderate	Slight
2.4	Lugatober Drain	Salmonid downstream	local lower	Proposed culvert crossing with backdrop manholes, some local channel realignment, inclusion of interceptor and toe drains and associated constructional impacts	moderate	Slight
2.5	Collinsford Stream	Salmonid downstream	local lower	Proposed culvert crossing, some local channel realignment, inclusion of road interceptor and toe drains outfalling to stream, treated road drainage outfall discharge and associated constructional impacts	moderate	Slight
2.6	Lugnagall	Salmonid downstream	local lower	Proposed culvert replacement, inclusion of road toe drains outfalling to stream, treated road drainage outfall discharge and associated constructional impacts	moderate	Slight

No.	Sites	Importance	Attribute Value	Residual Impact Impact description	Impact Magnitude	Significance of Impact
3 Aquatic Ecological Receptors						
3.1	Lugnagall Flush	Small remnants of Annex I alkaline fen and petrifying spring Tufa habitat of County Significance	High	Road development downgradient of the annex I habitat with no impact on hydrological regime or water quality both during operation and construction phases	negligible	imperceptible
3.2	Lugatober North	extensive area of of Annex I petrifying springs/seepage with Tufa habitat of National Significance	Very High	Road development downgradient of the annex I habitat with no impact on hydrological regime or water quality both during operation and construction phases	negligible	imperceptible
3.3	West of Castlegal	petrifying spring/seepage area with small amount of tufa formation within semi-natural woodland of County significance	High	Contaminated surface water from construction area could enter this site leading to pollution by sediment laden runoff waters during proposed widening and realignment works to the existing N16 - mitigated by the Outline Erosion and Sediment Control Plan.	small	Slight
3.4	South of Collinsford	tufa formation and vegetation with affinity to petrifying spring seepages of County significance	High	Site located down gradient and potentially at risk form construction generated pollution - mitigated by the Outline Erosion and Sediment Control Plan.	small	Slight
3.5	East of Drum	Rich fen and flush vegetation with some affinity to alkaline fen of local higher significance.	medium	Sufficiently downgradient and outside the zone of hydrogeological influence of the road development. Constructional pollution impacts mitigated by application of the Outline Erosion and Sediment Control Plan.	negligible	imperceptible

No.	Sites	Importance	Attribute Value	Residual Impact Impact description	Impact Magnitude	Significance of Impact
4 Water Resources and Aquifers						
4.1	Rosses Point GWB and Ballyshannon Limestones	Regionally Important karst conduit flow bedrock Aquifer	High	Road cuttings will increase aquifer vulnerability. Sealed drainage no direct discharges to groundwater	negligible	imperceptible
4.2	Drumcliff-Strandhill GWB Glencar Limestones	Locally important bedrock aquifer	medium	Road cuttings will increase aquifer vulnerability and the large bedrock cuttings including Borrow Pit with cause local drawdown of watertable. Sealed road drainage with no direct discharges to groundwater	small	imperceptible
5 Water Supplies						
5.1	GWS_1	Private well	Low	Well adjacent to existing N16 potential for pollution of supply during construction only - mitigated by Outline Erosion and Sediment Control Plan.	negligible	imperceptible
5.2	GWS_2	Private Borehole Supply	Low	Located over 300m downgradient of the road and well beyond the zone of hydrogeological influence in respect to yield and reasonably buffered from constructional pollution	negligible	imperceptible
5.3	GWS_3	Hill slope supply serving multiple properties	Low	Source located upgradient and beyond the hydrogeological zone of influence of the road development	negligible	imperceptible
5.4	GWS_4	Private well	Low	Source located upgradient and beyond the hydrogeological zone of influence of the road development	negligible	imperceptible

No.	Sites	Importance		Residual Impact		
			Attribute Value	Impact description	Impact Magnitude	Significance of Impact
5.5	GWS_5	Private well	Low	source located upgradient and beyond the hydrogeological zone of influence of the road development	negligible	imperceptible
5.6	GWS_6	Small hill slope spring/rising supplying two households	Low	source located upgradient and beyond the hydrogeological zone of influence of the road development	negligible	imperceptible
5.7	GWS_7	Lugnagall spring supplying multiple properties	medium	source located upgradient and beyond the hydrogeological zone of influence of the road development	negligible	imperceptible
6 **Flood Risk**						
6.1	Lugnagall Stream	overland flooding due to poor capacity downstream channel	medium	Replacement Culvert at similar invert and hydraulic capacity and attenuated road drainage discharge at greenfield runoff rates will not change the existing flood regime	negligible	imperceptible
6.2	Glencar Road Lugnagall	recurring flooding of a number of dwelling houses from overflow from Lugnagall Stream	high	The Proposed Road Development involves the realignment of a section of local Glencar road and the provision of road pavement drainage which will be piped to the open stream channel below the flood area and channel constriction	negligible	imperceptible
6.3	Collinsford Stream	moderately steep gradient with slight out of bank flooding in the downstream reach	medium	Suitably sized culvert and attenuated road storm drainage discharge with road embankment toe drainage and interceptor drains collecting and discharging overland flow to the stream resulting in a small local increase in flood flows	small	Slight

No.	Sites	Importance	Attribute Value	Residual Impact Impact description	Impact Magnitude	Significance of Impact
4	Lugatober Stream	Poor capacity culvert under existing N16 road and drainage channels	low	Suitably sized culvert and attenuated road storm drainage discharge with road embankment toe drainage and interceptor drains collecting and discharging overland flow to the stream resulting in a small local increase in flood flows	small	Slight
6.5	Tully Stream		medium	Full spanning bridge structure over stream, attenuated road drainage outfall discharge and provision of toe and interceptor drains to collect local overland flow and discharge to stream resulting in localised small increase in flood flow	small	Slight
6.6	Willsborough Stream	Outfall to stream downstream of proposed and existing N16 with flood risk to agricultural lands	medium	attenuated road drainage outfall discharge proposed	negligible	imperceptible
6.7	N16 road at Lugatober	Proposed National Road designed to be a low risk of flooding	High	Road alignment and associated drainage system designed to cater for the 100year with climate change allowance providing 2.54km of National Primary infrastructure having a low risk of flooding. Currently the Existing N16 Road with sections of high flood risk	small positive	slight to moderate beneficial

11.8 Relevant Figures and Appendices

11.8.1 Figures contained in Volume 3

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

Fig. 9.1: Designated Sites and River Names;

Fig. 11.1: Drainage Wells, OPW Gauges and Historical Flood Locations;

Fig. 11.2: Aquifer Classification;

Fig. 11.3: Aquifer Vulnerability;

11.8.2 Appendices contained in Volume 4

The following appendices have been produced specifically for the purposes of this Chapter and are contained within Volume 4 of the EIAR:

Appendix 4.3: Chapter 4 (Main Report Reference); Informal Scoping Responses; Outline Erosion and Sediment Control Plan;

Appendix 11.1: Chapter 11 (Main Report Reference); Chapter 11: HAWRAT Analysis.

12 Landscape & Visual

12.1 Introduction

This report has been prepared by RPS and sets out to make a Landscape and Visual Impact Assessment (LVIA) of the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*. This report has been prepared in order to undertake the Landscape & Visual Impact assessment necessary for the delivery of Phase 3 (Design) and Phase 4 (EIAR and the Statutory Process) as per the TII National Roads Project Management Guidelines. The overall approach is summarised as follows:

(i) Establish the baseline conditions:
   a. Record and analyse the existing character, quality and sensitivity of the landscape and visual resource. This should include elements of the landscape such as;
      i. Landform;
      ii. Land cover including the vegetation, the slopes, drainage, etc;
      iii. Landscape character;
      iv. Current landscape designations and planning policies; and
      v. Site visibility, comprising short, medium and long distance views.

(ii) Analyse baseline conditions:
   a. Comment on the scale, character, condition and the importance of the baseline landscape, its sensitivity to change and the enhancement potential where possible;
   b. A visual analysis describing characteristics which may be of relevance to the impact of the design and to the method of mitigation.

(iii) Describe the proposal;

(iv) Identify the Impacts of the proposal on the Landscape and Visual Resources:
   a. Identify the landscape and visual impacts of the *Proposed Road Development* at different stages of its life cycle, including:
      i. Direct & indirect *landscape impacts* of the *Proposed Road Development* on the landscape of the site and the surrounding area; and
      ii. *Visual impacts* including: the extent of potential visibility; the view and viewers affected; the degree of visual intrusion; the distance of views; and resultant impacts upon the character and quality of views.

(v) Assess the significance of the landscape and visual impacts in terms of the sensitivity of the landscape and visual resource, including the nature and magnitude of the impact.

(vi) Describe measures proposed to mitigate significant adverse landscape and visual impacts and assess their effectiveness.

(vii) Assess the ability of the landscape and visual resource to absorb the proposal with any mitigation proposed.

12.2 Methodology

12.2.1 General Approach

The methodology for the LVIA has been derived from the *Guidelines for Landscape and Visual Impact Assessment,* Third Edition (The Landscape Institute and Institute of Environmental Management & Assessment, 2013) (GLVIA3). The landscape mitigation measures have given regard to the NRA *Guide to Landscape Treatments for National Road Schemes in Ireland*.

The landscape has been appraised to allow it to be described and classified into landscape character areas that in turn enable the classification of landscape quality. The capacity of the landscape to accept change of the type proposed is assessed by determining the sensitivity of each landscape character area. Overall key landscape components are normally landform, vegetation and historical and cultural components. Landform relates to topography, drainage characteristics and geology. Historical and cultural components include historic landscapes, listed buildings, conservation areas and historic designed landscapes. Vegetation plays an important role in how the landscape and visual resources of an area are viewed and is an integral component of a landscape character.

Assessment has been undertaken through analysis of:-

- Up to date digital copies of OS Discovery Series raster and OS vector maps;
- Aerial photography;
- Sligo County Development Plan 2017-2023;
- Sligo County Development Plan Landscape Characterisation Map; and
- Detailed drawings of the *Proposed Road Development*.

Site visits were undertaken to assess the existing environment, to establish the existing visual resource and to identify sensitive receptors, i.e., principally scenic viewpoints. Site visits were also used to establish the perceived extent of landscape and visual impacts that may be associated with the *Proposed Road Development*.

The *Proposed Road Development* is then applied to this landscape and visual baseline and potential impacts predicted.

12.2.2 Identifying Effects

Assessing the significance of an effect is a key component of the LVIA and is an evidenced based process combining professional judgments on the nature of a landscape or visual receptor's sensitivity, their susceptibility to change and the value attached to the receptor. It is important to note that judgments in this LVIA are impartial and based on professional experience and opinion informed by best practise guidance.

The effects of the *Proposed Road Development* are of variable duration and are assessed as being either short-term or long-term, and permanent or reversible. Effects related to operations and infrastructure such as temporary construction compounds and stockpiling, apparent only during the construction period are considered to be short-term effects.

12.2.3 Assessment Criteria

The objective of the assessment process is to identify and evaluate the predicted significant effects arising from the proposal. Significance is a function of the:

- Sensitivity of the affected landscape and visual receptors; and
- Scale or magnitude of impact that they will experience.

These definitions recognise that landscapes vary in their capacity to accommodate different forms of development according to the nature of the receiving landscape and the type of change being proposed.

Significance is not graded in bands, and a degree of informed judgement is required. Even with the application of pre-defined criteria, interpretation may differ between individuals, but this allows the process of reaching these conclusions to be transparent.

12.2.4 Landscape Impact Assessment

The LVIA firstly assesses how the proposal would impact directly on any landscape features and resources. This category of effect relates to specific landscape elements and features (e.g. woods, trees, walls, hedgerows, watercourses) within the site that are components of the landscape that may be physically affected by the proposal. Physical effects are restricted to the area within the site boundary, and are the direct effects on the fabric of the site, such as the removal or addition of trees and alteration to ground cover and levels.

The LVIA then considers impacts on landscape character at two levels. Firstly, consideration is given to how the landscape character is affected by the removal or alteration of existing features and the introduction of new features. This is considered to be a direct impact on landscape character. Secondly, the indirect impacts of the proposal on the wider landscape are considered. The assessment of impacts on the wider landscape is discussed using the surrounding character areas identified in the relevant regional or county landscape character assessments and further refined by this LVIA. It is acknowledged there is an overlap between perception of change to landscape character and visual amenity, but it should be remembered that landscape character in its own right is generally derived from the combination and pattern of landscape elements within the view.

The significance of effects on landscape features and character is determined by cross referencing the sensitivity of the feature or landscape character with the magnitude of impact.

Consideration of the sensitivity of the landscape resource against the magnitude of impact caused by the proposal is fundamental to landscape and visual assessment and these two criteria are defined in more detail below.

12.2.5 Landscape Sensitivity

The determination of the sensitivity of the landscape resource is based upon an evaluation of each key element or characteristic of the landscape likely to be affected. The evaluation reflects such factors as its quality, value, contribution to landscape character and the degree to which the particular element or characteristic can be replaced or substituted. Each element is analysed below in order to inform the overall sensitivity rating.

For the purpose of this assessment, landscape quality is categorised as:-

(i) **Very High Quality:**
Areas of especially high quality acknowledged through designation such as Areas of Outstanding Natural Beauty (AONB; as referenced in some County Development Plans in Ireland but not with the same status as UK) or other landscape based sensitive areas. These are of landscape significance within the wider region or are designated so internationally / nationally;

(ii) **High Quality:**
Areas that have a very strong positive character with valued and consistent distinctive features that gives the landscape unity, richness and harmony. These are of landscape significance within the district;

(iii) **Medium Quality:**
Areas that exhibit positive character but which may have evidence of alteration/degradation or erosion of features resulting in a less distinctive landscape. These may be of some local landscape significance with some positive recognisable structure; and

(iv) Low Quality:
Areas that are generally negative in character, degraded and in poor condition. No distinctive positive characteristics and with little or no structure. Scope for positive enhancement.

As previously discussed, landscape sensitivity is influenced by a number of factors including value, condition and susceptibility to the type of change brought about by the proposal. In order to assist with bringing these factors together the following five point scale has been used as presented in Table 12-1. The table defines the criteria that have guided the judgement as to the Sensitivity of the Landscape Resource.

Table 12-1: Landscape Sensitivity

Definition		**Sensitivity**
Landscape Resource Sensitivity	**Landscape Resource Value**	
Exceptional landscape quality, no or limited potential for substitution. Key elements / features well known to the wider public. Little or no tolerance to change.	Nationally / internationally designated/ valued landscape, or key elements or features of national / internationally designated landscapes. Little or no tolerance to change	Very High
Strong / distinctive landscape character; absence of landscape detractors. Low tolerance to change.	Regionally / nationally designated / valued countryside and landscape features. Low tolerance to change.	High
Some distinctive landscape characteristics; few landscape detractors. Medium tolerance to change	Locally / regionally designated / valued countryside and landscape features. Medium tolerance to change	Medium
Absence of distinctive landscape characteristics; presence of landscape detractors. High tolerance to change	Undesignated countryside and landscape features. High tolerance to change	Low
Absence of positive landscape characteristics. Significant presence of landscape detractors. High tolerance to change	Undesignated countryside and landscape features. High tolerance to change	Negligible

12.2.6 Magnitude of Landscape Impacts

Direct resource changes on the landscape character in the study area are brought about by the introduction of the proposal and its impact on the key landscape characteristics. The categories and criteria used are given in Table 12-2 below:-

Table 12-2: Magnitude of Landscape Impact

Definition	**Magnitude**
Total loss or addition or/ very substantial loss or addition of key elements / features / patterns of the baseline, i.e., pre-development landscape and/ or introduction of dominant, uncharacteristic elements with the attributes of the receiving landscape.	Large
Partial loss or addition of or moderate alteration to one or more key elements / features / patterns of the baseline, i.e., pre-development landscape and / or introduction of elements that may be prominent, but may not necessarily be substantially uncharacteristic with the attributes of the receiving landscape.	Medium
Minor loss or addition of or alteration to one or more key elements / features / patterns of the baseline, i.e., pre-development landscape and or introduction of elements that may not be uncharacteristic with the surrounding landscape.	Small

Definition	Magnitude
Very minor loss or addition of or alteration to one or more key elements / features / patterns of the baseline, i.e., pre-development landscape and/or introduction of elements that are not uncharacteristic with the surrounding landscape approximating to a 'no-change' situation.	Negligible
No loss, alteration or addition to the receiving landscape resource.	No change

12.2.7 Visual Impact Assessment

The assessment of effects on views is an assessment of how the introduction of the proposal will affect views throughout the study area that has been established by site assessment that has been used to determine the Zone of Theoretical Visibility (ZTV) of the *Proposed Road Development* (See Figure 12.1 within Volume 3).

Assessment of visual effects within the ZTV therefore needs to consider:-

- Direct impacts of the proposal upon views of the landscape through intrusion or obstruction;
- The reaction of viewers who may be affected, e.g., residents walkers, road users; and
- The overall impact on visual amenity.

12.2.8 Visual Sensitivity

Visual sensitivity is defined with reference to the landscape sensitivity of the viewpoint location and the view. Other factors affecting visual sensitivity include:-

- The location and context of the viewpoint;
- The expectations and occupation or activity of the receptor; and
- The importance of the view.

Although the interpretation of viewers' experience can have preferential and subjective components, there is generally clear public agreement that the visual resources of certain landscapes have high visual quality.

Viewer sensitivity, as set out in Table 12-3 below, is a combination of the sensitivity of the human receptor (for example resident, commuter, tourist, walker, recreationist or worker, and the numbers of viewers affected) and viewpoint type or location (for example house, workplace, leisure venue, local beauty spot, scenic viewpoint, commuter route, tourist route or walkers' route).

Table 12-3: Viewer Sensitivity

Visual Resource Sensitivity	Visual Resource Value	Sensitivity
Views of remarkable scenic quality, of and within internationally designated landscapes or key features or elements of nationally designated landscapes that are well known to the wider public. Little or no tolerance to change.	Observers, drawn to a particular view, including those who have travelled from around Ireland and overseas to experience the views. Little or no tolerance to change.	Very High
Views from residential property. Public rights of way, National Trails, long distance walking routes and nationally designated countryside/ landscape features with public access. Low tolerance to change.	Observers enjoying the countryside from their homes or pursuing quiet outdoor recreation are more sensitive to visual change. Little tolerance to change.	High
Views from local roads and routes crossing designated countryside / landscape features and 'access land' as well as promoted paths.	Observers enjoying the countryside from vehicles on quiet/promoted routes are moderately sensitive to visual change.	Medium

Visual Resource Sensitivity	Visual Resource Value	Sensitivity
Medium Tolerance to change.	Medium tolerance to change.	
Views from work places, main roads and undesignated countryside / landscape features. High tolerance to change.	Observers in vehicles or people involved in frequent or infrequent repeated activities are less sensitive to visual change. High tolerance to change.	Low
Views from within and of undesignated landscapes with significant presence of landscape detractors. High tolerance to change.	Observers in vehicles or people involved in frequent or frequently repeated activities are less sensitive to visual change. High tolerance to change.	Negligible

12.2.9 Magnitude of Visual Impacts

The magnitude of impact on the visual resource results from the scale of change in the view, with respect to the loss or addition of features in the view, and changes in the view composition including the proportion of the view altered by the *Proposed Road Development* . Important factors to be considered include: proportion of the view occupied by the proposal, distance and duration of the view. Other man made features in the landscape and the backdrop to the proposal will all influence resource change. Magnitude of visual impact is defined in Table 12-4.

Table 12-4: Magnitude of Visual Impact

Definition	Magnitude
Complete or very substantial change in a view: impact of the development is dominant involving complete or very substantial obstruction of existing view or complete change in character and composition of baseline, e.g., through removal of key elements	Large
Moderate change in view: which may involve partial obstruction of existing view or partial change in character and composition of baseline, i.e., pre-development view through the introduction of new elements or removal of existing elements. Change may be prominent, but would not substantially alter scale and character of the surroundings and the wider setting. Composition of the view would alter. View character may be partially changed through the introduction of features which, though uncharacteristic, may not necessarily be visually discordant	Medium
Minor change in baseline, i.e., pre-development view - change would be distinguishable from the surroundings whilst composition and character would be similar to the pre change circumstances.	Small
Very slight change in baseline, i.e., pre-development view - change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.	Negligible
No alteration to the existing view	No change

12.2.10 Significance of Effects

The purpose of this LVIA is to determine, in a transparent way, the likely significant landscape and visual effects of the proposal.

GLVIA3[90] identifies that:

> *'The Regulations require that a final judgment is made about whether or not each effect is likely to be significant. There are no hard and fast rules about what effects should be deemed 'significant' but LVIAs should always distinguish clearly between what are considered to be significant and non-significant effects'.*

[90] Guidelines for Landscape and Visual Impact Assessment, third edition

Significance can only be defined in relation to each particular development and its specific location. The relationship between receptors and effects is not typically a linear one. Using the accepted principles of GLVIA3 it is for each LVIA to determine how judgements about receptors and effects should be combined to derive significance and to explain how this conclusion has been arrived at.

As a general guide it is considered that the following are likely to be considered effects of the greatest significance:-

- Major loss or irreversible negative effects, over an extensive area, on elements and/or aesthetic and perceptual aspects that are key to the character of nationally valued landscapes (as per paragraph 5.56 GLVIA3); or
- Irreversible negative effects on people who are particularly sensitive to changes in a views, on recognised and important viewpoints or scenic routes, large-scale change which introduces non-characteristic, discordant or intrusive elements into the view (paraphrased paragraph 6.44 GLVIA3).
- It should be noted that all views both from and of the *Proposed Road Development* along with effects on important viewpoints both within and adjacent to the development are assessed. Thus the view into and out of the proposal are included.

The identification of significant effects would not necessarily mean that the effect is unacceptable in planning terms. What is important is that the likely effects on the landscape and visibility are transparently assessed and understood in order that the determining authority can bring a balanced, well-informed judgement to bear when making the planning decision.

The significance of effects on landscape, views and visual amenity are evaluated according to a six-point scale: Substantial, Major, Moderate, Minor, Negligible or None.

For those effects indicated as being Moderate to Major the assessor will exercise professional judgement in determining if the effect is considered significant (as per paragraphs 5.56 and 6.43 GLVIA3).

For the purposes of this assessment those effects indicated as being of Substantial, Major to Substantial are considered significant as highlighted in Table 12-5, below. Effects of ‘Moderate’ and lesser significance have been identified in the assessment, but are not considered significant upon the character and quality of the landscape and on views although they remain worthy of consideration throughout the decision making process and in the design of mitigation measures.

Table 12-5: Significance of Effects Matrix

Magnitude of Impact	**Sensitivity**				
	Negligible	***Low***	***Medium***	***High***	***Very High***
No Change	None	None	None	None	None
Negligible	Negligible	Negligible to Minor	Negligible to Minor	Minor	Minor
Small	Negligible to Minor	Negligible to Minor	Minor	Minor to Moderate	Moderate to Major
Medium	Negligible to Minor	Minor	Moderate	Moderate to Major	Major to Substantial
Large	Minor	Minor to Moderate	Moderate to Major	Major to Substantial	Substantial

Change can be adverse or beneficial. A conclusion that an effect is 'significant' should not be taken to imply that the proposal is unacceptable. Significance of effect needs to be considered with regard to the scale over which it is experienced.

12.2.11 Landscape & Visual Assessment Definitions

The following provides a list of landscape and visual definitions for the terms used within this assessment:-

Landscape Capacity:

The capacity of a particular type of landscape to absorb change without unacceptable adverse effects on its character;

Landscape Character Area:

Distinct types of landscape which are generic in character in that they may occur in different parts of the country, but wherever they are they share broadly similar combinations of geology, topography, drainage patterns, vegetation and historical land use and settlement pattern. Landscape Character Area (LCA) names are generic, for example 'upland hills', 'river valley' and 'urban landscape';

Landscape Fabric:

Is the physical pattern of elements and features such as vegetation, landform and land use that combine to create landscape character. The effects of a development on landscape fabric are those that alter the physical pattern of elements. These effects are restricted to the landscape within which the proposal is located as it is within this area that the physical pattern will alter, for instance through loss of vegetation, re-contouring or changes to land use;

Landscape Quality (or Condition):

Is based on judgements about the physical state of the landscape, and about its intactness, from visual, functional, and ecological perspectives. It also reflects the state of repair of individual features and elements which make up the character in any one place;

Landscape Resource:

The combination of elements that contribute to landscape context, character and value;

Landscape Value:

The importance attached to a landscape (often as a basis for designation or recognition) that expresses national or local consensus, because of its quality, cultural associations, scenic or aesthetic characteristics;

Sensitivity:

Vulnerability of a sensitive receptor to change;

Sensitive Receptor:

Physical or natural resource, special interest or viewer group or observer that will experience an impact;

Magnitude:

Size, extent and duration of an impact;

Visual Amenity:

The value of a particular area or view in terms of what is seen;

Visual Character:

When a viewer experiences the visual environment, it is not observed as one aspect at a time, but rather as an integrated whole. The viewer's visual understanding of an area is based on the visual character of visible features and aspects and the relationships between them. The visual character is descriptive and not evaluative;

Visual Effect:

Is a change to an existing view as a result of development or the loss of particular landscape elements or features already present in the view;

Visual Resources:

The visual resources of the landscape are the stimuli upon which actual visual experience is based. They are a combination of visual character and visual quality; and

Visual Quality:

Although the interpretation of viewers' experience can have preferential and subjective components, there is generally clear public agreement that the visual resources of certain landscapes have high visual quality. The visual quality of a landscape will reflect the physical state of individual features or elements. Due to the subjective value of the evaluation there is no comprehensive official process for identifying visual quality. The visual quality of this evaluation has been carried out by one Chartered Landscape Architect and verified by another.

12.3Receiving Environment

The proposed study area has been established by the use of a ZTV (See Figure 12.1 within Volume 3) and for the purposes of this report, extends along the corridor of the existing N16 road corridor to the County Boundary with Leitrim and is located to the northeast of Sligo City and defined by the strong topography found in this part of Sligo. The project itself extends from the townland of *Drumkilsellagh* to the townland of *Lugnagall* and measures approximately 2.5km in length.

The topography along the existing N16 road rises gradually from its lowest level adjacent to Sligo City (approx. 50mASL) to its highest level above Glencar Lake (approx. 130m ASL). In between the existing road undulates significantly and meanders as well across and around small undulations in the topography.

The topography within the study area is dominated by the tall massive mountains that lie to the north and south of Glencar Lake. To the north the range of mountains at their closest are represented by Kings Mountain that extends to 469m ASL. To the south of Glencar Lake lies another range of mountains that at their closest has Copes Mountain that extends to 452m ASL. Both sets of mountains are very distinctive to this part of Sligo and Leitrim and have fairly level summits and steep and rocky side slopes. These steep and rocky side slopes in close proximity to the lowlands and particularly Glencar Lake create a highly scenic landscape with spectacular views. Due to the difficulty of access there are few to no residential properties and roads on the high mountain landscapes.

Glencar Lake is fed by Glencar Waterfall and the Diffreen Stream, it discharges to the Drumcliff River, that flows west to the Atlantic and is dominated to the north and south by the high mountains and the sense of enclosure is strong due to the narrowness of the valley created in between. The existing N16 road extends to the south of the Lake and as its sits at a higher level in the topography the existing N16 road is afforded views to the north across the Lake and the escarpments and summits of Kings Mountain beyond. There are several small County Roads in and around the Lake that offer views to the Kings and Copes Mountains including along the Drumcliff River and on the northern side of the Glencar Lake. Copes

Mountain is less visible from the existing N16 due to the fact that the existing road sits on the lower slopes of Copes Mountain and this close proximity restricts views.

To the west of Glencar Lake the topography broadens out to form a lowland landscape. The Drumcliff River continues to meander west. The topography of this broader lowland landscape undulates with the majority of contours running east – west which most likely reflects the processes of glaciation during the last Ice Age. There are numerous small County roads criss-crossing the lowland landscape and frequent rural residential properties. Properties increase in frequency with proximity to Sligo City.

12.3.1 Landscape Character

The distinctiveness of different landscape characters in the study area can be sub-divided into four distinctive Landscape Character Areas (see Figure 12.2 contained within Volume 3) as follows:

- Sligo Lowland Agricultural Landscape
- Sligo Urban Landscape
- Glencar Lake Valley Landscape
- Copes Mountain Upland Landscape

12.3.1.1 Sligo Lowland Agricultural Landscape Character Area

A broad lowland landscape is located between the upland mountains of Kings Mountain and Copes Mountain and the coast through which Drumcliff River flows west towards the Atlantic. This lowland landscape gently undulates but is predominantly low-lying and in places almost level particularly in close proximity to the river. The undulations in the landscape are generally gentle but are steeper with proximity to the uplands to the east. The undulations are predominantly aligned in an east to west axis. The landscape is predominantly pastoral in land use with sheep and beef cattle grazing. Hedgerows are well maintained and vary from thin with post and wire to substantial hedgerows with trees. The hedgerows are stronger with more frequent trees with proximity to Glencar Lake and thinner to the west. There are also frequent trees along small streams that flow west towards Drumcliff River and the Atlantic Ocean. Residential properties are scattered through the lowland landscape but are greater in frequency with proximity to Sligo City to the southwest of the study area and also with proximity to the N15 road corridor to the west of the study area.

This landscape character area has a medium sensitivity to the type of change proposed.

12.3.1.2 Sligo Urban Landscape Character Area

Sligo is one of the largest urban centres in the northwest of Ireland and serves a wide hinterland acting as a regional hub. The City has historically grown on the banks of the River Garvogue in an undulating landscape. The river flows west to Sligo Bay and the Atlantic. The undulating landscape on which the City has grown has resulted in prominent built form that offers views north across the lowland landscape and upland mountains beyond. The core of the City is retail dominated with shopping streets including Wine Street; O'Connell Street; Grattan Street; Stephen Street; Castle Street and Market Street. The northern side of the City has a mixed use of residential, educational and industrial uses. The AbbVie pharmaceutical plant is located on the northeast edge of the City adjacent to the N16. Similarly there are extensive grounds for the Institute of Technology Sligo in this northern area as well as the Clayton Hotel. The remainder of the urban landscape consists of residential land use with properties lining the N16 road corridor and small housing estates frequent.

This landscape character area has a low sensitivity to the type of change proposed.

12.3.1.3 Glencar Lake Valley Landscape

Glencar Lake lies in the Glencar Valley, between the Dartry Mountains (including Kings Mountain) to the north and the mountain range that includes Cope's Mountain to the south. The Lake is located about 10 kilometres northeast of Sligo and is approximately 2.5 km long and 0.6 km wide. The Lake is located in a narrow valley constrained to the north and south by upland landscapes that provide a sense of enclosure.

The Lake is known to contain two crannogs at the western and eastern ends of the Lake. The Lake is fed by Glencar Waterfall, on the lake's northern shore, and by the Diffreen River to the east. The water from the Lake flows west to Drumcliff River which in turn flows west to Sligo Bay and the Atlantic. The Glencar Waterfall is a tourist attraction and lies within Leitrim. W.B.Yeats referred to the Glencar Waterfall in his poem called The Stolen Child when he wrote: "*Where the wandering water gushes from the hills above Glen-Car*".

A small County Road is found on the northern shoreline and offers views south over the Lake to Copes Mountain and west along the valley towards the distinctive summit of Belbulben. It is important to note that the existing N16 road is located within views from the lake shore road and existing traffic particularly HGV's are visible in views.

There are scattered residential properties along the northern shoreline that are readily visible from the N16 road corridor.

This landscape has a high sensitivity to the type of change proposed.

12.3.1.4 Copes Mountain & Kings Mountain Upland Landscape Character Area

The upland landscapes adjacent to the existing N16 are very good examples of the distinctive uplands found in Sligo and western Leitrim with distinctive level summits and steep sides with frequent rocky escarpments. The steep side slopes occasionally consist of forestry but predominantly the side slopes are limited in vegetation to grass which contrasts strongly with the rocky outcrops. The uplands are highly scenic and their value is recognised by designations in both Leitrim and Sligo Development Plans. The uplands are also valued by hillwalkers and there are several promoted long distance walks.

The uplands offer panoramic views across Glencar Lake and west towards Sligo and the sea. It should be noted that as there are no roads that cross these uplands such views are limited to the infrequent hillwalkers that use the upland trails.

There are no residential properties within the upland landscapes. There are no roads that cross the upland landscapes.

This landscape has a high sensitivity to the type of change proposed.

12.3.2 **Visually Significant Trees**

There is limited vegetation cover within the study area that is in the vicinity of the project with potential to be effected by the *Proposed Road Development*. This shortage of potentially visually significant vegetation results in increasing the value of such vegetation where it does occur in the study area. In summary the key areas of visually significant vegetation are as follows (see also Figure 12.2 within Volume 3 for locations);

- Coniferous forestry woodland between L7416-0 and L7415-0;
- Strong tree lined hedgerows immediately north of L74151-0 and between N16 and L7421-0;
- Woodland on both sides of N16 and sharp bend in N16 near *Castlegal*;
- Woodland north and south of N16 at its junction with L34041-0 and L3404-0;
- Woodland and forestry along the Drumcliff River corridor;
- Small woodland belt south of N16 and south of Gortnagrelly Bridge;

- Woodland along small stream towards Drumcliff River from N16 and across L7411-0;
- Coniferous forestry blocks south of N16 between viewpoint car park and County Boundary

12.3.3 Landscape Designations

The relevant Development Plan for the *Proposed Road Development* is the Sligo County Development Plan 2017 - 2023. The most recent Development Plan was published in August 2017 and was reviewed as part of this assessment to establish any landscape and visual policy or designations relevant to this assessment.

12.3.3.1 Sligo County Development Plan 2017 - 2023

The following relevant landscape designations have been identified in the Development Plan. In summary the *Proposed Road Development* crosses through Normal Rural landscape and a Scenic Route on the existing N16. Policies have been put in place by the Development Plan such as P-LCAP-1 – to protect and enhance the physical landscape, visual and scenic qualities of County Sligo. The Development Plan states:

> *"Planning applications that have the potential to impact significantly and adversely upon landscape character especially in Sensitive Rural Landscapes, Visually Vulnerable Areas and along Scenic Routes, may be required to be accompanied by a visual impact assessment using agreed and appropriate viewing points and methods for the assessment".*

12.3.3.1.1 *Landscape Character*

Section 7.4.3 of the Development Plan sets out a range of landscape areas for development control purposes that includes; Normal Rural; and Sensitive Rural Landscapes. The Development Plan Landscape Characterisation Map indicates the location of the range of landscape areas and the relevant designations have been summarised in Figure 12.2 contained within Volume 3 of this EIAR.

The Normal Rural Landscapes are characterised 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. Normal Rural Landscapes cover the majority of County Sligo. The majority of the *Proposed Road Development* crosses Normal Rural Landscape that is robust and capable of absorbing the *Proposed Road Development* and is predicted to not have significant effects and is not taken forward to the impact assessment section.

The Sensitive Rural Landscapes are areas that tend to be open in character, with intrinsic scenic quality and a low capacity to absorb new development. The nearest Sensitive Rural Landscape area to the *Proposed Road Development* is located at the Cope's Mountain area east of the existing N16 at *Castlegal* and *Lugatober*. A further Sensitive Rural Landscape area is located to the west at King's Mountain.

The Development Plan has policies relating to these landscapes that include:

- P-LCAP-4 Strictly control new development in designated Sensitive Rural Landscapes, while considering exceptions that can demonstrate a clear need to locate in the area concerned. Ensure that any new development in designated Sensitive Rural Landscapes: - does not impinge in any significant way on the character, integrity and distinctiveness of the area; - does not detract from the scenic value of the area; - meets high standards of siting and design; - satisfies all other criteria with regard to, inter alia, servicing, public safety and prevention of pollution.

12.3.3.1.2 *Visually Vulnerable*

The Development Plan Landscape Characterisation Map shows areas that are Visually Vulnerable and which are described within the development plan as distinctive and conspicuous natural features of significant natural beauty or interest that have an extremely low capacity to absorb new development. The designation of Scenic Routes provided a basis for protecting views and prospects of certain Visually

Vulnerable features. Policy P-LCAP-2 of the Development Plan aims to discourage any developments that would be detrimental to the unique visual character of designated Visually Vulnerable Areas.

There are areas identified as visually vulnerable at Cope's Mountain and King's Mountain areas.

12.3.3.1.3 *Scenic Routes*

The Plan has designated a series of Scenic Routes that forms the basis of protecting views and prospects of certain Visually Vulnerable features. It is the policy (P-LCAP-3) of the Development Plan to preserve the scenic views listed in Appendix E of the Development Plan and as illustrated in the Landscape Characterisation Map and summarised in Figure 12.2 contained within Volume 3 of this EIAR. The nearest Scenic Route to the *Proposed Road Development* are summarised as follows:

National Primary Routes

- N16 from Leitrim County boundary to Sligo that preserves views of Glencar Lake, Benbulben and Atlantic Ocean.

Regional Routes

- R291 from Sligo to Rosses Point preserving views of Sligo Bay and Harbour, Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Daeane, Killery Mountain and Ox Mountains.

Local Roads

- L-3311 (in Rosses Point village) as far as junction at Yeats County Hotel turning south onto Rosses Point Promenade Road (R291) to mini-plan development limit preserving views of Sligo Bay and Harbour Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Daeane, Killery Mountain and Ox Mountains;
- Glencar Lake to Carney (L-3404, L-3403 & L-3402) protecting views of Glencar Lake, Kings Mountain and Benbulbin;
- From junction of L-3409 and R286 at Ballynamona, northwards through Loughanelteen to Keelogyboy (L-3409 & L-7418), then south to R278 via Fermoyle (L-7420 & L-3407) that preserves views of of Keelogyboy Mountain, Cope's Mountain, Lough Anelteen, Killery Mountain, Lough Gill, Ox Mountains, Slieve Daeane, Slieve Dargan, Kings Mountain, Benbulben, Knocknarea, the coast, Sligo Bay and Atlantic Ocean;
- Glencar Lake to N16 (L-3404) protecting views of Glencar Lake and Kings Mountain.

12.4 Potential impacts

12.4.1 **Construction Phase**

During the construction phase potential impacts include:-

- Site preparation/enabling works and operations including temporary stockpiles;
- Compound location;
- Removal of existing trees and woodlands;
- Site infrastructure and access for construction traffic;
- Haul route traffic;
- Vehicular and plant movements including earthworks; and
- Dust emissions.

Chapter 4 of the EIAR sets out a detailed description of the proposed construction and operation phases of the *Proposed Road Development*. The construction works will be short term and are anticipated to be up to 18 months in duration. Works will be potentially visible from within the study area during this phase to a varied extent that will be related to the individual construction activity at any given time. It is anticipated that the majority of the material fill deficit will be obtained from the road cuttings, the Soil Repository/Borrow Pit at *Castlegal* and abundant quarries locally within a radius of 20km. A steepened side slope is also proposed on the eastern side of the alignment at circa Ch. 1,400m which will be designed to allow for vegetation on the slope. Traffic from existing quarries is already a feature of the local road network and particularly the existing N16 corridor and any increase in HGV traffic importing fill material will not result in significant visual impacts in this context. Similarly any material excavated within the *Proposed Road Development* will not result in significant visual impacts as the construction activity is limited and will be read with the on-going activities adjacent with slopes being soiled and vegetated.

Elsewhere ground level views of the site activities will be restricted by intervening strong topography and vegetation in the rural areas adjacent to the N16 that will limit the extent of potential construction phase impacts to localised areas in close proximity to the works. However due to the existing topographical characteristics of the undulating agricultural landscape the proposed construction site will have potential to be more visible to the wider surrounding landscape from elevated locations albeit as a minor feature and will be read in views with the existing N16 corridor.

A site for the construction stage compound has been identified and is described in Chapter 4 of the EIAR and has been located within the footprint of the *Proposed Road Development*; not within proximity to residential properties; not within visually vulnerable areas namely Cope's Mountain and King's Mountain areas; not were potential detriment effect on views from Scenic Routes would occur; and the compound area will be fully re-instated prior to or at the end of the construction contract.

Within the wider landscape, impacts during the construction phase will be Minor to Moderate negative due to the limited extent of the works along a 2.54km corridor and the limited influence the construction works will have on the landscape, its phased/sequenced construction and the duration of the works at any given location and proximity of works to the existing N16.

Other identified wider sensitive visual receptors (that include Scenic Routes and Visually Vulnerable Areas) will not have a high magnitude of impact, due to a combination of the large distance between proposed construction works and receptors and/or the intervening topography and particularly vegetation cover of the landscape. The majority of construction traffic activities will be visibly linked to the activities on the existing N16 that is immediately adjacent to the works when viewed from distance offsetting potential effects.

Properties at close proximity to the *Proposed Road Development* will have Moderate to Major visual impact when construction activities are in close proximity and short term in duration. Other identified wider sensitive visual receptors will be less impacted, due to a combination of the large distance between proposed construction works and receptors and/or the intervening vegetation and topography of the landscape and proximity of works to the existing N16.

No significant landscape or visual effects are predicted for the construction phase.

12.4.2 **Operational Phase**

The *Proposed Road Development* will result in new built elements in the local landscape albeit directly along the existing N16 road corridor. The principal sources of impact of such a development include:-

(i) Disturbance from traffic during operation;
(ii) Imposition of new features in the landscape including road; structures; cuttings and embankments; signs; and lighting at the roundabout at *Drumkilsellagh*.

The following features have been taken into account during the prediction of impacts; the level of new roads, side roads; junctions; road signs; lighting; attenuation ponds; structures; traffic on road including headlight glare; loss of trees/vegetation; and landscape treatments including hedgerows and woodland planting will be an intrinsic part of the *Proposed Road Development* (see Section 12.5 for details).

12.4.2.1 Landscape Character Area Impacts

The following landscapes have been identified and are located directly within the *Proposed Road Development* corridor;

- Sligo Lowland Agricultural LCA
- Glencar Valley LCA; and
- Cope's Mountain & Kings Mountain Upland LCA;

These Landscapes are assessed as follows.

12.4.2.1.1 *Sligo Lowland Agricultural Landscape*

The proposed road project is directly located within this landscape character from *Drumkilsellagh* and the junction of the existing N16 with the L3406-0 to *Lugatober* and the junction of the existing N16 and L-7413-0 and there will be direct impacts as result. The proposals will result in a new alignment of the N16 with embankments and cuttings that will alter this landscape permanently. However the *Proposed Road Development* does follow very closely the existing N16 and is located on top of the existing N16 in part for at least 300m blending the new alignment of the N16 with this existing feature in this landscape. The existing N16 is not a noticeable feature in the wider context of this landscape and cannot be considered to be prominent. This limited influence is due to the fact that the existing road follows the contours of the topography and benefits from screening in hedgerows etc in the adjacent landscape. As the proposed road improvement closely follows the existing N16 there is no reason to suggest that the proposals will not similarly benefit from these features and have a limited influence on this landscape. It is important to note that landscape treatment of the roadside including any embankments and cuttings will take place and this will further assist the new alignment of the N16 blending with the existing road corridor and this landscape.

It is therefore predicted that the *Proposed Road Development* will not be prominent widely across this landscape, as this landscape due to its undulating nature, has potential to quickly absorb changes with distance. The *Proposed Road Development* follows the local contours of the topography through this landscape.

This landscape character area has a medium sensitivity to the type of change proposed. The predicted change in landscape resource is small in proximity to the proposed route being within 1km as while the change in landscape resource would be partly distinguishable from the surroundings, the composition and character of the landscape would be similar to the pre change circumstances. Beyond this 1 km distance the landscape resource change will be negligible as it will not be distinguishable from the existing N16 corridor surroundings.

When landscape impacts are assessed during the operational stage they will be Minor adverse in proximity to the *Proposed Road Development* and Negligible to Minor adverse beyond 1km. No significant effects are predicted.

12.4.2.1.2 *Glencar Valley Landscape*

The proposed road project is directly located within this landscape character for a short section of approximately 1km at *Lugatober* from the junction of the existing N16 with L-7413-0 to immediately north of the junction of the existing N16 and L-3404-0 (Ch900 to Ch2,500) and there will be direct impacts as result. The proposals will result in a new alignment of the N16 with embankments and cuttings that will alter this landscape permanently. A realigned side road is required for the L3404-0. However, as with the southern portion of the proposal, the *Proposed Road Development* follows very closely the existing N16 and is also located on top of the existing N16 in part for the tie in at *Lugnagall* and this will help blend the new alignment of the N16 with this existing feature in this landscape and limit the extent of landscape resource change. Between Ch1900 and Ch2200 the new alignment will result in removal of visually significant vegetation. The existing N16 is not a noticeable feature in the wider context of this landscape and cannot be considered to be prominent. This limited influence is due to the fact that the existing road follows the contours of the topography and benefits from screening in hedgerows etc in the adjacent landscape. As the proposed road improvement closely follows the existing N16 there is no reason to suggest that the proposals will not similarly benefit from these features and will have a resultant limited influence on this landscape with short to medium term impacts Proposed landscape treatment of the roadside including planting on new embankments and cuttings will take place and this will further assist the new alignment of the N16 in blending with the existing road corridor and this landscape.

This landscape has a high sensitivity to the type of change proposed. The predicted magnitude of landscape impact will be small in proximity to the proposed route within 1km. Beyond this distance the magnitude of landscape impact will be negligible.

When landscape impacts are assessed during the operational stage they will be Minor to Moderate adverse in proximity to the *Proposed Road Development* and Minor adverse beyond 1km. No significant effects are predicted.

12.4.2.1.3 *Cope's Mountain & Kings Mountain Upland Landscape*

The *Proposed Road Development* is not directly located within this landscape character but is adjacent to it from *Lugatober* to *Lugnagall*, there will be no direct landscape impacts as result and there will be no loss of key landscape features. The existing N16 forms the western edge of this landscape and is an existing feature in the context of these lower slopes of this upland landscape. There will be no change to the landscape character resource as a result.

This landscape has a high sensitivity to the type of change proposed. The predicted change in landscape resource is no change. No significant effects are predicted.

Table 12-6: Summary of Landscape Character Impact Assessment

Landscape Character Area	Landscape Impact Assessment
Sligo Lowland Agricultural Landscape	Minor adverse (within 1km of proposed road project)
Glencar Valley Landscape	Minor to Moderate adverse
Cope's Mountain & Kings Mountain Upland Landscape	No change

12.4.3 Planning Policy Designation Impacts

12.4.3.1 Sligo County Development Plan 2017-2023

Impacts on relevant designations contained within the Sligo CDP 2017-2023 are assessed below.

12.4.3.1.1 *Sensitive Rural Landscapes*

The nearest Sensitive Rural Landscape area to the *Proposed Road Development* is located at the Cope's Mountain area east of the existing N16 at *Castlegal* and *Lugatober*. A further Sensitive Rural Landscape area is located to the west at King's Mountain (see Figure 12.2 contained within Volume 3 of this EIAR). The *Proposed Road Development* is not located directly within the Sensitive Rural Landscapes and therefore does not impinge on the existing features of the landscape character of these areas. The existing

N16 road corridor is a feature of the landscape immediately adjacent to the Cope's Mountain area and a distant feature barely perceptible from the King's Mountain area. As a result the proposals do not detract from the scenic quality of these areas and has been carefully designed to minimise earthwork requirements and blend in with the existing N16 road.

No significant effects are predicted for the Sensitive Rural Landscapes.

12.4.3.1.2 *Visually Vulnerable Areas*

Figure 12.2 contained within Volume 3 of this EIAR, shows areas that are designated as Visually Vulnerable in proximity to the *Proposed Road Development*. There is a link between designation of Scenic Routes and Visually Vulnerable features as the Scenic Routes provided a basis for protecting views and prospects of certain Visually Vulnerable Areas. There are areas identified as Visually Vulnerable at Cope's Mountain and King's Mountain areas. Such areas are seen as visually vulnerable when viewed from the surrounding Scenic Routes. The *Proposed Road Development* is not directly located within these Visually Vulnerable Areas as it is located at some distance from these areas with a sufficient separation distance to avoid indirect visual impacts particularly when the screening effect of local topography and vegetation are considered along with proximity to the existing N16 road corridor.

The *Proposed Road Development* will not result in effects that would be detrimental to the unique visual character of designated Visually Vulnerable Areas.

No significant effects are predicted for the Visually Vulnerable Areas.

12.4.3.1.3 *Scenic Routes*

Scenic Routes are summarised in Figure 12.2 contained within Volume 3 of this EIAR. The nearest Scenic Route to the *Proposed Road Development* are summarised as follows:

National Primary Routes-

There is a Scenic Route on the N16 from Leitrim County boundary to Sligo that preserves views of Glencar Lake, Benbulben and Atlantic Ocean. The *Proposed Road Development* will not be located within views from the N16 towards Glencar Lake, Benbulben and Atlantic Ocean and will not detract from this Scenic Route. It could also be argued that the new improved road, that takes out sharp bends in the road, will promote visibility from the road to the Visually Vulnerable Areas through safer road driving conditions.

No significant effects are predicted for the Scenic Route on the N16.

Regional Routes-

There is a Scenic Route on the R291 from Sligo to Rosses Point preserving views of Sligo Bay and Harbour, Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Daeane, Killery Mountain and Ox Mountains. This Scenic Route is located at some distance from the *Proposed Road Development* and is not directed towards the proposals.

No significant effects are predicted for the Scenic Route on the R291.

Local Roads-

There is a Scenic Route on the L-3311 as far as junction at Yeats County Hotel turning south onto Rosses Point Promenade Road (R291) to mini-plan development limit preserving views of Sligo Bay and Harbour Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Daeane, Killery Mountain and Ox Mountains. This Scenic Route is located at some distance from the *Proposed Road Development* and is not directed towards the proposals.

No significant effects are predicted for the Scenic Route on the L-3311.

There is a Scenic Route on the Glencar Lake to Carney (L-3404, L-3403 & L-3402) protecting views of Glencar Lake, Kings Mountain and Benbulben. The *Proposed Road Development* will not be located in views from this road in the same context as Glencar Lake. Views from these roads will be maintained towards the Lake. Similarly views from these roads towards King's Mountain and Benbulben will also be maintained and the proposals will not play a part in the views towards these features.

No significant effects are predicted for the Scenic Route on the L-3404, L-3403 & L-3402.

There is a Scenic Route from junction of L-3409 and R286 at Ballynamona, northwards through Loughanelteen to Keelogyboy (L-3409 & L-7418), then south to R278 via Fermoyle (L-7420 & L-3407) that preserves views of of Keelogyboy Mountain, Cope's Mountain, Lough Anelteen, Killery Mountain, Lough Gill, Ox Mountains, Slieve Daeane, Slieve Dargan, Kings Mountain, Benbulben, Knocknarea, the coast, Sligo Bay and Atlantic Ocean. This Scenic Route is located at some distance from the *Proposed Road Development* (approx. 5km south) and it will not be possible to view the proposals from this road due to the separation distance and intervening topography and vegetation.

No significant effects are predicted for the Scenic Route on the L-3409 and R286 at Ballynamona, northwards through Loughanelteen to Keelogyboy (L-3409 & L-7418), then south to R278 via Fermoyle (L-7420 & L-3407).

There is a Scenic Route from Glencar Lake to N16 on the L-3404 protecting views of Glencar Lake and Kings Mountain. The majority of the *Proposed Road Development* will not be located in views from this road in the same context as Glencar Lake and King's Mountain. Views from this road towards the Lake and King's Mountain will predominantly have the *Proposed Road Development* to the rear and outside views. It is only for a short section immediately adjacent to the N16 where there is a side road required for the realignment of the L-3404 that will be stopped up at the existing junction with the N16 where views may include the proposals but views towards Glencar Lake and King's Mountain will be maintained from the realigned L-3404. Again, it could also be argued that the new improved road, that takes out sharp bends in the road, will promote visibility from the L-3404 through improved road safety. The viewer sensitivity is high. The predicted visual impact is small. The significance of effect will be Minor to Moderate.

No significant effects are predicted for the Scenic Route on the L-3404.

12.4.4 Visual Impact on Residential Properties

12.4.4.1 Visual Impacts on Residential Properties

An assessment has been completed to determine the magnitude of visual impact of the *Proposed Road Development* during the operational stage on potential views from sensitive visual receptors (residential properties).

The location of all individual residential properties affected in close proximity to the *Proposed Road Development* is illustrated in Figure 12.3.1 to 12.3.2 contained within Volume 3 of this EIAR, and details on impacts on individual properties in the absence of mitigation are summarised in Table 12-7. Specific Landscape Mitigation (SLM) has been identified in Section 12.5 to address the significant impacts established.

Table 12-7: Visual Impact (without mitigation)

Degree of Visual Impact	Number of Properties Before Mitigation
Major to Substantial Negative	3

Degree of Visual Impact	Number of Properties Before Mitigation
Moderate to Major Negative	5
Minor to Moderate Negative	3
Minor Negative	10
Negligible to Minor Negative	4
None	29
Minor Beneficial	1
Moderate to Major Beneficial	2

12.5 Mitigation

12.5.1 Aims of Landscape Mitigation

The following are the aims of Landscape Mitigation:

- To provide mitigation measures to help avoid, reduce or remedy any significant landscape and visual impacts arising from any elements within the *Proposed Road Development*;
- To ensure the physical and visual integration of the *Proposed Road Development* and associated features into surrounding landscape;
- To provide screening to avoid, reduce or remedy visual intrusion at residential properties to address any negative aspects regarding the visual impact of the *Proposed Road Development*;
- To provide replacement planting for visually significant woodland and hedgerows lost due to widening or other construction works.

12.5.2 General Objectives of Landscape Mitigation

Mitigation should be in keeping with the existing landscape character. Therefore, small copses of woodland will be acceptable and beneficial to the landscape. In instances where small corners of fields are disrupted the intention will be to plant them and provide small wooded clumps to break up the visible mass of the road where appropriate. Plant mixes of native trees and shrubs and wild meadow grass mix will be planted where appropriate.

In line with the NRA Guide to Landscape Treatments of National Road Schemes in Ireland it is a core objective of the landscape mitigation to use native plants and seed from indigenous sources. The implementation of the landscape mitigation measures must be in accordance with the NRA Guide to Landscape Treatments.

12.5.3 Specific Landscape Measures (SLM)

Specific landscape mitigation measures to address significant effects identified in previous sections are summarised in Table 12-8 and outlined in terms of detail with Figures 12.4.1 and 12.4.2 contained within Volume 3 of this EIAR

Table 12-8: Specific Landscape Measures (SLM)

Location	Description of SLM
SLM 01:- Ch. 00 – 200 west side	Screening Woodland Mix planting

Location	Description of SLM
SLM 02:- Ch. 600 – 800 east side; and both sides of side road east of Ch. 700	Screening Woodland Mix planting
SLM 03:- Ch. 1150 – 1500 both sides	Using individual trees replant areas to replace trees lost; Screening Woodland Mix planting
SLM 04:- Ch. 1600 – 1950 west side	Screening Woodland Mix planting
SLM 05:- Ch. 1600 – 1800 east side	Screening Woodland Mix planting
SLM 06:- Ch. 2050 – 2500 both sides	Screening Woodland Mix planting

12.5.4 **Planting Specifications**

12.5.4.1 Tree, Hedge and Shrub Planting

All trees, shrubs, transplants/whips, hedging material and ground cover planting shall conform fully to the specification, prepared by the landscape consultant, in respect of species, size and quality. All plants shall be well grown, sturdy and bushy according to type and free from all diseases and defects. The plants shall be available for inspection prior to planting works. Any plant material that does not conform to the specification will be automatically rejected and must be removed from site. All trees, shrubs and other plant material shall comply with the standards set out in National Plant Specification (NPS) prepared by the Committee on Plant Supply and Establishment and published with the backing of the Joint Council of Landscape Industries (JCLI, 1989).

12.5.4.2 Defective Plant Material

All trees, shrubs, transplants, hedging material and ground cover planting shall be maintained and guaranteed for a period against death, deformation, die-back, or disease other than that caused by malicious damage.

12.5.4.3 Plant Mixes

Essentially bank planting will consist of ‘bare root transplants’, ‘whips’ and ‘feathered trees’ which, due to their smaller stock size at time of planting, will adapt more easily to the disturbed ground and exposed site conditions. All plants are to be positioned in the locations and in the required numbers and centres indicated on the agreed planting plan.

12.5.4.4 Screening Woodland Mix

Landscape mitigation planting of slopes and as compensation for loss of existing screening and loss of woodland, individual trees and hedgerows along the *Proposed Road Development* will exclusively use Irish native species that reflect the existing vegetation of the area. Core species will include; Hybrid Oak, Scots Pine, Hawthorn, Hazel, Holly, Blackthorn, Goat Willow, Alder, Rowan and Birch.

Woodland Mix areas will be planted as whips and feathered transplants at a standard size of 60-90 cm or 90-120 cm augmented by semi-mature individual trees at 10m centres. Species shall be randomly planted in groups. The majority of species used will be quickly maturing species and will have formed dense woodland within ten years. The canopy will reach at least 7 to 10 metres, in places where groups of trees are planted.

12.5.4.5 Individual Tree Planting

Individual semi-mature tree planting using the core native species (Hybrid Oak and Scots Pine) shall include standard (2.5–3.0 m) and heavy standard (3.5–4.25 m) trees to provide specific screening and early effect.

12.5.4.6 Native Shrub Planting

Shrub planting shall consist of native species from the core and additional species listed above to provide woodland understorey, woodland edge and scrub areas. Shrub planting mixes shall complement areas of woodland and be used at locations consistent with the Biodiversity assessment mitigation measures.

12.5.4.7 Grass and Wildflower Mixes

The road verges and unplanted side slopes will be seeded with a general (Grade II) grass seed mix with the exception of where rock cut occurs at *Castlegal* which will be left naturally. Areas away from designated sight lines where mowing regimes are not required to be of a regular nature will be seeded with wild grasses and meadow flowers. Grass and wildflower mixes using seed from Irish native sources shall be employed to provide quality areas of low maintenance, rapid establishment, and visual appearance.

The construction contractor will adhere to the NRA's Draft Guidelines on the Implementation of Landscape Treatment on National Road Schemes in Ireland, 2011. Storage areas will be so located to avoid impacting on existing residential properties, trees, hedgerows, drainage patterns etc. and such areas will be fully re-instated prior to or at the end of the construction contract.

12.6 Residual Effects

This section of the Report assesses the impact of the *Proposed Road Development* on the landscape character and visual receptors (previously identified in Section 12.4 after the mitigation (described above in Section 12.5) has attained 10 years of growth.

After 10 years of growth the proposed planting will help to integrate the proposal into the existing landscape. The proposed mitigation planting will limit the extent of the influence of the *Proposed Road Development* on the adjacent Landscape Character Areas with a resultant reduction in landscape impact.

As the vegetation re-establishes at roadsides the landscape impacts predicted at the construction stage will decrease and the *Proposed Road Development* will become an integrated component of this landscape.

With regards to visual impact on sensitive receptors in general the visual impacts are reduced by the establishment of replacement or new screening woodland that will offset views towards the *Proposed Road Development* and its infrastructure and traffic on the road. The predicted residual visual impacts for all properties are provided in detail in Figure 12.3.1 and 12.3.2 contained within Volume 3 and summarised below in Table 12-9.

Table 12-9: Residual Visual Impacts (After Mitigation)

Degree of Visual Impact	**Number of Properties Before Mitigation**	**Number of Properties After Mitigation**
Major to Substantial Negative	3	0
Moderate to Major Negative	5	3
Minor to Moderate Negative	3	5
Minor Negative	10	3

Degree of Visual Impact	Number of Properties Before Mitigation	Number of Properties After Mitigation
Negligible to Minor Negative	4	10
None	29	33
Minor Beneficial	1	1
Moderate to Major Beneficial	2	2

12.7 Interactions

This Landscape and Visual Impact Assessment has interactions with the Biodiversity; Noise & Vibration; Population and Human Health; and Archaeology, Architecture and Cultural Heritage assessments in this EIAR.

The Biodiversity assessment has identified existing tree and vegetation cover and where this will be lost as a result of the *Proposed Road Development*. This has also been considered to predict the significance of effects in landscape and visual terms. Proposed mitigation measures for landscape and visual effects will use native species that are consistent with the mitigation set out in the Biodiversity assessment.

The Landscape & Visual Impact Assessment has interactions with the assessment of effect for Population and Human Health. Visual impacts from the *Proposed Road Development* have potential to impact on the visual amenity of the local population. Predicted residual visual impacts are set out in Table 12-9 above.

Developments can sometimes infringe upon the amenity use and visual setting of an archaeological or architectural heritage feature and as a result lead to unacceptable impacts. The Landscape & Visual Impact Assessment has interacted with the Archaeology, Architecture and Cultural Heritage chapter with this regards with predicted effects described in Chapter 13.

There is potential for noise barriers to create landscape and visual impact however there will be no noise barriers required for the *Proposed Road Development*. The Landscape & Visual Impact Assessment has interacted with the assessment of noise effects and location of noise barriers to predict the effects set out in this Chapter above.

12.8Conclusion

The *Proposed Road Development* is located in proximity to a number of landscape character areas identified as; Sligo Lowland Agricultural Landscape; Sligo Urban Landscape; Glencar Lake Valley Landscape; Copes Mountain Upland Landscape.

The *Proposed Road Development* has been predicted to have the following landscape effects;

When Sligo Lowland Agricultural landscape impacts are assessed during the operational stage they will be Minor adverse in proximity to the *Proposed Road Development* and Negligible to Minor adverse beyond 1km. No significant effects are predicted.

When Glencar Lake Valley landscape impacts are assessed during the operational stage they will be Minor to Moderate adverse in proximity to the *Proposed Road Development* and Minor adverse beyond 1km. No significant effects are predicted.

The Copes Mountain Upland Landscape has a high sensitivity to the type of change proposed. The predicted change in landscape resource is no change. No significant effects are predicted.

The proposal will have no direct or indirect landscape effects on the Sligo Urban landscape.

On completion of the proposed Landscape Planting will assist in blending the new alignment of the N16 into the landscape further and reduce the predicted landscape effects during the operation stage.

An assessment of the Sligo County Development Plan has been completed to establish potential effects of landscape & visual designations. It has been predicted that there will be no significant landscape or visual effects for any relevant landscape policy and designations in the Plan in particular with regards to Scenic Routes, Visually Vulnerable Areas and Sensitive Rural Landscapes.

A detailed visual impact assessment for residential properties in proximity to the *Proposed Road Development* has been completed. Before mitigation a total of 3 properties are predicted to have Major to Substantial negative impact; 5 properties are predicted to have a Moderate to Major negative impact; 3 properties are predicted to have a Minor to Moderate negative impact; 14 properties are predicted to have a Minor negative impact; 29 properties are predicted to have No impact; 1 property has Minor beneficial impact; and 2 properties have Moderate to Major beneficial impact. Following completion of the proposed SLM measures the visual impacts are reduced as follows; No properties are predicted to have a Major to Substantial negative impact; 3 properties are predicted to have a Moderate to Major negative impact; 5 properties are predicted to have a Minor to Moderate negative impact; 3 properties are predicted to have a Minor negative impact; and 43 properties are predicted to have No impact; 1 property has Minor beneficial impact; and 2 properties have Moderate to Major beneficial impact.

12.9Relevant Figures and Appendices

12.9.1 Figures contained in Volume 3

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

Fig. 12.1: Zone of Theoretical Visibility;

Fig. 12.2: Landscape Character Map, CDP Sensitivities, and Visually Significant Trees;

Fig. 12.3.1 – 12.3.2: Property Impact Assessment;

Fig. 12.4.1 – 12.4.2: Specific Landscape Mitigation

12.9.2 Appendices contained in Volume 4

There are no appendices associated with this Chapter contained within Volume 4 of the EIAR:

13 Archaeology, Cultural Heritage and Architectural Heritage

13.1 Introduction

This chapter provides an assessment of the archaeological, cultural heritage and architectural heritage effects and impacts associated with the *Proposed Road Development*. This assessment has been undertaken by CRDS Ltd. on behalf of the TII National Roads Project Office of Sligo County Council.

The *Proposed Road Development* will run through the townlands of *Drumkilsellagh*, *Doonally (ED Drumcliff East)*, *Castlegal (ED Glencar)*, *Drum East*, *Lugatober* (occurring predominately within), *Collinsford* and *Lugnagall*, County Sligo.

13.2 Legislation, Standards and Guidelines

The following legislation, standards and guidelines were considered during the assessment:

- Advice notes on Current Practice (in the preparation of Environmental Impact Statements), 2003, Environmental Protection Agency.
- Architectural Heritage (National Inventory) and Historic Properties (Miscellaneous Provisions) Act, 1999.
- Code of Practice for Archaeology agreed between the Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs and Transport Infrastructure Ireland, 2017, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.
- Council of Europe Convention on the Protection of the Archaeological Heritage of Europe, (the ‘Granada Convention’) ratified by Ireland in 1997.
- Draft Advice notes for preparing Environmental Impact Statements, 2015, Environmental Protection Agency.
- Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports, 2017, Environmental Protection Agency.
- Environmental Impact Assessment of National Road Schemes – A Practical Guide, 2008, NRA.
- European Convention Concerning the Protection of the Archaeological Heritage (the ‘Valetta Convention’) ratified by the Republic of Ireland in 1997.
- Framework and Principles for the Protection of the Archaeological Heritage, 1999, Department of the Arts, Heritage, Gaeltacht and the Islands.
- Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes, 2005, National Roads Authority.
- Guidelines for the Assessment of Architectural Heritage Impacts of National Road Schemes, 2005, National Roads Authority.
- Guidelines on the information to the contained in Environmental Impact Statements, 2002, Environmental Protection Agency.
- Heritage Act, 1995.
- Local Government (Planning and Development) Act, 2000.
- National Cultural Institutions Act, 1997.
- National Monuments Act, 1930, amended 1954, 1987 and 2004.
- Roads Act, 1993, 1995, 2007.
- The Settings of Heritage Assets: Historic Environment Good Practice Advice in Planning, Note 3, Historic England, 2017.
- Transport Infrastructure Ireland, Project Management Guidelines.

13.3Methodology

13.3.1 Recorded Archaeological Monuments and Places

The Record of Monuments and Places (RMP), comprising the results of the Archaeological Survey of Ireland, is a statutory list of all recorded archaeological monuments known to the National Monuments Service. The relevant files for these sites contain details of documentary sources and aerial photographs, early maps, OS memoirs, the field notes of the Archaeological Survey of Ireland and other relevant publications. Sites recorded on the Record of Monuments and Places all receive statutory protection under the National Monuments Act 1994. The information contained within the RMP is derived from the earlier non-statutory Sites and Monuments Record (SMR); some entries, however, were not transferred to the statutory record as they refer to features that on inspection by the Archaeological Survey were found not to merit inclusion in that record or could not be located with sufficient accuracy to be included. Such sites however remain part of the SMR. The record is a dynamic one and is updated to take account of on-going research. The Record of Monuments and Places was consulted in the Archives of the Department of Culture, Heritage and the Gaeltacht. The Recorded Monuments and Places within c. 50m of the *Proposed Road Development* are listed in Appendix 13.1 contained with Volume 4 of this EIAR and their locations are shown in Figures 13.2.1 and 13.2.2 contained within Volume 3.

13.3.2 List of Monuments in State Ownership of Guardianship

National Monuments may be acquired by the Minister whether by agreement or by compulsory order. The State or Local Authority may assume guardianship of any national monument (other than dwellings). The owners of National Monuments (other than dwellings) may also appoint the Minister of the Local Authority as guardian of that monument if the State or Local Authority agrees. Once the site is in the ownership or guardianship of the State it may not be interfered with without the written consent of the Minister. The list of Monuments in State Ownership or Guardianship was consulted in the Archives of the Department of Culture, Heritage and the Gaeltacht. There are no National Monuments located within the study area.

13.3.3 List of Preservation Orders

Sites deemed to be in danger of damage or destruction can be allocated Preservation Orders under the 1930 National Monuments Act. Preservation Orders make any interference to the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation surrounding the site must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders by the written consent, and at the discretion of, the Minister. The List of Preservation Orders was consulted in the Archives of the Department of Culture, Heritage and the Gaeltacht. There are no sites subject to preservation orders located within the study area.

13.3.4 Topographical Finds

The National Museum of Ireland's (NMI) topographical files are a national archive of all known archaeological finds from Ireland. They relate primarily to artefacts but also include references to monuments and contain a unique archive of records of previous excavations. The topographical files were consulted to determine if any archaeological artefacts had been recorded from the area. Other published catalogues of prehistoric material were also studied: Raftery (1983 - Iron Age antiquities), Eogan (1965; 1983; 1994 - bronze swords, Bronze Age hoards and goldwork), Harbison (1968; 1969a; 1969b - bronze axes, halberds and daggers). There are no topographical finds recorded from the townlands within the study area.

13.3.5 Cartographic Sources

Cartographic sources were used to identify additional potential archaeological and architectural heritage constraints. Primary cartographic sources consulted consisted of the Ordnance Survey 6" and 25" maps, first and subsequent editions (T.C.D. Map Library, www.osi.ie). Pre-Ordnance Survey map sources assessed include the Down Survey County Map of Sligo, the Down Survey Barony Map of Carbury, the Down Survey Parish Map of Drumcliff and Taylor and Skinner's Maps of the Roads of Ireland Survey 1777.

13.3.6 Previous Excavations

The excavation bulletin website (www.excavations.ie) was consulted to identify previous excavations that have been carried out within the study area. This database contains summary accounts of excavations carried out in Ireland from 1970 to 2017. No excavations have been recorded from the townlands in the study area.

13.3.7 Local Authority Development Plan

The Sligo County Development Plan 2017 – 2023, the Sligo and Environs Development Plan 2010 – 2016 and Draft Sligo City and Environs Local Area Plan 2018-2024 were consulted. The plans include policy objectives for the protection of the city and county's archaeological, architectural and cultural heritage and list items of special interest within its functional area. The plans also contain a Record of Protected Structures (RPS) which includes every structure which is of special architectural, archaeological, artistic, cultural, scientific, social or technical interest within its functional area. No structures assigned to the RPS have been recorded in the study area.

The Landscape Character Assessment (LCA) in the Sligo County Development Plan 2017 – 2023 was reviewed for the study area. The LCA identifies Normal Rural Landscapes, Sensitive Landscapes and Visually Vulnerable Areas and Scenic Routes within the county. All sites of archaeological and historical interest are considered as visually vulnerable areas within the LCA.

13.3.8 National Inventory of Architectural Heritage.

The National Inventory of Architectural Heritage (NIAH) is a systematic programme of identification, classification and evaluation of the architectural heritage of the State. The Minister for Culture, Heritage and the Gaeltacht is currently using the Inventory as the basis for making recommendations for the inclusion of structures in the Record of Protected Structures (RPS). Buildings of architectural heritage potential are listed in Appendix 13.2 contained within Volume 4 of this EIAR.

13.3.9 Aerial Photography

Aerial photographs held by the Geological Survey of Ireland were consulted in the offices of the GSI in Beggars Bush. The collection consists of a comprehensive aerial survey of Ireland undertaken in the mid-1970s. The photographs are in black and white and the survey was flown at a height of c. 4750m (15000ft) giving a nominal scale of 1:30,000 (Photographic reference G373/G374). These were supplemented by modern Ordnance Survey aerial photographic mapping dating from 1999, 2000 and 2005 (www.osi.ie) and the Department of Agriculture orthographic photographs, 2012.

13.3.10 Historical Research

The baseline historical research included consultation of the JSTOR digital library, the National Library of Ireland catalogue, the Archaeology Data Service (http://archaeologydataservice.ac.uk/library/) and Hayes's catalogue of Manuscript Sources for the History of Irish Civilisation (Hayes 1965). Other sources consulted include the Ordnance Survey Records for Sligo, national and local historical and archaeological journals (see References).

13.3.11 **Site Assessment**

A full field survey of the proposed route was undertaken in April 2018. This involved the examination of archaeological, architectural and cultural heritage constraints identified during the desk-based assessment to determine their current extent and condition and to identify additional areas of archaeological potential (see Appendix 13.3 contained within Volume 4 of this EIAR.).

13.4 Archaeological, Cultural Heritage and Architectural Heritage background

While the area in which the *Proposed Road Development* is located is predominantly characterised by upstanding monuments of early medieval date (see below) there are a number of monuments indicating that the area was inhabited since the later prehistoric period.

13.4.1 **Geological Heritage**

The proposed route is located in an area of Carboniferous sediments, divided almost evenly north and south by a large east-west trending fault (see Soils and Geology, Figure 10.3.1 of Volume 3). The southern portion of the proposed route runs through an area known as the Ballyshannon Limestone Formation, consisting mostly of medium to light grey, massively bedded crinoidal calcarenite. Of note are the occurrence of black chert nodules interspersed through the sediment. The northern half of the proposed route runs through an area of laminated dark-grey calcareous shale, with abundant bioclastic debris (crinoid, brachiopod, solitary coral with large caniniids in the upper part, and bryozoans), known as the Benbulben Shale Formation. As noted, the two halves of the proposed route, and the geology described above, are separated by a geological fault as opposed to a conformable stratigraphic transition. At this fault junction also occurs (to the east) the Mullaghmore Sandstone Formation, a formation consisting of a series of cyclical units of siltstones and shales which coarsen up into medium to coarse grained sandstones. Trace fossils are abundant and varied, particularly in the shale; siltstones and rippled fine sandstones (Avbovbo 1973).

There are two significant geological landscapes in the area of the proposed route. Approximately 10km to the southeast occurs the northeast extent of the Ox Mountains. The Ox Mountains are an inlier forming a very long, narrow island of hills that extend for 104km from Co. Leitrim to Co. Mayo (see Long and Yardley 1979). They consist of Proterozoic metamorphic rocks, including gneiss of Dalradian Supergroup, formed over 600 Ma ago when a major rift formed between land of what has been named the Laurentian Continent (later to become North America) and the Avalonian Continent (later to become the western part of Eurasia). An ocean formed between the continents as they separated, called the Iapetus Ocean. A continuation of these rocks occurs today in the northeast of the USA, the Appalachian Mountains. Portions of the Ox Mountains are more recent granitic intrusions of Lough Talt and Easky Lough, dating to c. 400 Ma relating to the closure of the Iapetus Ocean.

The second significant geological feature in the surrounding landscape is Benbulben, a dramatic mountain of sandstone, silt, shale and limestone that dominates the views across the area. The northern portion of the proposed route traverses land underlain by rocks of the same formation as that at Benbulben.

The region has been subjected to numerous glaciations, the imprints of which have shaped the landscape. The region is part of what is known as the Drumlin Belt, which consists of tens of thousands of tightly-packed hills in a band stretching from county Down to Donegal Bay. These hills, called Drumlins, are a low oval mound or small hill, typically occurring in clusters, consisting of compacted boulder clay moulded by past glacial action. They are quite poor agriculturally, and the hollows between them tend to become water-logged, particularly in the west of Ireland where the rainfall is higher.

The soils of the area are representative of the underlying geology and glacial landforms and range from exposed bedrock and blanket peat bogs in the higher ground to alluvium in the valleys.

13.4.2 Prehistory (c. 8000 BC – AD 500)

The *Proposed Road Development* is located in Co. Sligo, which contains one of Europe's highest densities of archaeological sites. The county contains sites dating from the Mesolithic (c. 8000 – 4000 BC to the modern period but is probably best known for sites dating to the Neolithic period (c. 4000 – 2400 BC) particularly the passage tomb complexes including Carrowmore and Carrowkeel.

The earliest upstanding monuments in the study area date to the Early Bronze Age. The Bronze Age period saw the introduction of new technologies bringing about radical changes in settlement and burial practices throughout the country. The monuments in the area comprise two wedge tombs, one in the townland of *Drum East* (RMP SL009-028) and one in the townland of *Drumkilsellagh* (RMP SL009-031). Wedge tombs are the latest and most widespread form of megalithic tomb in the country. They comprise a rectangular chamber, generally tapering in width and height from the front to back of the monument giving the characteristic wedge shape which gives this monument type its name. They are typically roofed with stone slabs and covered in rubble stone cairns of circular, oval or D-shaped plan. Both cremations and inhumations were deposited in the tombs often accompanied by Beaker pottery, and flint or chert tools.

The wedge tomb at *Drum East* (CHC 01 - RMP SL009-028) is located within 50m of the *Proposed Road Development*. The tomb is now overgrown with a number of ash trees and other vegetation but was recorded by Ó'Nualláin during the Survey of the Megalithic Tombs of Ireland in the late twentieth century. At this time the tomb was already ruinous but consisted of an apparently wedge-shaped gallery flanked by the remains of outer-walling, retaining a single roofstone. The gallery was incorporated in a low mound measuring 11m east-west and 6m north-south. Wood-Martin (1889) records that an excavation carried out under the roofstone revealed little 'save a few calcined bones, large fragments of charcoal, shells of oyster and cockle and some uncalcined human bones lying together in a heap'.

Two barrow monuments are recorded in the townland of *Castlegal* (SL009-030 and CHC 02 - RMP SL009-027). Barrows are burial monuments, usually consisting of a circular central area, which may be flat, slightly dished or domed which is enclosed by a ditch and occasionally by an external bank. They are typically Bronze Age in date, but excavated examples date from the late Neolithic to the Iron Age. The central mound, created from the up-cast from the ditch, generally contains a burial or group of burials contained within stone lined cist or earth-cut pits often accompanied by grave goods including pottery. Barrows are categorised on the basis of surface morphology and the examples from the area comprise an embanked barrow (SL009-030) and a ring-barrow (CHC 02 – RMP SL009-027).

An assessment of the landscape potential of the study area indicates the presence of a number of small streams and areas of marshy ground in proximity to the *Proposed Road Development*. This indicates potential for a site type known as burnt mounds or 'fulacht fiadh'. Burnt mounds are thought to be the most common prehistoric monument type in the country. The most consistent elements are mounds of charcoal rich soil, heat-fractured stones accompanied by a trough sometimes lined with wooden planks, stone slabs or even clay (Waddell 2000). An essential element of the site type is their location close to water sources: streams, rivers, lakes or marshy ground. The exact use of these sites is still somewhat ambiguous with their traditional interpretation as cooking places coming into question. They date predominantly to the Bronze Age primarily to the second millennium BC (Brindley, Lanting & Mook 1989-90) but date ranges from the Mesolithic period to the medieval period have been returned.

13.4.3 **Early Medieval Period (c. AD 500 – 1170)**

The landscape in which the *Proposed Road Development* is located underwent radical changes from the fifth century AD. Significant increases in population were brought about by new agricultural practices associated with the development of pasture and arable farming.

Early medieval settlement is very well represented in the archaeological record and a large number of ringforts survive. Ringforts are the characteristic settlement site of this period, generally consisting of a circular area surrounded by a bank or fosse, or simply by a rampart of stone. In the latter case they are often referred to as cashels (from the Irish caisel) while those with earthen enclosures are also known by the Irish terms rath or lios. Ringforts are usually interpreted as being defended farmsteads. The interior space would have contained a house and other buildings with the area forming a farmyard. Although the emphasis in the literary sources from the period is on pastoral farming, the results of excavations and palynological studies have emphasised the importance of a mixed farming economy during this period (Edwards 2005). There are six recorded ringforts within c. 500m of the *Proposed Road Development* (SL009-023, SL009-026, SL009-029, SL009-035, SL009-037 and SL009-061). A ringfort situated in the townlands of *Lugatober* and Castlegar (CHC 11/RMP SL009-026) is located within 50m of the *Proposed Road Development*. The site has been impacted by quarrying, possibly associated with the construction of the existing N16 road which runs to its west, and the construction of the townland boundary between *Lugatober* and *Castlegal*. Another ringfort situated in the townland of *Doonally* (CHC 12 – RMP SL009-035) is located within 50m of the *Proposed Road Development*. It consists of a slightly raised circular area with a diameter of 22m, enclosed by a low, broad earthen bank and external fosse.

Many raths and cashels have been partially or completely destroyed since the 1960s and often the only indication of the former presence of a ringfort is preserved in townland name elements such as Dún, Rath, Cashel or Lios. However, monuments which have experienced above-ground disturbance continue to be of archaeological interest due to the potential for subsurface remains to exist at their locations. The term 'enclosure' is applied to monuments that cannot be classified more accurately without archaeological assessment but were identified as enclosures during fieldwork or through the study of aerial photography or other sources. When investigated further through archaeological assessment, enclosures often prove to be highly denuded ringforts, former church sites, or some other archaeological site type. They can also prove to be of no archaeological significance. There are two recorded enclosures within c. 500m of the *Proposed Road Development* (SL009-034 and SL009-038).

13.4.4 **Late Medieval and Post Medieval Period (c. AD 1170 – 1700)**

The later medieval history of the area is dominated by the City of Sligo, located c. 4.5km to the southwest of the *Proposed Road Development*. Sligo is the second largest urban centre in Connacht and the largest in Co. Sligo. Its site on the Garavoge (Garavogue) River and its strategic location between Lough Gill and the sea made it important from early times. The modern city of Sligo may have developed from a small settlement which grew up on a crossing point on the river. A bridge, possible of timber, is mentioned in 1188 and again in 1236 when it was burnt along with the settlement by the Anglo-Normans (Gallagher and Legg 2012). Following this, Sligo together with extensive territories, was granted to the Norman baron Maurice Fitzgerald, ancestor of the Geraldine Earls of Kildare.

Fitzgerald played a leading part in Richard de Burgos annexation of Connaught; as a reward, he gained an extensive feudal lordship in North Connaught. Sligo was convenient both as an administrative centre for the Geraldine Lordship and as a springboard for the claims over Tyrconnell and Fermanagh which had been conveyed to Maurice Fitzgerald by Hugh de Lacy as Earl of Ulster. Sligo's strategic location at the intersection of the territories of the O'Connor's of Connacht and the O'Donnell's of Tyrconnell led to a sustained period of warfare throughout the later thirteenth and fourteenth centuries for control over the castle and the river crossing (Gallagher and Legg 2012).

Following some economic success in the fifteenth and early sixteenth centuries the city again became a strategic military objective. It was attacked and destroyed by the Burkes of Mayo in 1574 and the Scots in 1582. After the conclusion of the Nine Years Way in 1603 the settlement began to prosper again. In 1613 the city was granted corporation and parliamentary status by King James I (Gallagher and Legg 2012). Sir Frederick Hamilton attacked the city in 1642, sacking the priory and killing several of the friars. Following the attack, he retreated to his home in Manorhamilton, Co. Leitrim through the Glencar Valley where some of his men were led to their death.

13.4.5 Early Modern

Following a period of rebellion and unrest, the eighteenth century heralded a period of relative stability in Co. Sligo. The major redistribution of lands as part of the Cromwellian settlements was followed by the imposition of a system of estate landholding on the landscape and was linked to the construction of classical houses with demesne landscapes and associated large farms. In the early nineteenth century, the principal estate house in the area were *Doonally* House, located c. 750m to the south of the *Proposed Road Development* and Willowbrook House, located c. 925m to the southeast of the *Proposed Road Development*. Both are included in the list of principal seats compiled by Samuel Lewis (1837) in the parish of Drumcliffe. The Parke family had been granted lands in Sligo, including *Doonally* (Dunally) as part of the Cromwellian settlement. The lands had previously belonged to the O'Connor's. The present house at *Doonally* dates to the first half of the nineteenth century and was occupied by Roger K. Parke at the time of the Griffith's primary valuation (http://www.landedestates.ie/LandedEstates/jsp/search.jsp?q=*Doonally*%3E). Willowbrook was part of the estate of the Ormsby Gore (Lord Harlech's) which contained extensive lands in counties Sligo, Leitrim, Mayo and Roscommon. At the time of Griffiths Valuation, the property was leased by Andrew McCullough. The house was accidently destroyed by fire in December 1867 (http://www.landedestates.ie/LandedEstates/jsp/search.jsp?q=willowbrook).

Population levels in Co. Sligo dropped from over 180,000 in 1841 to 120,000 in 1851 as a result of the Great Famine. The second half of the nineteenth century saw the rationalisation of the rural landscape and the setting out of the current field systems and rural settlement patterns. The architectural heritage is dominated by the presence of farmhouses and outbuildings. The surviving structures are typically rectangular in plan, single-storey with some larger two-storey examples. They are constructed of roughly dressed limestone, generally extracted from small local quarries. They have single-span pitched roofs, which would originally have been covered in natural slate or thatch, though many have been re-covered in corrugated iron. At some sites the older farmhouse located in the centre of the farm and accessed by means of a laneway has been replaced by a modern bungalow or house on the roadside. Some of the original farmhouses are derelict or have been modified for use as agricultural outbuildings (AHC 43 and AHC 44).

Castlegal House (AHC 41) is the only named house within the study area. It comprises a four-bay, two-storey house, built c. 1820 and extended or rebuilt in the mid-nineteenth century. The outbuildings include an early nineteenth century three-bay, two-storey barn, constructed of coursed squared rubble masonry. In the mid-nineteenth century *Castlegal* was one of two houses leased by the Parke family from George Dunne:

(http://landedestates.nuigalway.ie:8080/LandedEstates/jsp/search.jsp?q=*Castlegal*).

The land on which the house was built was originally part of the Cope estate.

13.4.6 Cultural Heritage

The term 'Cultural Heritage' can be seen to reflect the value communities place on tangible features such as buildings, historic places, monuments and artefacts, as well as intangible features such as stories, festivals and language. Memory, tradition and folklore can play an important role in determining the cultural heritage of an area.

The tangible cultural heritage of the study area might include such landscape features as earthen townland, parish and barony boundaries, field boundaries, early road signs and milestones, twentieth century roadside memorials, sites with local historical significance (i.e. famine graveyards, mass rocks and sports grounds) or sites associated with well-known personages. The intangible cultural heritage may be taken to include any folkloric aspects.

13.4.6.1 Townland Names

Townland names are derived from a number of sources and provide valuable information about natural and man-made features or important local personal names. The townlands through which the *Proposed Road Development* runs were investigated in the Placenames Database of Ireland (www.logainm.ie) and in the historic Ordnance Survey Records for Sligo (see Table 13-1). The Placenames Database is a database of place names in Ireland, founded by Fiontar and Scoil na Gaeilge (DCU) and The Placenames Branch (Department of Culture, Heritage and the Gaeltacht). The database contains archival material including translations and historical information from the Ordnance Survey Records.

Table 13-1 Townland Names

Townland Name	Derivation	Additional Historical Information
Castlegal	*Castlegal* (white) from a house built by Mr. Cope.	The Sligo and Manorhamilton road passes through it. There is a pound situated in the southern extremity of the townland close to where two roads meet, there are also four old forts in the townland.
Collinsford	Ath a Choilin – Collins' ford	There are two old forts in this townland, one of which situated on the west side of *Collinsford* trigonometrical station. There is also a corn and tuck mills situated close to the N.W. boundary of this townland. The road leading from Sligo to Manorhamilton passes through it. A branch from the above road crosses the river by a ford which is the northern boundary of this townland. There is also a quarry situated on the southern boundary. OS Letters - It is called in Irish Ath Achoilin's – Vadum Collini. Tradition further says that at this ford O'Conor always opposed O'Donnell...There is a curious coincidence between this tradition and O'Conor's marching, A.D. 1536, to Braghait Choillighe to oppose O'Conor, which if it be the same with Bradchoillin, lies between this ford and Benbulbin ... Collins, from whom the ford took its denomination, lived there at the time of O'Donnell. He is said to have been a very cruel rascal, who beheaded every person detected by him making an attempt to cross the ford.
Doonally	Dun Aile, fort of the cliff or precipice.	There are two forts in the townland. Willowbrook House, the residence of Col Parks is situated this townland. The glen road runs close to its eastern boundary.
Drum East	Druim, a ridge.	There is a quarry situated in the easterly part of the townland. The Sligo and Manorhamilton Road runs along its eastern boundary.
Drumkilsellagh	Druim-cill-saileach, ridge of the church of the sallows (sally trees).	There is an old fort and gravel pit in the townland. The Sligo and Manorhamilton Road passes through it with a bye road.
Lugatober	Lug a' tobair, hollow of the well or spring.	On the northern boundary 6 ½ chains east of the road is a quarry, there is also a Deer Park and fort in this townland and the Sligo and Manorhamilton road passes through it and sever bye roads.

Townland Name	Derivation	Additional Historical Information
Lugnagall	Lag nan Gall, 'hollow of the foreigners'.	There are two forts in this townland. The Sligo and Manorhamilton road passes through it with several bye roads.
Willowbrook	Gabhlann, an Irish name meaning a small fork.	There are two forts, one in the southeast corner, the other convenient to its western boundary. There is a tuck mill close to the northern boundary.

13.4.6.2 Schools Collection

The Schools' Collection of the National Folklore Collection (see https://www.duchas.ie/en) comprises approximately 740,000 pages of local folklore and tradition compiled by primary school pupils between 1937-9. The scheme was initiated by the Irish Folklore Commission and involved enlisting pupils to collect local folklore from their parents, grandparents and neighbours. The records typically contain 'oral history, topographical information, folktales and legends, riddles and proverbs, games and pastimes, trades and crafts'.

While there was no specific story relating to a possible mass rock within the townland of *Doonally*, the presence of locations within the neighbouring townland of *Castlegal* where mass was held secretly is recorded in the story the Protestant Fall.

Stories collected in the townland of *Lugatober* record the retreat of Lord Hamilton following the sacking of Sligo Abbey in 1642. As he and his men retreated over the hills between Sligo and Manorhamilton, a portion of his men became lost in the mist. They met McSharry, a stranger, and asked him to guide them through the hills. The soldiers dressed him in a white friar's cowl. McSharry intentionally led them over a steep rock cliff to their death. For years after the incident old bayonets and swords were found by the inhabitants of the locality. The incident is commemorated in William Butler Yeats short story 'The Curse of the Fires and of the Shadows'.

13.4.6.3 William Butler Yeats and Sligo

William Butler Yeats is recognised as one of the greatest poets and playwrights in the English language. Though born in Dublin in 1865 Yeats spent much of his childhood years in Sligo and his poetry vividly evokes the local landscapes including Benbulben, Rosses Point and Inishfree. His mother's family the Pollexfens were a wealthy merchant family in Sligo town, who owned a milling and shipping business and Yeats regularly visited the home of his uncle Matthew as a child. The house, Fort Louis (NIAH reg. ref. 32323005), is located in the townland of Rathbraghan c. 2.8km to the southwest of the *Proposed Road Development*. It was constructed in the mid-eighteenth century and comprises a nine-bay single storey house. The *Proposed Road Development* is located within Glencar Valley which is referenced in his writings including the poems 'Towards Break of Day' and 'The Stolen Child'. Glencar Waterfall is located at the head of the valley c. 3.5km northeast of the *Proposed Road Development*.

Extract from Towards Break of Day:

I thought 'There is a waterfall

Upon Ben Bulben side

That all my childhood counted dear

Were I to travel far and wide

I could not find a thing so dear'

Extract from The Stolen Child:

Where the wandering water gushes

From the hills above Glen-car,

In pools among the rushes

That scarce could bathe a star,

We seek for slumbering trout

And whispering in their ears

Give them unquiet dreams."

13.5 Archaeological, Cultural Heritage and Architectural Heritage Impact Assessment

13.5.1 Archaeological and Cultural Heritage Impact Assessment

The purpose of the assessment is to identify the likely and significant impacts on the constraints identified in the desk survey. The assessment refers to definitions included in Draft Advice notes for preparing Environmental Impact Statements, EPA 2015 and Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes, NRA 2005.

Along with physical impacts on monuments, legislation provides for the protection of the amenity or setting of a monument. English Heritage in their guidance document on the Setting of Heritage Assets (2011, 2) defines the setting of a heritage asset as 'the surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve'.

They set out a series of steps to consider in the assessment of impact on heritage assets (2011, 8):

- Step 1 - Identify which heritage assets and their settings are affected;
- Step 2 - Assess the degree to which these settings make a contribution to the significance of the heritage asset(s) or allow significance to be appreciated;
- Step 3 - Assess the effects of the *Proposed Road Development*, whether beneficial or harmful, on that significance or on the ability to appreciate it;
- Step 4 - Explore ways to maximise enhancement and avoid or minimise harm;
- Step 5 - Make and document the decision and monitor outcomes.

13.5.1.1 Construction Phase Impacts

Twenty archaeological and cultural heritage sites or areas of archaeological potential were identified within 50m of the *Proposed Road Development* (shown on Figures 13.2.1 and 13.2.2 contained within Volume 3 and Table 13-5 Inventory of Archaeological and Cultural Heritage Sites within c. 50m of the *Proposed Road Development*). These sites have been compiled from various sources including the Record of Monuments and Places, Ordnance Survey maps, aerial photographs and field survey.

The assessment of the terrain potential and the examination of the type, density and distribution of archaeological sites within the landscape give rise to the identification of areas and sites of archaeological potential. These areas may be included given their:

- Proximity to recorded archaeological monuments
- Association with either topographic features or wetland terrain
- Place name evidence
- Find spots of stray finds

The significance criteria, outlined in the NRA Guidelines was used to assess the significance (e.g. legal status, condition, historical significance, group value, rarity, visibility, fragility and amenity value; NRA, 2005) of impacts.

Avoidance is the preferred mitigation measure. However, given the widespread and geographical nature of linear road development it is inevitable that impacts will occur. Early recognition of the type and level of impact should make it possible to minimise and reduce the loss of archaeological heritage features and provide suitable mitigation measures.

The impacts of the proposed route on the archaeological, and cultural heritage environment are first assessed in terms of their quality i.e. positive, negative or neutral.

Table 13-2 Type of Impact (Source NRA 2005)

Direct	Where an archaeological feature or site is physically located within the footprint of a potential route and entails the removal of part, or all of the monument or feature.
Indirect	Where a feature or site of archaeological heritage merit or its setting is located in close proximity to the footprint of a potential route alignment. Mitigation could ameliorate and reduce potential negative impacts.
None predicted	Where the potential route does not adversely or positively affect an archaeological heritage site.

There are twenty (20 no.) archaeological and cultural heritage constraints within the study area. _Pre-mitigation the type of impacts is considered:

- Direct for fifteen (15 no.) of the sites
- Indirect for our (4 no.) of the sites; and
- There will be no predicted impact for one (1 no.) of the sites.

Table 13-3 Quality of Impact (Source NRA 2005)

Negative impact	A change that will detract from or permanently remove an archaeological monument from the landscape.
Neutral impact	A change that does not affect the archaeological heritage.
Positive impact	A change that improves or enhances the setting of an archaeological monument.

A rating of the significance of each impact is then given i.e. profound, significant, moderate, slight, or imperceptible:

Table 13-4 Levels of Perceived Significance of Impact (Source NRA 2005)

Profound	Applies where mitigation would be unlikely to remove adverse effects. Reserved for adverse, negative effects only. These effects arise where a site is completely and irreversibly destroyed by a *Proposed Road Development*.
Significant	An impact which, by its magnitude, duration or intensity alters an important aspect of the environment. An impact like this would be where part of a site would be permanently impacted upon, leading to a loss of character, integrity and data about the feature/site.
Moderate	An impact where a change to the site is proposed which though noticeable is not such that the archaeological integrity of the site is compromised, and which is reversible. This arises where an archaeological feature can be incorporated into a modern-day development without damage and that all procedures used to facilitate this are reversible.

Slight	An impact which causes noticeable changes in the character of the environment which are not significant or profound and do not directly impact or affect an archaeological feature or monument.
Imperceptible	An impact capable of measurement but without noticeable consequences.
No impact	No perceived impact.

Pre-mitigation the potential impact of the *Proposed Road Development* is considered:

- Moderate for eighteen (18 no.) of the constraints,
- No predicted impact for two (2 no.) constraints.

Table 13-5 Inventory of Archaeological and Cultural Heritage Sites within c. 50m of the Proposed Road Development

ID no.	Status	Ref no.	Site type	ITM Reference (E,N)	Distance to CPO/ Route	Perceived Significance	Type of Impact	Significance & Quality of Impact
AAP 07	N/A	N/A	Stream	571775, 840335	0	Regional	Direct	Moderate, negative
AAP 15	N/A	N/A	Stream	571798, 840956	0	Local	Direct	Moderate, negative
AAP 16	N/A	N/A	Stream	572195, 841506	0	Local	Direct	Moderate, negative
AAP 17	N/A	N/A	Area with settlement potential	572199, 841639	0	Local	Direct	Moderate, negative
AAP 18	N/A	N/A	Raised circular platform and possible palaeo-channel	571869, 840103	50	Local	No predicted impact	No impact
AAP 19	N/A	N/A	Area of wet, rushy ground	571982, 841386	0	Local	Direct	Moderate, negative
AAP 20	N/A	N/A	Quarry	572144, 8410509	0	Local	Direct	Moderate, negative
CHC 01	RMP	SL009-028	Megalithic tomb - wedge tomb	571651, 840453	8	National	Indirect	Moderate, negative. Imperceptible impact on setting.
CHC 02	RMP	SL009-027	Barrow – Ring barrow	571912, 840728	55	National	No predicted impact	No impact
CHC 11	RMP	SL009-026	Ringfort - rath	571681, 840765	0	National	Direct	Moderate, negative.
CHC 12	RMP	SL009-035	Ringfort - rath	571607, 839729	12	National	Indirect	Moderate, negative. Imperceptible impact on setting.
CHC 72	N/A	N/A	Old road	571699, 840333 to 571973, 840668	0	Local	Direct	Moderate, negative
CHC 80	N/A	N/A	Building, site of	571646, 839810	0	Local	Direct	Moderate, negative
CHC 82	N/A	N/A	Building, site of	571736, 840359	0	Local	Direct	Moderate, negative
CHC 83	N/A	N/A	Building, site of	571734, 841056	0	Local	Direct	Moderate, negative

ID no.	Status	Ref no.	Site type	ITM Reference (E,N)	Distance to CPO/ Route	Perceived Significance	Type of Impact	Significance & Quality of Impact
CHC 84	N/A	N/A	Mass rock (possible), current site of	571750, 839644	0	Local	Direct	Moderate, negative
CHC 85	N/A	N/A	Well	571745, 840358	0	Local	Direct	Moderate, negative
TB 05	N/A	N/A	Townland boundary	571690, 839765	0	Local	Direct	Moderate, negative
TB 06	N/A	N/A	Townland boundary	571775, 840335	0	Local	Direct	Moderate, negative
TB 07	N/A	N/A	Townland boundary	571655, 840500	0	Local	Direct	Moderate, negative
TB 08	N/A	N/A	Townland boundary	571738, 840771	0	Local	Direct	Moderate, negative
TB 09	N/A	N/A	Townland boundary	572191, 841508	0	Local	Direct	Moderate, negative
TB 20	N/A	N/A	Townland boundary	571268, 841610	0	Local	Direct	Moderate, negative
TB 21	N/A	N/A	Townland boundary	572320, 841640	8	Local	Indirect	No impact

13.5.1.2 Summary of Perceived Significance of Sites and Impact Significance

Table 13-6 Direct Impacts

Impact Significance	International	National	Regional	Local	Record only
Profound	0	0	0	0	0
Significant	0	0	0	0	0
Moderate	0	1	1	17	0
Slight	0	0	0	0	0
Imperceptible	0	0	0	0	0
Total	0	1	1	17	0

Table 13-7 Indirect Impacts

Impact Significance	International	National	Regional	Local	Record only
Profound	0	0	0	0	0
Significant	0	0	0	0	0

Impact Significance	International	National	Regional	Local	Record only
Moderate	0	2	0	1	0
Slight	0	0	0	0	0
Imperceptible	0	0	0	0	0
Total	0	3	0	1	0

Table 13-8 No Impacts

Impact Significance	**International**	**National**	**Regional**	**Local**	**Record only**
Total	0	1	0	2	0

The paragraphs below summarise the impact of the proposed route on archaeological and cultural heritage sites including Recorded Archaeological Monuments and Places, Areas of Archaeological Potential (including watercourses), townland boundaries and cultural heritage constraints. The information is summarised from Table 13-5 above.

13.5.1.3 Pre-mitigation construction phase impacts

13.5.1.3.1 *Impacts on Sites included in the Record of Monuments and Places*

The *Proposed Road Development* will impact directly on one site included in the Record of Monuments and Places namely a ringfort (CHC 11 – RMP SL009-026).

The *Proposed Road Development* will impact indirectly on two sites included in the Record of Monuments and Places namely a ringfort (CHC 12 – RMP SL009-035) and a wedge tomb (CHC 01 – RMP SL009-028).

13.5.1.3.2 *Impacts of Areas of Archaeological Potential*

The *Proposed Road Development* will impact directly on six sites of archaeological potential namely three streams (AAP 07, AAP 15 and AAP 16),an area with settlement potential (AAP 17), an area of wet, rushy ground (AAP 19) and the site of a former quarry (AAP 20).

Watercourses are considered to be of high archaeological potential, containing features such as *fulachta fiadh* or burnt mounds, fords, ancient bridging sites, mills, and longphorts (Viking harbours) and producing archaeological artefacts such as log boats, organic material and votive offerings of axeheads and metalwork. Riverbank sites have been favoured for human occupation since prehistoric times for their proximity to rich food sources and fresh water and have additionally served as routeways, boundaries, and defences and as a focus for ritual.

While much of the study area has been subject to field drainage and other land improvements some areas of wet ground were noted during the assessment. These areas are considered to have high archaeological potential due to their preservative qualities.

13.5.1.3.3 *Cultural Heritage Constraints*

The *Proposed Road Development* will impact directly on a further six cultural heritage constraints namely the site of an old road (CHC 72), the site of three buildings marked on the 1st edition map (CHC 80, CHC 82, CHC 83),the current site of a possible mass rock (CHC 84) and a well (CHC 85).

13.5.1.3.4 *Impacts on Townland Boundaries*

The *Proposed Road Development* will impact directly on six townland boundaries comprising natural features such as streams and manmade features such as roads, laneways or earthen banks and ditches (TB 05, TB 06, TB 07, TB 08, TB 09 and TB 20).

The *Proposed Road Development* will impact indirectly on one further townland boundary (TB 21).

13.5.1.3.5 *Additional Area Impacts*

Provision has been made as part of this *Proposed Road Development* for a compound and for a soil repository within the CPO, and mitigation has been included for these areas. In the event that additional areas are required outside of the CPO for disposal of or acquisition of material, other than in areas that are already licenced for such activity, then this activity could have an archaeological impact. In particular there are four known monuments within 50m of the *Proposed Road Development* and numerous other sites also within 500m.

13.5.1.4 Operational Phase Impacts

The operational phase of the *Proposed Road Development* will have a permanent impact on the setting of three recorded archaeological monuments namely two ringforts (CHC 11 and CHC 12) and a wedge tomb (CHC 01). These sites are currently located on private land and are not currently accessible to members of the public. A portion of CHC 11 will be acquired as part of the CPO for severance reasons, however it will be excluded from the Lands Made Available for construction and thus preserved in situ.

13.5.2 Architectural Heritage

The inventory of architectural heritage sites identified during the assessment is included below (Appendix 13.2 contained within Volume 4 of this EIAR and Table 13-12). Their locations are marked on the accompanying maps (see Figures 13.2.1 and 13.2.2 contained within Volume 3).

13.5.2.1 Architectural Heritage Impact Assessment

Impacts may be categorised as either:

- Direct Impacts – where a feature or site of architectural heritage merit is physically located in whole or in part within the footprint of a potential route alignment.
- Indirect impacts – where a feature or site of architectural heritage merit or its setting is located in close proximity to the footprint of a potential route alignment.
- No predicted impact – where the potential route option does not adversely or positively affect an architectural heritage site.

Avoidance of architectural heritage is the preferred mitigation measure. However, given the widespread and geographical nature of linear road development it is inevitable that impacts will occur.

Definitions of the significance of each impact are as follows.

Impacts of Negative Quality

- Profound – An impact that obliterates the architectural heritage of a structure or feature of national or international importance. These effects arise where an architectural structure or feature is completely and irreversibly destroyed by the *Proposed Road Development*. Mitigation is unlikely to remove adverse effects.

- Significant – An impact that, by its magnitude, duration or intensity alters the character and / or setting of the architectural heritage. These effects arise where an aspect or aspects of the architectural heritage is / are permanently impacted upon leading to a loss of character and integrity in the architectural structure or feature. Appropriate mitigation is likely to reduce the impact.
- Moderate – An impact that results in a change to the architectural heritage which, although noticeable, is not such that alters the integrity of the heritage. The change is likely to be consistent with existing and emerging trends. Impacts are probably reversible and may be of relatively short duration. Appropriate mitigation will reduce the impact.
- Slight – An impact that causes some minor change in the character or architectural heritage of local or regional importance without affecting its integrity or sensitivities. Although noticeable, the effects do not directly impact on the architectural structure or feature. Impacts are reversible and of relatively short duration. Appropriate mitigation will reduce the impact.
- Imperceptible – An impact on architectural heritage of local importance that is capable of measurement but without noticeable consequences.

Impacts of Positive Quality

- Significant – A beneficial effect that permanently enhances or restores the character and / or setting of the architectural heritage in a clearly noticeable manner.
- Moderate – A beneficial effect that results in partial or temporary enhancement of the character and / or setting of the architectural heritage and which is noticeable and consistent with existing and emerging trends.
- Slight – A beneficial effect that causes some minor or temporary enhancement of the character of architectural heritage of local or regional importance which, although positive, is unlikely to be readily noticeable.
- Imperceptible – A beneficial effect on architectural heritage of local importance that is capable of measurement but without noticeable consequences.

The assessment identified seven (7 no.) architectural heritage sites within the study area. Of these, three (3 no.) will be impacted directly, two (2 no.) will be impacted indirectly and two (2 no.) will have no perceptible or predicted impact. The potential impact of the *Proposed Road Development* is considered moderate negative for three (3 no.) sites, slight negative for two (2 no.) sites and no impact is predicted for the remaining two (2 no.) sites.

The tables below summarise the impact of the proposed route on architectural heritage sites. The information is summarised from Table 13-12 below.

Table 13-9 Summary of Direct Negative Impacts

Impact Significance	International	National	Regional	Local	Record only
Profound	0	0	0	0	0
Significant	0	0	0	0	0
Moderate	0	0	0	3	0
Slight	0	0	0	0	0
Imperceptible	0	0	0	0	0
Total	0	0	0	3	0

Table 13-10 Summary of Indirect Negative Impacts

Impact Significance	International	National	Regional	Local	Record only
Profound	0	0	0	0	0
Significant	0	0	0	0	0
Moderate	0	0	0	0	0
Slight	0	0	1	1	0
Imperceptible	0	0	0	0	0
Total	0	0	1	1	0

Table 13-11 Summary of No Impacts

Impact Significance	International	National	Regional	Local	Record only
Total	0	0	0	2	0

Table 13-12 Inventory of Architectural Heritage Sits within c. 50m of the Proposed Road Development

ID no.	Status	Ref no.	Site type	ITM Reference (E,N)	Distance to CPO/Route	Perceived Significance	Type of Impact	Significance & Quality of Impact
AHC 41	N/A	N/A	*Castlegal* House and outbuildings	571817, 840528	2	Regional	Indirect	Slight, negative impact on setting
AHC 42	N/A	N/A	House, partial remains of	571735, 840958	0	Local	Direct	Moderate, negative
AHC 43	N/A	N/A	House	571845, 841063	0	Local	Direct	Moderate, negative
AHC 44	N/A	N/A	House	571902, 841082	10	Local	Indirect	Slight, negative impact on setting
AHC 45	N/A	N/A	Milestone, site of	571999, 841270	11	Local	No predicted impact	No impact
AHC 46	N/A	N/A	Milestone, site of	871793, 840030	0	Local	No predicted impact	No impact
AHC 47	N/A	N/A	House	871775, 840045	0	Local	Direct	Moderate, negative

13.5.2.2 Pre-mitigation Construction Phase Impacts on Architectural Heritage Sites and Features

There will be no impacts on any sites included in the Record of Protected Structures or in the National Inventory of Architectural Heritage within the CPO associated with the *Proposed Road Development*.

The *Proposed Road Development* will have a direct negative impact on three (3 no.) locally significant sites namely the partial remains of a house (AHC 42) and two houses (AHC 43 and AHC 47).

The *Proposed Road Development* will have no predicted impact on two locally significant structures namely the sites of two milestones (AHC 45 and AHC 46) as the features are no longer extant.

13.5.2.3 Operational Phase Impacts

The operational phase of the *Proposed Road Development* will have an indirect slight negative impact on the setting of one regionally significant structure namely *Castlegal* House and outbuildings (AHC 41), and one locally significant structure namely a house (AHC 44).

13.6Proposed Mitigation Measures

13.6.1 **Archaeology and Cultural Heritage**

This report illustrates the extent to which specific archaeological heritage constraints may be impacted on the *Proposed Road Developme*nt. In addition to the identified archaeological sites, there may be previously unidentified sub-surface archaeological remains surviving. In order to mitigate for the potential impact that construction of the *Proposed Road Development* would have on the surviving and potential archaeological and cultural heritage, the following measures were considered, and specific mitigation measures are proposed for predicted impacts. Mitigation measures are summarised in Table 13-13.

13.6.1.1 Consultation

Consultation has taken place at various stages of the project development to date, these include consultations with the National Monuments Service of the Department of Culture, Heritage and the Gaeltacht in August 2017, who upon review of the route selection report and the emerging preferred route selected, responded with ‘no comment’ on the proposal. The Development Applications Unit of the aforementioned government body, were also contacted at various other stages of the project development, including the informal scoping period described in Chapter 5 of the EIAR.

Further consultation will be undertaken with stakeholders with statutory roles including: the National Monuments Service and the Built Heritage and Architectural Policy Section of the Department of Culture, Heritage and the Gaeltacht.

13.6.1.2 Ministerial Direction

Subject to approval by An Bord Pleanála, the *Proposed Road Development* will be subject to the National Monument Act 2004 Amendment and all works with potential archaeological implications on or adjacent to the construction works will be subject to Directions given by the Minister for Culture, Heritage and the Gaeltacht in consultation with the National Museum of Ireland.

13.6.1.3 Avoidance

The first option for mitigation is the avoidance of known or suspected archaeological sites, monuments and features by redesign of the development. The *Proposed Road Development* has been designed so as to minimise the potential impact on archaeological sites listed in the Record of Monuments and Places. Three sites included in the Record of Monuments and Places are located within 50m of the CPO line but will not be impacted directly by construction (CHC 01 – RMP SL009-028, CHC 02 – RMP SL009-027 and CHC 12 – RMP SL009-035). One RMP site CHC 11 - SL009-026 is partially within the CPO, for severance reasons, however it will be excluded from the Lands Made Available (LMA) for construction, thus preserving the site in situ. The mass rock CHC 84 will be preserved in situ, it will be cordoned off during construction in order to avoid potential damage.

13.6.1.4 Archaeo-geophysical Survey

Geophysical investigation embraces non-invasive methods of investigating the subsurface for monumental and artefactual remains. The use of archaeo-geophysical prospection is effective at detecting a wide variety of archaeological features. For archaeological investigative purposes, it is used to identify areas of archaeological potential which can then be target tested. Archaeo-geophysical investigations are proposed for the off-line greenfield sections of the route where suitable. The archaeo-geophysical survey will take into consideration the location of areas of archaeological potential identified in the field survey and the proximity of recorded archaeological monuments.

13.6.1.5 Topographical and Photographic Survey

Topographical survey will be carried out in order to make an accurate record in plan, of an individual site and will be supplemented by a photographic survey. Topographical survey is required for the following townland boundaries TB 05, TB 08 and TB 20 and the old road CHC 72. Where suitable, a section of each feature will also be recorded during blanket test excavations (see below).

13.6.1.6 Wade Survey

The *Proposed Road Development* crosses a number of small, shallow watercourses, two of which correspond with townland boundaries. A wade survey will be undertaken for impacted sections of each watercourse including AAP 07/TB 06, AAP 15 and AAP 16/TB 09.

13.6.1.7 Photographic Survey and Written Record

A photographic survey and written record will be undertaken for the following sites AAP 07/TB 06, TB 07, AAP 15 and AAP 16/TB 09.

13.6.1.8 Targeted Test Excavations

Targeted test excavation takes place where there is an indication that archaeological remains are likely to occur. Evidence from cartographic, historical or photographic sources may point to areas of archaeological significance. Targeted testing then allows an assessment to be made on the extent of any surviving archaeology before any further mitigation is decided upon. Should any archaeological material be uncovered, excavation will then be required. Targeted test excavation will be undertaken within the CPO/LMA at the following sites: AAP 17, AAP 19, AAP 20, AHC 42, CHC 01, CHC 11, CHC 12, CHC 80, CHC 82, CHC 83, CHC 84, CHC 85, TB 05, TB 08 and TB 20. Pending the results of the targeted test excavations further mitigation measures, including full excavation (see below) may be required.

13.6.1.9 Blanket Test Excavation

It is considered best practice by the Department of Culture, Heritage and the Gaeltacht and TII to identify and record previously unknown archaeological sites in advance of the main contractor beginning construction. Blanket testing is typically implemented on all large-scale road developments and has proven to be an effective mitigation strategy for identifying archaeological features not identified at earlier phases of the assessment. The intention is to identify previously unknown archaeological sites at an early enough stage to minimise archaeological involvement with the development by the time the contractor is on site.

Phase 1 of the archaeological investigations will take the form of test trenches excavated by machine under archaeological supervision. The testing layout may vary from one area to another, to take account of the varying width of the development, local topographical features and the presence of potential archaeological features. The blanket testing will be undertaken within and to the edge of the CPO line including areas required for compounds, attenuation ponds and soil repository/borrow pits. The overall aim will be to perform an adequate amount of archaeological testing in all areas subject to this method. The total amount of testing in any one area investigated by this method – or by a combination of methods – will amount to a consistent percentage of the land area.

13.6.1.10 Archaeological Excavation

Archaeological excavation is the preservation by record of archaeological remains. It would normally be undertaken following the discovery of archaeological material that cannot be preserved by being left in-situ in the ground. Archaeological excavation may be required pending the results of archaeological testing. Any archaeological sites identified during the course of advance archaeological investigations or uncovered during road construction will be excavated in full, following consultation with the National Monuments Section of the Department of Culture, Heritage and the Gaeltacht.

13.6.1.11 Preservation In Situ

The possible mass rock (CHC 84) will be cordoned off during construction to allow for its preservation in situ and to avoid potential damage.

13.6.1.12 Publication

Publication of the results of all archaeological investigation will be undertaken as part of the archaeological mitigation for the construction of the *Proposed Road Development*, in order to ensure that the knowledge gained from the investigation is collated and assessed within the context of current archaeological theory. In addition, publication should ensure the dissemination of the knowledge gained to the widest audience, both general and professional. It is envisaged that publication will take place in a number of media; suitable formats may include the TII monograph series, Seanda, Archaeology Ireland and local historical and archaeological journals.

13.6.1.13 Project Archaeologists and the Code of Practice

A Code of Practice was agreed between the Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs and Transport Infrastructure Ireland (2017) to provide a structured and strategic framework for the management of all archaeological aspects of road planning and construction. Project Archaeologists have been appointed to ensure the proper management of the archaeological work and that mitigation strategies are in keeping with best practice and policies.

13.6.1.14 Construction Impacts and Mitigation Measures

Archaeological and cultural heritage issues will be resolved where possible at the pre-construction stage of the development. In any areas where this is not possible archaeological test excavation or archaeological monitoring will take place at construction stage. There are four recorded archaeological monuments, wholly or partially outside of but, in close proximity to the *Proposed Road Development* (CHC 01 – RMP SL009-028, CHC 02 – RMP SL009-027, CHC 11 - RMP SL009-026, and CHC 12 - RMP SL009-

035). Their location and the requirement to avoid impacting them will be communicated to advance work contractors and to the construction contractors.

13.6.1.15 Operational Phase Mitigation

Archaeological, architectural and cultural heritage surveys, investigations and excavations will be completed by the operational phase of the development

13.6.1.16 Residual Impacts

It is not anticipated that any significant residual impacts will remain where full archaeological, archaeological and cultural heritage mitigation measures are undertaken.

Table 13-13: Summary of Mitigation Proposals and Impacts after Mitigation for Inventory of Archaeological and Cultural Heritage Sites within c. 50m of the Proposed Road Development

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
AAP 07	Stream	571775, 840335	Direct	Moderate, negative	A wade survey, photographic survey and written record of the impacted section of the stream will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
AAP 15	Stream	571798, 840956	Direct	Moderate, negative	A wade survey, photographic survey and written record of the impacted section of the stream will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
AAP 16	Stream	572195, 841506	Direct	Moderate, negative	A wade survey, photographic survey and written record of the impacted section of the stream will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
AAP 17	Area with settlement potential	572199, 841639	Direct	Moderate, negative	The area within the CPO will be subject to geophysical survey and targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
AAP 18	Raised circular platform and possible palaeo-channel	571869, 840103	No predicted impact	No impact	No further mitigation required	None
AAP 19	Area of wet, rushy ground	571982, 841386	Direct	Moderate, negative	The area within the CPO will be subject to geophysical survey and targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
AAP 20	Quarry	572144, 8410509	Direct	Moderate, negative	The area within the CPO will be subject to geophysical survey and targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 01	Megalithic tomb - wedge tomb	571651, 840453	Indirect	Moderate, negative. Imperceptible impact on setting.	The area within the CPO will be subject to geophysical survey and targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 02	Barrow – Ring barrow	571912, 840728	No predicted impact	No impact	No further mitigation required	None
CHC 11	Ringfort - rath	571681, 840765	Direct	Moderate, negative.	Part of the monument is included in the CPO for severance reasons however it will be excluded from the LMA for construction and thus preserved in situ. The area within the CPO will be subject to geophysical survey. Any archaeology discovered within the LMA will be subject to targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR. Permanent impact on setting of monument.
CHC 12	Ringfort - rath	571607, 839729	Indirect	Moderate, negative. Imperceptible impact on setting.	The area within the CPO will be subject to geophysical survey and targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 72	Old road	571699, 840333 to 571973, 840668	Direct	Moderate, negative	A topographic and photographic survey of the impacted section of the road will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
CHC 80	Building, site of	571646, 839810	Direct	Moderate, negative	The area within the CPO will be subject to targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 82	Building, site of	571736, 840359	Direct	Moderate, negative	The area within the CPO will be subject to targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 83	Building, site of	571734, 841056	Direct	Moderate, negative	The area within the CPO will be subject to targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 84	Mass rock (possible), current site of	571750, 839644	Direct	Moderate, negative	The area within the CPO will be subject to targeted test excavation prior to development. The mass rock will be cordoned off during construction in order to avoid potential damage. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
CHC 85	Well	571745, 840358	Direct	Moderate, negative	The area within the CPO will be subject to targeted test excavation prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
TB 05	Townland boundary	571690, 839765	Direct	Moderate, negative	A topographic and photographic survey of the impacted section of the townland boundary will be undertaken prior to development. Targeted test excavation of a cross-section of the townland boundary will be undertaken prior to development. Further mitigation including	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
					archaeological excavation may be required.	
TB 06	Townland boundary	571775, 840335	Direct	Moderate, negative	A photographic survey and written record of the impacted section of the townland boundary will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
TB 07	Townland boundary	571655, 840500	Direct	Moderate, negative	A photographic survey and written record of the impacted section of the townland boundary will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
TB 08	Townland boundary	571738, 840771	Direct	Moderate, negative	A topographic and photographic survey of the impacted section of the townland boundary will be undertaken prior to development. Targeted test excavation of a cross-section of the townland boundary will be undertaken prior to development. Further mitigation including archaeological excavation may be required.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHG) for inclusion in the SMR.
TB 09	Townland boundary	572191, 841508	Direct	Moderate, negative	A photographic survey and written record of the impacted section of the townland boundary will be undertaken prior to development.	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHGDCHG) for inclusion in the SMR.
TB 20	Townland boundary	571268, 841610	Direct	Moderate, negative	A topographic and photographic survey of the impacted section of the townland boundary will be undertaken prior to development. Targeted test excavation of a cross-section of the townland boundary will be undertaken prior to development. Further mitigation including	Positive residual impact, any archaeological features will be recorded prior to construction. If required site will be notified to the Archaeological Survey of Ireland (DCHGDCHG) for inclusion in the SMR.

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
					archaeological excavation may be required.	
TB 21	Townland boundary	572320, 841640	Indirect	No impact	No further mitigation required	None

13.6.2 Architectural Heritage

Avoidance of architectural heritage is the preferred mitigation measure, although either direct or indirect impacts on architectural heritage could occur within a new road development. For details of mitigation measures see Table 13-13, Table 13-14 below and Appendix 13.2 contained within Volume 4 of this EIAR.

13.6.2.1 Construction Phase Mitigation

Mitigation by architectural record involves the production of a written account generally supplemented by measured drawing and a photographic survey. The level of recording will depend on the significance of the building in question (*Guidelines for the Assessment of Architectural Heritage Impacts of National Road Schemes 2005*).

The minimum level of documentation should involve:

- An accurate and succinct description of the structure.
- An assessment by competent expert of its architectural heritage merit.
- The extent of the structure set out on a map of sufficient scale.
- A sufficient number of photographs taken before demolition with a clear indication of scale that illustrates the built for and architectural heritage significance.
- An assessment of the impact which the development is likely to have on the structure.
- Supporting information e.g. research documents, sketch plans of each floor level of structures which are directly impacted.

This will be applied to the following structures AHC 42, AHC 43, and AHC 47.

13.6.2.2 Operational Phase Mitigation

The landscape screening provided as part of this *Proposed Road Development* (see Ch. 12) will minimise the visual impact from the *Proposed Road Development* at the following structures: AHC 41 and AHC 44.

13.6.2.3 Residual Impacts

It is not anticipated that any significant residual impacts will remain where full architectural heritage mitigation measures are undertaken. The *Proposed Road Development* will have a slight negative impact on the setting of two architectural heritage constraints namely two buildings (AHC 41 and AHC 44). The landscape screening which will be provided at these sites (see Chapter 12) will minimise the visual impact of the *Proposed Road Development*.

Table 13-14: Summary of Mitigation Proposals and Impacts after Mitigation for Inventory of Architectural Heritage Sites within c. 50m of the Proposed Road Development

ID no.	Site type	ITM Reference (E,N)	Type of Impact	Significance & Quality of Impact	Mitigation Proposals	Impact after Mitigation
AHC 41	*Castlegal* House and outbuildings	571817, 840528	Indirect	Slight, negative impact on setting	The landscape screening being provided for the *Proposed Road Development* (see Ch. 12) will minimise the visual impact on the building.	Slight, negative
AHC 42	House, partial remains of	571735, 840958	Direct	Moderate, negative	The building will be subject to architectural recording prior to development. The area within the CPO will be subject to targeted test excavation prior to development. Further mitigation may be required.	Slight, negative
AHC 43	House	571845, 841063	Direct	Moderate, negative	The building will be subject to architectural recording prior to development.	Slight, negative
AHC 44	House	571902, 841082	Indirect	Slight, negative impact on setting	The landscape screening being provided for the *Proposed Road Development* (see Ch. 12) will minimise the visual impact on the building.	Slight, negative
AHC 45	Milestone, site of	571999, 841270	No predicted impact	No impact	No further mitigation required	None
AHC 46	Milestone, site of	871793, 840030	No predicted impact	No impact	No further mitigation required	None
AHC 47	House	871775, 840045	Direct	Moderate, negative	The building will be subject to architectural recording prior to development.	Slight, negative

13.7Relevant Figures and Appendices

13.7.1 **Figures contained in Volume 3**

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

Fig. 13.2.1 13.2.2: Archaeology, Architecture & Cultural Heritage Impact Assessemnt

13.7.2 **Appendices contained in Volume 4**

Appendix 13.1: Chapter 13 (Main Report Reference); Archaeological and Cultural Heritage Sites

Appendix 13.2: Chapter 13 (Main Report Reference); Architectural Heritage Sites

Appendix 13.3: Chapter 13 (Main Report Reference); Field Survey Results

Appendix 13.4: Chapter 13 (Main Report Reference); Plates

14 Material Assets and Land – Agriculture

14.1 Introduction

This chapter of the EIAR considers and assesses the potential for likely significant effects of the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development* on agricultural property.

Other impacts on Material Assets are also addressed throughout this EIAR, most particularly in the following sections:

- Chapter 6 Population and Human Health;
- Chapter 7 Noise and Vibration;
- Chapter 8 Air Quality & Climate Change;
- Chapter 10 Soils & Geology;
- Chapter 11 Hydrology & Hydrogeology;
- Chapter 12 Landscape & Visual.
- Chapter 13 Archaeology, Architecture and Cultural Heritage; and
- Chapter 15 Material Assets: Non-Agricultural Property;

14.2Methodology

In line with best practice this section was prepared with regards to the following documents:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft) (EPA, 2017);
- Advice notes for preparing Environmental Impact Statements (Draft) (EPA, 2015);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008);
- Advice notes on current practice in the preparation of Environmental Impact Statements (EPA, 2003);
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002);

The methodology for the assessment of the significance of impact on agriculture comprised of a desktop survey of project mapping and information, a roadside survey of the *Proposed Road Development* and detailed farm surveys involving landowner consultation. The roadside surveys and landowner consultation took place from February to May 2018 and in January 2019.

14.2.1 Data sources

The methodology for this section relied on information from the sources outlined in Table 14-1.

Table 14-1: Information and sources

Information	Source
Land registry / landownership information	Property Registration Authority through Sligo County Council.
Land use, farm details	Landowner consultations, walkover farm surveys and roadside surveys.
Agricultural statistics	National census of agriculture statistics derived from the June 2010 census of agriculture (Central Statistics Office, 2012). Statistical Yearbook of Ireland 2017 (Central Statistics Office, 2017).

Information	Source
Soils information	Irish National Soils Map, 1:250,000k, V1b (2014).Teagasc, Cranfield University (EPA, 2014). Creamer, R. "Irish SIS Final Technical Report 13: Irish Soil Information System Legend" (EPA, 2014). Creamer, R. "Irish SIS Final Technical Report 10: Soil Profile Handbook" (EPA, 2008).
Planning and zoning objectives	Sligo County Development Plan (2017-2023); Sligo & Environs Local Area Plan (2018-2024) – Consultation Paper.
Design mapping & project information	Sligo County Council
CPO deposit mapping & schedule (Draft)	Sligo County Council

14.2.2 Study area

The study area for the *Proposed Road Development* comprises of agricultural properties directly impacted within the townlands of *Doonally*, *Drumkilsellagh*, *Drum East*, *Castlegal*, *Lugatober*, *Collinsford* and *Lugnagall*. The affected properties are not within the extents of the Sligo & Environs Development Plan.

There are twenty-one agricultural properties directly impacted by the proposed development. Landtake will comprise of approximately 20.8ha of agricultural lands. All landowners directly impacted by the *Proposed Road Development* were consulted. The agricultural impact on properties was completed using information gathered from consultations with landowners, the roadside survey and project mapping.

14.2.3 Assessment methodology

The baseline environment for agricultural property was evaluated on an individual property basis and assigned a baseline rating. This baseline rating combined with a magnitude of impact from construction and operation impacts associated with the *Proposed Road Development* will determine the significance of the agricultural impact.

Baseline Rating

Farm holdings within the study area were assigned a baseline rating which is determined by the farm type, farm size, land quality, sensitivity to construction and any existing adverse effects. This information was sourced from landowner consultation and walkover surveys on farm holdings directly affected by the *Proposed Road Development*.

Farm type influences the degree of the baseline rating with higher ratings for specialist farm types or enterprises that consist of the breeding or farming of high value livestock. Enterprises that are farmed at an intensive level, such as dairying i.e. with a high stocking rate, and indoor farm enterprises such as pig or poultry farms are indicative of a high baseline rating. Tillage-based and horticultural farm enterprises are indicative of a high baseline rating. Less intensive farm enterprises such as beef and sheep farms are generally indicative of a medium baseline rating.

Larger farm holdings or single unit farms will allow for greater scale of production and are indicative of a high baseline rating. Farms that are smaller or fragmented in structure are generally indicative of a medium baseline rating.

Land quality on a farm holding will determine farm productivity and lands of good quality will be indicative of a high baseline rating. Farms with lands that are limited in agricultural usage due to soil type, typography or drainage will be indicative of a medium or low baseline rating.

The sensitivity of some farm enterprises to the effects of construction or operational impacts will influence the baseline rating of farm holdings. Such farms will include specialist dairy farms and specialist equine farms. Dairy farms are sensitive to impacts that will reduce available grassland area and existing access between grazing paddocks and the farmyard. Equine livestock used for the breeding and training of horses can be regarded as sensitive to impacts such as noise, dust and visual impacts.

The determination of a baseline rating may also be influenced by existing adverse effects such as the proximity of the lands to urban areas and the zoning of lands for other than agricultural uses.

Baseline Rating Criteria

The criteria used to determine the baseline rating for the farm holdings within the study area are shown in Table 14-2 Baseline Rating Criteria. The criteria for each of the baseline ratings have been developed in consideration of the relevant EPA guidelines on describing the existing environment.

Table 14-2: Baseline Rating Criteria

Impact	Criteria
High	Intensively managed farm enterprises. Specialist dairy enterprises or farm enterprises involved in the breeding of high quality livestock. Farm enterprises considered sensitive to development works. Tillage enterprises on good quality lands. Mixed livestock and/or tillage enterprises on good quality lands. Agricultural lands used for research and education.
Medium	Livestock and / or tillage enterprises on medium quality lands. Agricultural lands of good quality leased for livestock or tillage production. Agricultural lands of good quality which is zoned or planning permission exists for non-agricultural purposes.
Low	Extensively managed farm enterprises on medium quality lands. Land parcels with limited agricultural capacity due to size or shape. Agricultural lands of medium or poor quality leased for livestock or tillage production. Lands under commercial forestry or woodland. Agricultural lands of medium quality which is zoned or planning permission exists for non-agricultural purposes.
Very low	Extensively managed livestock farm enterprises on poor quality lands. Unused agricultural lands of medium or poor quality. Agricultural lands of poor quality which is zoned or planning permission exists for non-agricultural purposes.

Impact Magnitude

Impacts on agricultural properties arising from construction and operation of the *Proposed Road Development* include:

- Landtake;
- Land severance;
- Impact on farm buildings / facilities; and
- Other impacts such as on land drainage and services.

Landtake

The effect of agricultural landtake can be significant and the acquired area together with its location and duration will determine the magnitude of impact. The greater the area of landtake indicates a higher magnitude of impact. The area and location of landtake are often interlinked as landtake near a farmyard on a single unit farm will generally be of a greater magnitude than a similar area on a fragmented part of the farm holding. The duration of landtake may be either permanent or temporary. Permanent landtake will have a duration of greater than 60 years. The effect of Temporary landtake may be less than one year or range from one to seven years in duration. The degree of the magnitude of impact decreases with shorter durations.

Agricultural landtake for the *Proposed Road Development* will be permanent and will be located on twenty-one properties adjacent to the existing N16 road.

Land severance

The severance of lands is largely determined by the landtake location and can often result in more significant impacts on farm holdings. Similarly with landtake, the area of severed lands and their location relative to remaining lands and duration will influence the magnitude of impact. The severance of a significant area or proportion of available land will indicate a high magnitude of impact. The severance of lands adjoining a farmyard, particularly an intensive farm such as a dairy farm, will have a higher magnitude of impact than the severance of lands at the external boundary of a farm. The permanent severance of lands will have a greater magnitude of impact than temporary severance.

The *Proposed Road Development* will result in land severance on several farm holdings. During the construction period, there will be a temporary impact on access to both severed and remaining lands due to traffic diversions required for the construction of the proposed alignment and the associated junctions with the existing N16.

Impact on farm buildings / facilities

The impact of a *Proposed Road Development* on farm buildings or facilities is generally indicative of a medium to high magnitude of impact. The degree of magnitude will depend on the type and nature of farm buildings that are affected. Where animal housing and animal manure storage or fodder storage facilities are affected the degree of magnitude will be high. Farm buildings such as general-purpose sheds or animal handling facilities are indicative of a medium magnitude of impact. Other facilities such as the loss of natural shelter are indicative of a medium magnitude of impact.

The *Proposed Road Development* will impact on farm buildings / farm facilities on two farm holdings. The impacted facilities include animal handling facilities on one farm and farm buildings and yard area on the second farm.

Other impacts such as impacts to land drainage and services

The construction activities on a road realignment project may result in the disturbance of existing land drainage and the interruption of services such as water, power and other utilities. The magnitude of impact will be influenced by the type of disturbance and the duration involved. These impacts are generally of a temporary to short term duration being limited to the extent of construction works.

The *Proposed Road Development* may temporarily impact on the local drainage network and the field drainage immediately adjacent to the proposed site. There will be a temporary impact on water supply where existing connections to water mains are affected. There will be a temporary disruption of power supply (for agricultural fencing) where existing fencing is affected.

14.2.3.1 Magnitude of Impact Criteria

The criteria used to determine the magnitude of impact for the farm holdings on the *Proposed Road Development* are shown in Table 14-3 Magnitude of Impact Criteria. The criteria for each of the impact ratings have been developed in consideration of the relevant EPA guidelines on the assessment of impact.

Table 14-3: Magnitude of Impact Criteria

Impact	Criteria
Very high	The impact on the farm is such that the farm enterprise(s) cannot continue. Permanent landtake of such an area that the farm holding is unworkable. Permanent land severance of such an area that the farm enterprise is unworkable. Essential farm buildings / facilities may be significantly impacted.
High	The impact on the farm is such that the farm enterprise(s) cannot continue without significant management changes. Permanent landtake of such an area that the continued management of the farm enterprise will require significant change. Permanent land severance of a nature that the continued management of the farm enterprise will require significant change. Essential farm buildings / facilities may be directly or indirectly impacted.
Medium	The impact on the farm is such that the farm enterprise(s) can be continued as before but with increased management difficulties. Permanent landtake of such an area that the management of the farm enterprise(s) can be continued but with increased difficulties. Permanent land severance of a nature that the management of the farm enterprise(s) will require management changes. Farm buildings and/or farm facilities may be directly or indirectly impacted.
Low	The impact on the farm is such that the farm enterprise(s) can be continued as before with minor management changes. Permanent or short-term landtake of such an area that the farm enterprise(s) suffer minor difficulties as a result. Permanent or short-term land severance of a nature that the farm enterprise(s) will require minor management changes. Farm buildings / facilities would not be directly impacted. There may be indirect impacts. Temporary construction impacts.
Very low	The impact on the farm is such that the farm enterprise can be continued as before with temporary or short-term management changes. Temporary or short-term landtake of such an area without noticeable consequences. Permanent landtake involving public roadbed only. Temporary or short-term land severance of a nature that the farm enterprise can be continued but with minor management changes. Farm buildings / facilities would not be directly impacted. There may be indirect impacts. Temporary construction impacts.

Impact Significance

The significance of impact on an agricultural property is determined by the baseline rating of a farm holding combined with the magnitude of impact of the *Proposed Road Development*. There are four categories of baseline rating ranging from 'very low' to 'high'. There are five categories of magnitude of impact ranging from 'very low' to 'very high'. The likely significance rating is determined by reference to the matrix in Table 14-4 Significance of Impact using the baseline rating and magnitude of impact. The likely significance of impact is prior to the implementation of any mitigation measures. Table 14-4 Significance of Impact has been developed in consideration of the relevant EPA guidelines on the assessment of impact.

Table 14-4: Significance of Impact

Baseline rating	Magnitude of impact				
	Very high	High	Medium	Low	Very low
High	Profound	Significant to Very Significant	Moderate	Slight	Slight
Medium	Very Significant	Significant	Moderate	Slight	Imperceptible
Low	Moderate	Moderate	Slight	Slight	Imperceptible
Very low	Slight	Slight	Slight	Imperceptible	Imperceptible

14.3Description of Existing Environment

14.3.1 General

The study area for the *Proposed Road Development* is comprised of agricultural farm holdings with a number of residential properties along the local road network.

The drumlin topography is generally rolling and hilly with steeply sloping lands from Cope Mountain. Elevations range from 80m to 100m. The land use is predominantly grassland-based, and farming activities are based on livestock production involving sheep primarily with beef and dairy also present.

14.3.2 Agriculture in Ireland

The *Proposed Road Development* which will require the permanent acquisition of agricultural lands will result in a reduction in the national utilisable agricultural area. In 2016, the agricultural area farmed is 4,447,200ha including rough grazing. When rough grazing is excluded there is 3,563,000ha of silage, hay and pasture; 281,100ha of cereals and 70,600ha of other crops, fruit and horticulture (Central Statistics Office, 2018).

There are 139,860 farms in Ireland with an average farm size of 32.7ha. The main agricultural enterprises are beef (77.6%), dairying (7.9%), mixed grazing livestock (7.2%) and mixed field crops (5.9%), Sheep (0.7%), tillage (0.2%), mixed crops and livestock (0.2%) and other (0.3%) are the remaining enterprises (Central Statistics Office, 2012).

14.3.3 Agriculture in County Sligo

The total agricultural area of Co. Sligo is 128,417ha and when commonage and rough grazing are excluded there is 102,380ha grassland, 42ha cereals and 100ha of other crops, fruit and horticulture (Central Statistics Office, 2012).

There are 4,395 farms with an average farm size of 26.3ha which is significantly lower than the national average of 32.7ha. The main agricultural enterprises are beef (67.6%), sheep (11.2%), mixed grazing livestock (10.4%) and mixed field crops (7.1%). There is a low level of dairy farming (3.2%) and there are very low levels of farms specialising in mixed crops and livestock (0.2%) and tillage (<0.1%) (Central Statistics Office, 2012).

14.3.4 Agriculture in the study area

The study area for the *Proposed Road Development* is comprised of the agricultural farm holdings directly affected. Farm enterprises in the study area are predominantly involved in sheep with the remainder leased, mixed livestock (of sheep and beef) and dairy farming. Farm size ranges from 2ha to 60ha with an average farm size of 27.3ha.

Details of baseline ratings for agricultural property affected by the *Proposed Road Development* are presented in Table 14-5. The magnitude of impact on agricultural property ranges from Low to High.

Table 14-5: Agricultural property – Baseline rating

Baseline Rating	No. of farms	% of total farms
High	3	14.3%
Medium	15	71.4%
Low	3	14.3%
Very low	0	0%
Total	21	100.0%

Summary details of the assessment of the baseline ratings are presented in Table 14-8.

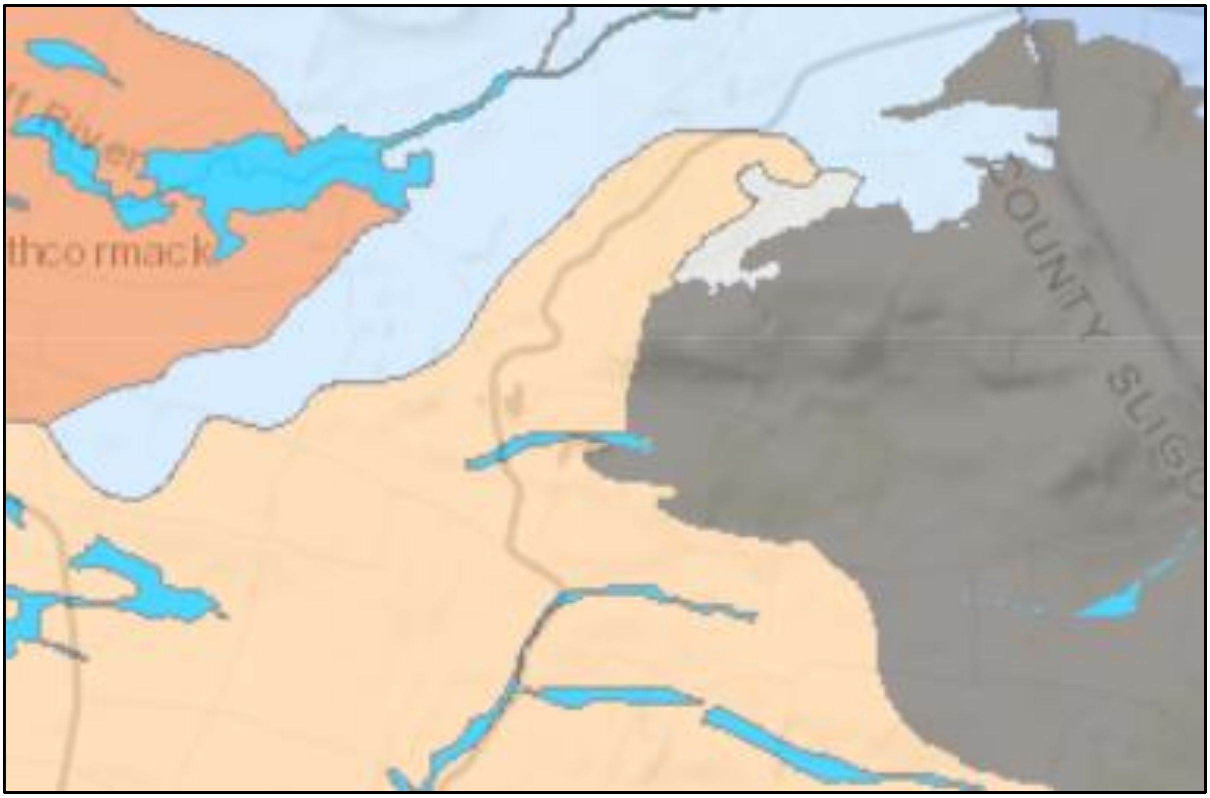
14.3.5 Soils

Agriculture in the study area is defined by the drumlin topography and the suitability of the soils to agricultural use. Soils information is assembled as Soils Associations – mapping of local soils or soil types that commonly occur in the landscape.

There are two soil associations within the study area, namely Mullabane and Boyne. Soils within the Mullabane association (Figure 14-1 - Light orange) are Typical Brown Earth soils described as having a coarse loamy texture and derived from limestone drift. The soils are well drained and are regarded as moderately suitable for grassland use. Soil Association Boyne soils (Figure 14-1 – Blue) are a Silty River Alluvium and are classified as a Typical Alluvial Gley soil. These soils are found along the Tully River (Teagasc, Cranfield University, 2008).

The Soil Associations within the study area are presented in Figure 14-1.

Figure 14-1: Study area soils map (Teagasc, Cranfield University, 2018)



14.4 Description of Likely Impacts

14.4.1 <u>'Do Nothing' or 'Do Minimum' Impact</u>

Under the 'Do Nothing' or 'Do Minimum' scenario, no direct impact would occur on agricultural property. The existing N16 would continue to be used for access to farm holdings and agricultural lands.

14.4.2 <u>Potential Impact of the Proposed Road Development</u>

The *Proposed Road Development* will directly impact upon farm holdings within the study area with permanent impacts on these holdings due to land acquisition, land severance, disturbance of farming operations and temporary impacts associated with the proposed construction activities.

At the route selection stage for the N16 Sligo to the County Boundary road project, the assessment for agriculture considered landownership information within the study area and existing agricultural constraints such as farm dwelling houses, farmyards and sensitive farm enterprises.

14.4.2.1 Impact on agriculture nationally

The permanent acquisition of approximately 20.8ha of agricultural land is not significant at a national level.

14.4.2.2 Impact on agriculture in County Sligo

The *Proposed Road Development* will involve the permanent acquisition of approximately 20.8ha of agricultural land from twenty-one farm holdings. This area, which may be significant on some individual farms, is not significant at a county level.

14.4.2.3 Impact on agriculture in the study area

The impact on agriculture extends to those farm holdings directly impacted by the *Proposed Road Development*. The twenty-one farm holdings also include a long-term leasehold interest on lands directly impacted.

The primary agricultural impact is landtake which will comprise of approximately 20.8ha of agricultural lands and 3.1ha of public road. Of farm holdings directly impacted, the acquired area ranges from <1% to 31% of the total farm area.

Details of the magnitude of impact on agricultural property are presented in Table 14-6. The magnitude of impact on agricultural property ranges from Low to High. On five farm holdings the magnitude of impact is High due to impacts including landtake, access to lands and impacts to farm buildings.

Table 14-6: Impact on agricultural property - Magnitude

Magnitude	No. of farms	% of total farms
Very high	0	0.0
High	5	23.8%
Medium	6	28.6%
Low	8	38.1%
Very low	2	9.5%
Total	21	100.0%

Measures to mitigate the adverse effects of the *Proposed Road Development* are described in Section 14.5. The significance of the residual impacts following the implementation of mitigation measures are described in Section 14.6.

Summary details of the assessment of the impact on agriculture are presented in Table 14-8.

Details of the significance of impact on agricultural property are presented in Table 14-7. The significance of impact, which is determined by combining the magnitude of impact and the baseline rating for that farm, ranges from Imperceptible to Significant. On five farm holdings (23.8% of farms) the significance of impact is assessed as Significant, due to impacts including landtake, access to lands and impacts to farm buildings. On these farms, the farm enterprises are sheep or are leased out on a short-term basis and the impact is such that these farm enterprises cannot continue without significant management changes. Such management changes may involve changes to livestock type and numbers, areas of fodder production and the use of farmyard facilities.

Table 14-7: Impact on agricultural property – Significance

Significance	***No. of farms***	***% of total farms***
Profound	0	0
Very Significant	0	0
Significant	5	23.8%
Moderate	6	28.6%
Slight	8	38.1%
Imperceptible	2	9.5%

Significance	***No. of farms***	***% of total farms***
Total	21	100.0%

On six farm holdings (28.6% of farms) the significance of impact is assessed as Moderate, primarily due to the impact of landtake. These farm enterprises can be continued as before but will experience increased management difficulties.

On eight farm holdings (38.1% of farms), the significance of impact is Slight, due to either low levels of landtake or temporary construction impacts. These farm enterprises can continue with minor management changes.

On two farm holdings (9.5% of farms), the significance of impact is Imperceptible, due to landtake of public roadbed.

Summary details of the assessment of the impact on agriculture are presented in Table 14-8.

Table 14-8: Impact on agricultural property – Significance

CPO No.	Farm Size (ha)	Farm enterprise type	Landtake (ha)			Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
			Permanent Public road	Permanent Agri / land	Temporary Other						
144	40.5	Sheep	0.0152	0.1878	0.0000	Medium	Reduction in agricultural area due to Drum Road Junction. Impact on farmyard entrance, field access and existing animal handling pen. Impact on existing field boundaries.	Medium	Moderate	Replace farmyard entrance and field access. Replace boundary with permanent stockproof boundary.	Slight
146	60.7	Leased - Long term	0.1833	1.2114	0.0000	High	Reduction in agricultural area due to Drum Road Junction, attenuation pond and drainage outfall. Impact on field access gate. Impact of field drainage. Impact on existing field boundaries.	Medium	Moderate	Replace field access on affected lands. Replace boundary with permanent stockproof boundary.	Slight
146	60.7	Dairy	0.1833	1.2114	0.0000	High	Reduction in agricultural area due to Drum Road Junction, attenuation pond and drainage outfall. Reduction in area of milking platform. Impact on field access gate. Impact of field drainage. Impact on existing field boundaries.	Medium	Moderate	Replace field access on affected lands. Replace boundary with permanent stockproof boundary.	Slight
149	10.1	Summer Grazing - Equine	0.0692	0.0416	0.0000	Medium	Reduction in agricultural area due to Drum Road realignment. Impact on field access gate. Impact of private well. Impact on existing field boundary.	Low	Slight	Replace field access gate. Replace boundary with permanent stockproof boundary.	Slight
150 & 155	38.0	Dairy	0.5096	1.1382	0.0000	High	Reduction in agricultural area due to Drum Road Junction, main alignment and attenuation pond. Reduction in area of milking platform. Impact on field access gate. Impact of field drainage. Impact on existing field boundary.	Medium	Moderate	Replace boundary with permanent stockproof boundary.	Moderate
159 & 164	40.5	Sheep	0.1823	0.1810	0.0199	Medium	Reduction in agricultural area due to Drum Road Junction. Impact of field drainage. Impact on existing field boundary.	Low	Slight	Replace boundary with permanent stockproof boundary.	Slight

CPO No.	Farm Size (ha)	Farm enterprise type	Landtake (ha)			Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
			Permanent Public road	Permanent Agri / land	Temporary Other						
171	32.8	Mixed Livestock - Sheep & Beef	0.1067	0.0847	0.0000	Medium	Reduction in agricultural area due to the main alignment. Impact on field access gates. Impact on existing field boundary.	Low	Slight	Replace boundary with permanent stockproof boundary.	Slight
172	2.0	Leased - Short term	0.1578	0.3027	0.0000	Low	Reduction in agricultural area due to the main alignment. Impact on field access gate. Impact on field drainage. Impact on existing field boundary.	Low	Slight	Replace field access gate. Replace boundary with permanent stockproof boundary.	Slight
173 & 186	48.6	Sheep	0.1370	0.8917	0.0371	Medium	Reduction in agricultural area due to main alignment. Impact on two plots on opposite sides of N16 road. Landtake and severance impact on leased lands. Impact on access to leased lands east of N16. Impact on the management of farm enterprise. Impact on existing field boundaries.	High	Significant	Provide access for pedestrians and small livestock only, through the combined usage of the Vulnerable Road Users Underpass Public Facility (2.7m headroom) which is being provided at c. Ch. 1,300m. Replace boundary with permanent stockproof boundary.	Moderate
174	40.5	Mixed Livestock - Sheep & Beef	0.0035	0.7185	0.6862	Medium	Reduction in agricultural area due to main alignment. Temporary impact on severed area due to Site Compound. Severance of main plot into two separate areas. Loss of access from severed area to the farmyard facilities. Impact on existing field boundaries.	Medium	Moderate	Replace field access gate. Replace boundary with permanent stockproof boundary.	Moderate

CPO No.	Farm Size (ha)	Farm enterprise type	Landtake (ha)			Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
			Permanent Public road	Permanent Agri / land	Temporary Other						
181	15.8	Leased - Short term	0.3723	4.9363	0.0000	Medium	Significant reduction in agricultural area due to main alignment, Soil Repository Borrow Pit, *Castlegal* Junction and *Drum East* Junction. Severance of main plot into three separate areas. Loss of access from severed areas to the farmyard facilities. Impact on field access gates. Impact on field drainage. Impact on existing field boundaries.	High	Significant	Provide access to the severed areas. Replace field access gate. Replace boundary with permanent stockproof boundary.	Moderate
184	40.5	Leased - Short term	0.000	0.1403	0.0005	Low	Reduction in agricultural area due to main alignment. Impact on existing field boundaries.	Low	Slight	Replace boundary with permanent stockproof boundary.	Slight
185, 187 & 188	13.0	Leased - Short term	0.5249	2.9405	0.0632	Medium	Significant reduction in agricultural area due to main alignment, *Lugatober* (East) Junction and *Lugatober* (West) Junction. Direct impact on farm buildings and animal handling facilities. Severance of both plots into separate areas. Loss of direct access to severed area. Impact on field access gates. Impact on field drainage. Impact on existing field boundaries.	High	Significant	Provide access for small livestock only via access tracks and limited height underpass structure at Ch. 1+300m. Replace boundary with permanent stockproof boundary.	Moderate
190	1.2	Leased - Short term	0.0265	0.0000	0.0000	Low	Public road only	Very Low	Imperceptible		Imperceptible
193	22.3	Sheep	0.000	1.0326	0.0000	Medium	Reduction in agricultural area due to main alignment. Severance of lands into two separate areas. Loss of access to the western area. Impact on existing field boundaries.	High	Significant	Provide access to the severed area. Replace boundary with permanent stockproof boundary.	Moderate
195	0.7	Grassland	0.0041	0.000	0.0000	Medium	Public road only	Very Low	Imperceptible		Imperceptible

CPO No.	Farm Size (ha)	Farm enterprise type	Landtake (ha)			Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
			Permanent Public road	Permanent Agri / land	Temporary Other						
197 & 200	50.0	Sheep	0.1809	2.3529	0.0111	Medium	Significant reduction in agricultural area due to main alignment, *Collinsford* (East) Junction and attenuation pond. Impact on main farm entrance and farm access. Severance of lands into two separate areas. Loss of direct access to the southern area. Impact on field access gates. Impact on field drainage. Impact on existing field boundaries.	High	Significant	Provide access to the farm. Replace boundary with permanent stockproof boundary.	Moderate
198	34.0	Sheep	0.3498	0.7318	0.0012	Medium	Reduction in agricultural area due to main alignment. Impact on existing field boundaries.	Low	Slight	Replace field access gate. Replace boundary with permanent stockproof boundary.	Slight
201 & 208	16.2	Beef	0.0222	2.3276	0.0132	Medium	Reduction in agricultural area due to main alignment, Glencar Junction and attenuation pond. Impact on field gate. Impact on existing field boundaries.	Medium	Moderate	Replace boundary with permanent stockproof boundary.	Moderate
202	22.7	Sheep	0.0678	0.2513	0.0011	Medium	Reduction in area of area of scrub due to main alignment and Glencar Junction. Impact on existing field boundaries.	Low	Slight	Replace boundary with permanent stockproof boundary.	Slight

14.4.2.4 Construction Impacts

The assessment of the impact on agricultural land includes the effects of the construction impacts of the *Proposed Road Development*. Construction activity associated with the project will give effect to further impacts on agricultural property such as:

- Construction noise;
- Dust;
- Restricted access to land;
- Disturbance of field drainage; and
- Disturbance of services.

The nature of each specific impact is discussed below.

14.4.2.4.1 *Construction Noise*

The activity of earth moving machinery, transport lorries and other ancillary vehicles will generate additional noise emissions in the immediate vicinity of 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. Intermittent noises close to farm buildings can distress livestock.

Mitigation

Measures to mitigate noise impacts on sensitive receptors are detailed within Chapter 7 Noise and Vibration. Good communication between the contractor and adjacent landowners during the construction phase, especially when excessively loud activities are programmed, will prevent undue disturbance to farm animals due to noise. It will also facilitate farm enterprises so that valuable livestock sensitive to noise can be moved away from the construction work during critical times.

14.4.2.4.2 *Dust*

Dust generated from the exposure of soil to the atmosphere during construction may cause annoyance or nuisance to the farmer and farm animals. Livestock are at risk of eye irritations from high levels of windblown dust particles. This stress may reduce productivity and increase management difficulties.

Mitigation

Measures to control the production of dust will be put in place by the contractor (refer Chapter 8- Air Quality and Climate which presents a series of measures to control dust). 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 as possible from the construction work during critical times.

14.4.2.4.3 *Restricted access to land*

Access to agricultural land will be required to be maintained during the construction process (i.e. following the commencement of construction but before the accommodation works have been completed). In addition to the severance of lands there may be temporary impacts on existing farm access to lands and farmyards during the construction of the main alignment and the associated junctions with the existing N16 road and local road network.

Mitigation

Access will be restored to lands where it is removed by the *Proposed Road Development*. The location of such access will be at a suitable location and, where possible, with the agreement of the landowner.

Where access to lands or farmyard is expected to be temporarily impacted during construction, alternative access will be put in place in advance of such restrictions or landowner consultation will ensure a workable arrangement during this period. Good communication between the contractor and individual farmers will facilitate reasonable access to lands during construction by agreement.

Temporary fencing may be erected, as required, to delineate the boundary and to minimise disturbance to adjacent lands. Temporary access gates may be required until such time as the permanent access arrangements are in place.

14.4.2.4.4 *Disturbance of field drainage*

Field drainage systems currently in situ will be disturbed and in places destroyed by the construction works. These systems will be restored as part of the completed works. However, there may be temporary impaired drainage in the period between initial disturbance and final reinstatement of such drainage works.

Mitigation

In cases where impeded drainage during construction will cause obvious difficulty to a particular landowner, temporary measures will be looked at on a site-specific basis. This may include allowing waters to drain to less critical areas, so as to minimise the impact.

14.4.2.4.5 *Disturbance of services*

Access to either piped water or drinking points on watercourses may be affected during construction through the severance of piping on the farm or the diversion of watercourses used by livestock on the farm. Electric fencing used on farms to stock proof farm boundaries or control the movement of stock may also be affected.

Mitigation

Where required, an alternative source of water / electricity will be provided to ensure that disruption to farming is minimised during the construction phase.

14.4.3 Interactions and Cumulative Impacts

14.4.3.1 Interactions

The direct impacts on agriculture will interact / or interrelate with the following:

Population and Human Health

Primary impacts on population and human health due to material assets & land will entail landtake and other agricultural property impacts. Potential impacts on human beings will be mitigated by measures including the provision of new accesses and replacement boundaries to affected properties. Other mitigation measures include the provision of accesses to severed areas of land and fields and stockproof boundary treatment. The loss of land, impact on farm buildings and farmyard facilities and disturbance will be dealt with via compensation. Monetary compensation will be subject to negotiation with all relevant parties from whom land or property is acquired for the *Proposed Road Development*.

Noise and Vibration

Noise impacts during both the construction and operation phases may result in disturbance to farming activities. The removal of soils and rock excavation could affect neighbouring livestock. Good communication between the contractor and adjacent landowners during the construction phase will allow farm animals to be moved, avoiding undue disturbance.

Air Quality and Climate

Air quality impacts on agricultural property may arise during the construction phase and may result in dust deposition on agricultural lands and farmyards. A dust minimisation plan will be followed during the construction phase of the project to avoid any impacts on property.

Hydrology

Field drainage systems currently in situ will be disturbed and in places impacted by the construction works. These systems will be restored as part of the completed road works. Temporary impacts during construction will be mitigated on a site-specific basis to minimise this impact.

14.4.3.2 Cumulative Impacts

There are no recent road or other projects immediately adjoining the *Proposed Road Development* and as a result there are no cumulative impacts on agricultural property.

14.5 Mitigation Measures

This section describes the measures that when implemented will mitigate the adverse impact on agriculture. The assessment does not consider at this stage measures such as compensation for land acquisition and disturbance. These matters will be agreed with landowners or their representative(s) once planning approval for the *Proposed Road Development* has been granted. If agreement is not possible, such compensation will be decided upon by a property arbitrator.

The following general mitigation measures are recommended:

- Access will be restored to lands where it is removed or restricted. The location of such access will be at a suitable location and, where possible, with the agreement of the landowner;
- Access will be possible for pedestrians and small livestock only, through the combined usage of the Vulnerable Road Users Underpass Public Facility (2.7m headroom) which is being provided at c. Ch. 1,300m;
- In general, permanent fencing will comprise of timber post and tension mesh fencing in accordance with CC-SCD-00320. Where permanent fencing is erected on the boundary of the *Proposed Road Development* or the associated attenuation ponds, it will be maintained by TII;
- In general, on side road tie-ins with the *Proposed Road Development* the permanent fencing will comprise of timber post and tension mesh fencing in accordance with CC-SCD-00320 unless otherwise agreed with the landowner and will be maintained by the landowner.
- All existing land drains and watercourses severed by the *Proposed Road Development* will be incorporated into a new drainage system as outlined in Figure 4.7.1 to 4.7.2 contained within volume 3 of this EIAR. The new drainage system has been designed to ensure that the current drainage situation will not be made any worse and there will be no increased risk of flooding to adjoining lands;

- Any services that are interfered with as a result of the *Proposed Road Development* will be repaired / replaced without unreasonable delay; and
- Ducting for the restoration of water and power supply services will be provided, as necessary, at a suitable location with the agreement of the landowner.

Details of mitigation measures for individual farms affected by the *Proposed Road Development* are presented in Table 14-8.

14.6 Residual Impacts of the *Proposed Road Development*

The significance of the residual impact on agriculture has been assessed following the implementation of general mitigation measures as outlined in Section 14.6. A summary of the residual impact on agriculture is presented in Table 14-9.

Table 14-9: Residual impact on agricultural property – Significance

Significance	No. of farms	% of total farms
Profound	0	0
Very Significant	0	0
Significant	0	0
Moderate	8	38.1%
Slight	11	52.4%
Imperceptible	2	9.5%
Total	20	100.0%

Following mitigation, there are no farm holdings on which the agricultural impact will be Profound, Very Significant or Significant.

The residual impact will be Moderate on eight farms (38.1% of farms), Slight on eleven farms (52.4%) and Imperceptible on two farms (9.5% of farms).

Summary details of the assessment of the impact on agriculture are presented in Table 14-8.

14.7Relevant Figures and Appendices

14.7.1 Figures contained in Volume 3

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

- Fig. 15.1.1; Landownership Mosaic, Sheet 1 of 2;
- Fig. 15.1.2; Landownership Mosaic, Sheet 2 of 2;

14.7.2 Appendices contained in Volume 4

There are no appendices associated with this Chapter contained within Volume 4 of the EIAR:

15 Material Assets and Land – Non-Agriculture

15.1 Introduction

This chapter of the EIAR considers and assesses the potential for likely significant effects of the N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development* on non-agricultural property.

Other impacts on Material Assets are also addressed throughout this EIAR, most particularly in the following sections:

- Chapter 6 Population and Human Health;
- Chapter 7 Noise and Vibration;
- Chapter 8 Air Quality & Climate Change;
- Chapter 10 Soils & Geology;
- Chapter 11 Hydrology & Hydrogeology;
- Chapter 12 Landscape & Visual.
- Chapter 13 Archaeology, Architecture and Cultural Heritage; and
- Chapter 14 Material Assets: Agricultural Property;

Non-agricultural property includes the following:

- Residential property;
- Commercial property;
- Community property – Public park, open space or lands that are used for recreation amenity; and
- Development land – Lands or sites including lands zoned for development and / or with planning permission.

15.2Methodology

In line with best practice this section was prepared with regards to the following documents:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (Draft) (EPA, 2017);
- Advice notes for preparing Environmental Impact Statements (Draft) (EPA, 2015);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA, 2008);
- Advice notes on current practice in the preparation of Environmental Impact Statements (EPA, 2003);
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002);

The methodology for the assessment of the significance of impact on non-agricultural property comprised of a desktop survey of project mapping and information and a roadside survey of the *Proposed Road Development*. The roadside surveys took place between February and May 2018.

15.2.1 **Data sources**

The methodology for this section relied on information from the sources outlined in Table 15-1.

Table 15-1: Information and sources

Information	Source
Land registry / landownership information	Property Registration Authority through Sligo County Council.

Information	Source
Planning and zoning objectives	Sligo County Development Plan (2017-2023); Sligo & Environs Local Area Plan (2018-2024) – Consultation Paper.
Design mapping & project information	Sligo County Council.
CPO deposit mapping & schedule (Draft)	Sligo County Council.

15.2.2 Study area

The study area for the *Proposed Road Development* comprises of non-agricultural properties directly impacted within the townlands of *Doonally*, *Drumkilsellagh*, *Drum East*, *Castlegal*, *Lugatober*, *Collinsford* and *Lugnagall*. The affected properties are not within the extents of the Sligo & Environs Development Plan.

There are fifteen non-agricultural properties directly impacted by the *Proposed Road Development*. Landtake for the *Proposed Road Development* will comprise of approximately 0.43ha of property, agricultural land and public road.

15.2.3 Assessment methodology

The effect of the *Proposed Road Development* on property, other than agricultural property, was considered in this assessment and includes impacts on residential and development lands.

The baseline environment for non-agricultural property was evaluated on an individual property basis and assigned a baseline rating. This baseline rating combined with a magnitude of impact from construction and operation impacts associated with the *Proposed Road Development* will determine the significance of the non-agricultural property impact.

Baseline Rating

Property within the study area was assigned a baseline rating determined by the property type. Residential, commercial, community and development property (with planning permission) are indicative of a high baseline rating. Development property without planning permission is indicative of a medium baseline rating, e.g. a house site.

Baseline Rating Criteria

The criteria used to determine the baseline rating for property within the study area is shown in Table 1-2 Baseline Rating Criteria. The criteria for each of the baseline ratings have been developed in consideration of the relevant EPA guidelines on describing the existing environment.

Table 15-2: Baseline Rating Criteria

Impact	Criteria
High	Residential property. Commercial property. Community property used for public and private recreation amenity. Development land / site with planning permission.
Medium	Development land / site without planning permission. Residential property (vacant / derelict). Commercial property (vacant / derelict).

Impact	Criteria
Low	Property consisting of public roadbed only.

Impact Magnitude

Impacts on non-agricultural properties arising from the *Proposed Road Development* include:

- Non-agricultural properties that are to be acquired and permanently demolished.
- Non-agricultural properties where a portion is to be acquired on a permanent basis, e.g. property area.
- Non-agricultural properties where a portion is to be acquired on a temporary basis, e.g. property area.
- Non-agricultural properties to which access will be directly restricted or altered, e.g. reinstatement of a property entrance.
- Non-agricultural properties where a portion consisting entirely of public road will be acquired on a temporary or permanent basis

15.2.3.1 Magnitude of Impact Criteria

The criteria used to determine the magnitude of impact for the non-agricultural property on the *Proposed Road Development* are shown in Table 15-3 Magnitude of Impact Criteria. The criteria for each of the impact ratings have been developed in consideration of the relevant EPA guidelines on the assessment of impact.

Table 15-3: Magnitude of Impact Criteria

Impact	Criteria
High	An impact on the property where the use of the property cannot continue.
Medium	An impact on the property where the use of the property can continue. An impact of permanent duration resulting in a change to the character of the property.
Low	An impact on the property where the use of the property can continue. An impact of permanent or temporary duration with a minimal or temporary effect on the character of the property.
Very low	An impact on the property that does not affect the use of the property (i.e. acquisition of public road only)

Impact Significance

The significance of impact on a property is determined by the baseline rating assigned to the property combined with the magnitude of impact of the *Proposed Road Development*. There are three categories of baseline rating ranging from ‘low’ to ‘high’. There are four categories of magnitude of impact ranging from ‘very low’ to ‘high’. The likely significance rating is determined by reference to the matrix in Table 15-4 Magnitude of Impact Criteria using the baseline rating and magnitude of impact. The likely significance of impact is prior to the implementation of any mitigation measures. Table 15-4 Significance of Impact has been developed in consideration of the relevant EPA guidelines on the assessment of impact.

Table 15-4: Significance of Impact

Baseline rating	Magnitude of impact			
	High	Medium	Low	Very low
High	Profound	Significant	Slight	Imperceptible
Medium	Significant	Moderate	Slight	Imperceptible
Low	Imperceptible	Imperceptible	Imperceptible	Imperceptible

15.3 Description of Existing Environment

15.3.1 Property in the Study Area

The study area for the *Proposed Road Development* is comprised of non-agricultural property directly impacted by the project. There are fifteen non-agricultural properties comprising eleven residential properties, three development sites and local authority property comprised of public road. The baseline rating for property will be High on twelve properties, Medium on two properties and Low on one property.

15.4 Description of Likely Impacts

15.4.1 'Do Nothing' or 'Do Minimum' Impact

Under the 'Do Nothing' or 'Do Minimum' scenario, no direct impact would occur on non-agricultural property. The existing N16 would continue to be used for access to residential and other non-agricultural property.

15.4.2 Potential Impact of Proposed Road Development

The *Proposed Road Development* will directly impact upon non-agricultural property and permanent impacts include landtake and temporary impacts on access to property associated with the proposed construction activities.

At the route selection stage for the N16 Sligo to the County Boundary road project, the assessment for non-agricultural property considered landownership information within the study area and existing constraints such as residential dwelling houses, commercial property and development lands.

15.4.2.1 Impact on non-agricultural property in the study area

The impact on property is limited to property directly impacted by the *Proposed Road Development*. The *Proposed Road Development* will involve the permanent acquisition of approximately 0.43ha from fifteen non-agricultural properties. This landtake area consists of a permanent acquisition of non-agricultural property, agricultural land and public road.

Details of the magnitude of impact on agricultural property are presented in Table 15-5. The magnitude of impact on non-agricultural property ranges from Very Low to Medium. On three properties the magnitude of impact is Medium due to impacts including landtake and/ or access to property.

Table 15-5: Impact on non-agricultural property – Magnitude

Magnitude	No. of properties	% of total
High	0	0
Medium	3	20.0%

Magnitude	No. of properties	% of total
Low	5	33.3%
Very low	7	46.7%
Total	15	100.0%

Details of the significance of impact on non-agricultural property are presented in Table 15-6. The significance of impact, which is determined by combining the magnitude of impact and the baseline rating for that property, ranges from Imperceptible to Significant.

Table 15-6: Impact on non-agricultural property – Significance

Significance	No. of properties	% of total
Profound	0	0%
Very Significant	0	0%
Significant	2	13.3%
Moderate	1	6.7%
Slight	5	33.3%
Imperceptible	7	46.7%
Total	15	100.0%

On two properties (13.3% of property) the significance of impact is assessed as Significant, due to impacts including landtake and access to property. On these properties, the impact consists of the permanent acquisition of property curtilage. There are further property impacts on the property boundary and existing access.

Measures to mitigate the adverse effects of the *Proposed Road Development* are described in Section 15.6. The significance of the residual impacts following the implementation of mitigation measures are described in Section 15.7.

Details of magnitude of impact and impact significance for property affected by the *Proposed Road Development* are presented in Table 15-7.

Table 15-7: Impact on non agricultural property – Significance

CPO No.	Property type	Permanent Public Road (ha)	Permanent Non-agri Land (ha)	Temporary Non-agri land (ha)	Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
158	Residential	0.0339	0.0000	0.0000	High	Public road only	Very Low	Imperceptible		Imperceptible
165	Residential	0.0273	0.0015	0.0121	High	Reduction in curtilage area of property. Impact on property boundary.	Low	Slight	Replace affected property boundary.	Slight
166	Residential	0.0179	0.0000	0.0076	High	Public road only	Very Low	Imperceptible		Imperceptible
168	Residential	0.0169	0.0006	0.0078	High	Reduction in curtilage area of property. Impact on property boundary.	Low	Slight	Replace affected property boundary.	Slight
170	Development Site	0.0046	0.0000	0.0000	Medium	Public road only	Very Low	Imperceptible		Imperceptible
177	Residential	0.0118	0.0000	0.0000	High	Public road only	Very Low	Imperceptible		Imperceptible
179	Residential	0.0201	0.0000	0.0090	High	Public road only	Very Low	Imperceptible		Imperceptible
180	Residential	0.0390	0.0159	0.0088	High	Reduction in curtilage area of property. Impact on existing property entrance and access. Impact on property boundary.	Medium	Significant	Restore property entrance and access. Reinstate property boundary on a like for like basis.	Slight
191	Residential	0.0252	0.0000	0.0018	High	Reduction in curtilage area of property. Impact on existing property entrance and access. Impact on property boundary.	Medium	Significant	Restore property entrance and access. Reinstate property boundary on a like for like basis.	Slight
203	Development Site	0.0056	0.0160	0.0176	Medium	Reduction in entrance to site. Impact on property boundary.	Medium	Moderate	Replace affected property boundary.	Moderate
204	Residential	0.0095	0.0280	0.0000	High	Reduction in curtilage area of property. Impact on site drainage. Impact on property boundary.	Low	Slight	Replace affected property boundary.	Slight

CPO No.	Property type	Permanent Public Road (ha)	Permanent Non-agri Land (ha)	Temporary Non-agri land (ha)	Baseline rating	Impact details	Magnitude of impact	Impact significance	Mitigation measures	Residual impact significance
205	Residential	0.0000	0.0000	0.0096	High	Temporary reduction in curtilage area of property. Impact on site drainage. Impact on property boundary.	Low	Slight	Replace affected property boundary.	Imperceptible
207	Roadbed	0.0150	0.0000	0.0000	Low	Public road only	Very Low	Imperceptible		Imperceptible
300	Development Site	0.0000	0.0591	0.0000	High	Reduction in curtilage area of property. Impact on existing property entrance and access. Impact on property boundary.	Low	Slight	Replace affected property boundary.	Slight
301	Residential		0.000	0.000	High	Public road only	Very Low	Imperceptible		Imperceptible

15.4.2.2 Construction Impacts

The assessment of the impact on non-agricultural property includes the effects of the construction impacts of the *Proposed Road Development*. Construction activity associated with the development will give effect to further impacts on non-agricultural property such as:

- Access
- Noise and vibration;
- Dust;
- Disturbance of drainage systems; and
- Disturbance of services.

The nature of each specific impact is discussed below.

15.4.2.2.1 *Access*

Access to some properties will be affected during the construction phase. The construction of local road junctions / crossings in particular may impact on access to properties.

Mitigation

Access shall be maintained to all properties during the construction works. Where access is impeded to properties alternative access arrangements will be made on a case by case basis without undue delay. Traffic management measures will be put in place during construction where temporary or minor diversions are required.

15.4.2.2.2 *Noise and Vibration*

The activity of construction vehicles will generate additional noise emissions in the immediate vicinity of the road construction. Noise and vibration may be a cause of disturbance to those residing in dwelling houses located in close proximity to the proposed road construction.

Mitigation

Measures to mitigate noise impacts on sensitive receptors are detailed within Chapter 7 Noise and Vibration. Prior to the commencement of works and subject to landowner agreement a condition survey will be undertaken of any dwelling house/building in use located within 50 metres of the extents of the CPO boundary.

15.4.2.2.3 *Dust*

Dust generated during the construction phase may have a nuisance effect on nearby properties.

Mitigation

Measures to control the production of dust will be put in place by the contractor (refer Chapter 8- Air Quality and Climate which presents a series of measures to control dust).

15.4.2.2.4 *Disturbance of field drainage*

Existing drainage systems will be disturbed and in places removed by the construction of the new road. These systems will be restored as part of the completed road works. However, there may be temporary impaired drainage in the period of time between initial entry and final reinstatement of such drainage works.

Mitigation

Where drainage is impeded during construction, temporary measures will be provided on a site-specific basis including drainage of surface waters to less critical areas, so as to minimise any impact.

15.4.2.2.5 *Disturbance of services*

The construction of the *Proposed Road Development* may impact on services including supply of water, electricity and phone service and facilities for or connections to wastewater treatment.

Mitigation

Consultation with property owners will be necessary to ensure these services are maintained and reinstated. When the interruption of such services is required, reasonable prior notice shall be given and services shall be restored in a timely manner.

15.4.3 Interactions and Cumulative Impacts

15.4.3.1 Interactions

The direct impacts on non-agricultural property will interact / or interrelate with the following:

Population and Human Health

Primary impacts on population and human health due to material assets & property will primarily entail landtake of curtilage, access and impacts to the existing boundary.

Noise and Vibration

Noise impacts during both the construction and operation phases may result in disturbance.

Air Quality and Climate

Air quality impacts on property may arise during the construction phase and may result in dust deposition on residential and development property. A dust minimisation plan will be followed during the construction phase of the project to avoid any impacts on property.

Hydrology

Field drainage systems currently in situ will be disturbed and in places impacted by the construction works.

15.5 Cumulative Impacts

There are no recent road or other projects immediately adjoining the proposed road project and as a result there are no cumulative impacts on non-agricultural property.

15.6 Mitigation Measures

This section describes the measures that when implemented will mitigate the adverse impact on property. The assessment does not consider at this stage measures such as compensation for land acquisition and disturbance. These matters will be agreed with landowners or their representative(s) once planning approval for the proposed development has been granted. If agreement is not possible, such compensation will be decided upon by a property arbitrator.

The following general mitigation measures are recommended:

- Access will be maintained to all affected property.
- Where part of the curtilage of a property is to be permanently acquired, the acquiring authority will hold discussions with the property owner and generally agree to replace boundaries on a like for like basis, subject to safety considerations, or it will be treated as a compensation issue.
- Prior to construction and subject to written agreement of the relevant property owners, property condition surveys will be undertaken in relation to all buildings / structures in use located within 50 metres of the extents of the CPO boundary.
- Any services that are interfered with as a result of the *Proposed Road Development* will be repaired / replaced without unreasonable delay.

Details of mitigation measures for individual property affected by the proposed development are presented in Table 15-7.

15.7 Residual Impacts of the Proposed Road

The significance of the residual impact on non-agricultural property has been assessed following the implementation of general mitigation measures as outlined in Section 15.6. A summary of the residual impact on non-agricultural property is presented in Table 15-8.

Table 15-8: Residual impact on non-agricultural property – Significance

Significance	No. of properties	% of total
Profound	0	0%
Very Significant	0	0%
Significant	0	0%
Moderate	0	0%
Slight	7	46.7%
Imperceptible	8	53.3%
Total	11	100.0%

Following mitigation, there are no properties on which the non-agricultural impact will be Profound, Significant or Moderate. This represents a reduction of two properties previously rated as Significant and one property rated as Moderate following the recommended mitigation measures.

The residual impact will be Slight on seven properties (46.7% of properties) and Imperceptible on eight properties (53.3% of properties).

Summary details of the assessment of the impact on non-agricultural property are presented in Table 15-6.

15.8Figures 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 within Volume 3 of the EIAR:

- Fig. 15.1.1; Landownership Mosaic, Sheet 1 of 2;
- Fig. 15.1.2; Landownership Mosaic, Sheet 2 of 2;

15.8.2 Appendices contained in Volume 4

There are no appendices associated with this Chapter contained within Volume 4 of the EIAR:

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 N16 *Lugatober* (*Drumkilsellagh* to *Lugnagall*) *Proposed Road Development*; which will be specified in the contract documents/client specification.

The environmental measures detailed within the EIAR 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
6.1	C&O	## 16.2 Population ### 16.2.1 Construction & Operational Phase Mitigation Measures The following mitigation measures have now been included in the road development or are proposed: ➢ Provide for community interaction and pedestrian movement with informal pedestrian and cyclist crossing facilities at the roundabout junction with the L-3406-0. ➢ Provide pedestrian underpass access during construction from a severed farmhouse at the start of the L-7413-0 to permit crossing of the road to family members located on the other side. ➢ Include good and continuous signage for all diversions using minor roads. ➢ Include good and continuous signage for diversions using regional roads, including ensuring warning signage for potentially hazardous or more populated sections unfamiliar to diverted motorists and HGV drivers. Avoid school term. ➢ Consider facilities to enhance the tourism attraction of the proposed cycleway, for example, erection of information boards at natural viewpoints such as that at *Lugatober*. ➢ Provide road marking **t**o facilitate southbound cyclists to cross the L3404-0 to join the proposed cycleway. ➢ Include uncontrolled crossing point for southbound cyclists between Ch. 0 to Ch. 350.	6.5
7.1	C	### 16.2.2 Noise & Vibration ### 16.2.3 Construction Phase Noise Mitigation Measures In order to ensure that the noise limit of 70 dB(A) $L_{Aeq,\ 1\ hour}$ will be achieved, noise emissions at the construction phase will be managed in accordance with the mitigation measures outlined below, which are consistent with the recommendations contained within BS 5228 *"Noise control on open and construction sites"*. ➢ No plant used on site will be permitted to cause an ongoing public nuisance due to noise.	7.5.1 and 7.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ To ensure that where rock blasting / breaking is required, the noise limits outlined in Table 7-5 are not exceeded at 1m from the façade of the nearest noise sensitive properties, noise monitoring will be carried out at the nearest noise sensitive properties (i.e. within approximately 100m of the construction works) during these works. ➢ If the noise limits outlined in Table 7-5 are exceeded at 1m from the façade of the nearest noise sensitive properties, temporary noise screens will be erected in close proximity to the noise source such as rock breakers, etc. to ensure that a noise level of less than 70 dB(A) $L_{Aeq\ 1\ hour}$ is achieved at the nearest noise sensitive properties. 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 ensure that: ➢ The best means practical, 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 of the “sound reduced” 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. ➢ Machines which are used intermittently will be shut down or throttled back to a minimum during those periods when they are not in use. ➢ Any plant such as generators or pumps which are required to work outside of normal working hours will be surrounded by an acoustic enclosure. ➢ Throughout the contract the supervision of the works will include ensuring compliance with the limits using the methods set out in BS 5228.	

No.	Stage	Description	Main Report (Volume 2) Reference
		Works other than the pumping out of excavations, security and emergency works will not be undertaken outside the working hours outlined in Table 7-5 without the written permission of Sligo County Council. Works other than pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of Sligo County Council. When overtime and shift working, outside normal working hours, is permitted, the maximum permissible noise limits outlined in Table 7-5 will apply, subject to confirmation of operating hours and noise levels with Sligo County Council. **16.2.4 Construction Phase Vibration Mitigation Measures** If utilised by the contractor, blasting works may generate a potential vibration impact associated with the construction works that would be of sufficient magnitude to generate noticeable ground vibration. The design, execution and completion of any blasting within 150 metres of any existing structure shall require special considerations. In such cases, the following recommended mitigation measures are proposed; ➢ Blasting trials will be carried out in order to monitor vibration patterns and provide an independent field assessment of full scale blasting, ➢ The blasting design, execution and completion of the rock excavation works shall limit the weight of explosive charges in each delay in order to: reduce vibration to a minimum, minimise overbreak, minimise induced instability in the rock mass, minimise fracturing of the rock in the rock slope as a result of the method of excavation and also prevent undercutting of embankment or cutting slopes, structure foundations and buried services and the like, ➢ The Design shall ensure that in a rock cutting containing intermediate benches, the drill holes and depths of sub-drill at each blast level shall be designed, executed and completed to minimise damage and instability at the edges of the bench, ➢ The Contractor shall liaise with land and property owners adjacent to the area of blasting and minimise disturbance or intrusion to the general public and prevent surprise or alarm being caused to the public and livestock during the execution and completion of the blasting,	

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ Prior to any rock blasting, the Contractor shall be responsible for notifying the public of any proposed blasting activities no later than 14 days in advance of the commencement of the blasting activities and shall publicise the work with an advisory notice which shall be published in the local press and be posted at public buildings and offices and other locations. Written notification and public notices shall as a minimum include all the following: ➢ project details and name of Contractor, ➢ location of proposed blasting activities, ➢ precise dates and times of blasts, ➢ the name, address and telephone number of a contact within the Contractors organisation who shall deal with queries from members of the public, ➢ the period over which the blasting shall be undertaken or likely to undertaken and, ➢ details of audible and visual warnings that shall be provided prior to all individual blasts. ➢ Where possible, blasting shall be carried out at the same time or times on each date, ➢ Carriageways shall be protected from fly rock or other debris, and there shall be no damage to adjacent property or infrastructure during the execution and completion of the blasting works, ➢ The potential for flyrock during blasting will be controlled by the blasting contractor. The blasting contractor will be required to take precautions for the protection of persons and property, including proper loading and stemming of holes and the use of blasting mats or other effective means of controlling the blast or resultant flying material. The blasting contractor will ensure that the danger area is clear of workers and residents and is kept clear during the blasting period.	

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ As and if deemed necessary during the construction phase, vibration monitoring will be carried out at affected properties (if any) during critical stages of the rock blasting and rock breaking/piling works (subject to property owner consent), ➢ The TII vibration limits will be complied with during rock blasting and rock breaking/piling works, and ➢ Property condition surveys will be offered for all buildings within 50m of the development boundary and those within 500m of proposed blasting works along the *Proposed Road Development*. Property condition surveys will also be carried out at buildings and structures considered appropriate relative to their proximity to the works. Such property condition surveys shall be carried out by a Chartered Surveyor or Chartered Structural Engineer. Such property condition surveys, subject to the written agreement of relevant property owners, shall be carried out in two stages as follows: ➢ the first stage shall consist of pre-construction condition surveys including photographic records which shall be carried out prior to project commencement, ➢ the second stage shall consist of post-construction condition surveys which shall include photographic records. As stated, the main rock cut area along the proposed N16 alignment is at *Castlegal* (approximate chainage 900 – 1,160). The cutting required in this area will be approximately 13m deep at the deepest section (measured along the road centreline). A combination of rock breaking and blasting will also be undertaken to allow for the excavation of the Soil Repository/Borrow Pit, east of the proposed alignment at *Castlegal*. **16.2.5 Operation Phase Noise Mitigation Measures** The requirement for noise mitigation measures at the noise sensitive receiver locations has been examined based on a review of the three conditions which are required to be satisfied in order for mitigation measures to be deemed necessary as stipulated in the TII Guidelines. Of the 46 No. receiver locations assessed, no receivers were deemed to require mitigation measures in the Year of Opening (2021) or the Design Year (2036) as the predicted traffic noise levels at noise sensitive receiver locations comply with the TII design goal	

No.	Stage	Description	Main Report (Volume 2) Reference
		criteria. Therefore, other than the Low Noise Surface already described in Chapter 7 of this EIAR, no noise mitigation measures need to be incorporated into the design of the proposed N16 road development.	
8.1	C	**16.3 Air Quality & Climate Change** **16.3.1 Construction Phase Mitigation Measures** 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 receiver locations and whether the wind can carry the dust to these locations. The implementation of a Dust Minimisation Plan during the construction phase of the project will include standard measures such as: ➢ Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only. ➢ Any site roads with the potential to give rise to dust will be regularly watered, as appropriate, during dry and/or windy conditions (also applies to vehicles delivering material with dust potential). ➢ Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary. ➢ Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. ➢ Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods. Water bowers will be used across the areas as required on roads, stockpiles and material handling systems. ➢ All vehicles which present a risk of spillage of materials, while either delivering or removing materials, will be loaded in such a way as to prevent spillage on to the public road. ➢ The contractor will be required to ensure that all vehicles are suitably maintained to ensure that emissions of engine generated pollutants is kept to a minimum. ➢ Site traffic on haul roads will be restricted to 20 km/hr to minimise dust re-suspension. ➢ All material handling will be carried out to minimise drop heights from plant to plant or from plant to stockpile.	8.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		By adhering to good working practices and the implementation of the dust mitigation measures, the levels of dust generated will not cause an environmental nuisance. The Contractor will be required to maintain monthly dust levels below the guideline of 350 $mg/m^2/day$ as an annual average at sensitive receivers. Where dust levels are found to be above this threshold, the mitigation measures in the area must be reviewed as part of the Dust Minimisation Plan. Blasting mitigation measures Blasting mitigation measures will form part of the Environmental Management System for the construction site. These measures relate to blasting procedures such as quantity of explosive and charge-hole spacing. Measures to control blasting impacts on air quality will include the following: ➢ Geological considerations in blast design. ➢ Dust filters fitted on the drilling rig when preparing blast holes. ➢ Optimise blast design with adequately spaced charges. ➢ Minimise air overpressure through proper blast design, spacing and timing of multiple charges. ➢ Inform nearby residents on day prior to planned blasting schedule using house-calls, written note/signage at entrance (or combination). ➢ A warning siren will be sounded prior to blast taking place.At *Lugatober*, Property No.'s 125 and 126 are approximately 50m and 20m respectively from a proposed 4m deep cutting which will have steepened earth slopes. At this location there is the potential for rock to be encountered at a depth of 3m. Therefore, in this localised area, excavation of the rock in close proximity to the nearby properties will be undertaken using a process of rock splitting rather than rock breaking or blasting. This method is significantly quieter and produces significantly less vibration.	

No.	Stage	Description	Main Report (Volume 2) Reference
9.1	C	**16.4 Biodiversity** **16.4.1 Construction Stage** **16.4.1.1 Mitigation by Avoidance** The *Proposed Road Development* has been designed to avoid ecologically sensitive areas and has been constraint led from the initial design phase (the N16 Sligo to County Boundary Route Selection Process). The project design has followed the basic principles outlined below to eliminate the potential for ecological effects on KERs where possible and to minimise such effects where total elimination is not possible. The *Proposed Road Development* has been designed to: ➢ avoid any direct, indirect or residual adverse effects on the integrity of European sites or other designated sites for nature conservation; ➢ to avoid/minimise effects on habitats that correspond to those that are listed on Annex I of the EU Habitats Directive outside of the European and nationally designated sites; ➢ minimise direct or indirect effects on any habitats or species that were classified as being of National, County or Local Importance (Higher Value) in the design of the *Proposed Road Development*. Through careful planning and design, direct or indirect effects on receptors of International, National & County importance have been avoided at the design stage. In addition, the *Proposed Road Development* layout minimises the potential for effects on receptors of Local Importance (Higher Value). **16.4.1.2 Mitigation by Design** The *Proposed Road Development* has been progressed having regard to all relevant TII/NRA guidelines, for the planning and construction of National Road Schemes, and National and European legislation. The guidelines for the planning and construction of national roads provide, within the design, for the protection of the environment. The following is an overview of the design measures that will be employed throughout the entire length of the *Proposed Road Development* to minimise and avoid significant negative impacts on the ecological receptors within the ZOI.	9.5.1

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ Landscaping associated with the *Proposed Road Development* will involve the planting of native hedgerow and woodland to mitigate for losses associated with the *Proposed Road Development*; ➢ The main watercourse crossings have been designed to minimise the potential for both short and long term negative ecological impacts on all watercourses including drainage ditches. The design of the *Proposed Road Development* minimises loss of habitat through appropriate design, ensuring that the points do not result in a barrier effect and that significant changes to the nature of the channel are avoided; ➢ An Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent watercourses including various tributaries of the Drumcliff River (The (OESC) is contained within Volume 4 of this EIAR). The potential for run off pollutants during the construction phase of the development will be fully managed with impacts on significant receptors avoided; ➢ The proposed operational road drainage has been designed to avoid the potential for ongoing pollution of the wider environment during the lifetime of the road and is likely to lead to a positive impact. **16.4.1.3 Hydrologically Sensitive Habitats** The *Proposed Road Development* passes within proximity to several hydrologically & hydrogeologically sensitive habitats that are included as KERs and where potential indirect impacts were identified. Through consultation with the hydrology team on the project, it has been possible to prescribe mitigation to maintain a drainage neutral situation in these areas thereby not altering the existing hydrological situation and thereby not impacting on the ecology of the habitats. Full details of the measures to be included are provided in Chapter 11 (Hydrology & Hydrogeology) of this EIAR. The measures have effectively removed the potential for significant hydrological or hydrogeological effects on Key Ecological Receptors outside the footprint of the *Proposed Road Development* during the construction phase. An Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent hydrologically sensitive habitats. The OESC also contains measures to minimise dust arisings during the construction stage. ***16.4.1.3.1 Culverts and Diversions*** **General** All works in proximity to watercourses shall follow the specific protection and mitigation measures described in the Outline Erosion and Sediment Control Plan and the best practice guidance outlined in the following documents: ➢ TII/NRA 'Guidelines for the crossing of Watercourses During Construction of National Road Schemes (2008);	

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ Shannon Regional Fisheries Board (SRFB) Protection and Conservation of Fisheries Habitat with Particular reference to Road Construction (2009); ➢ Inland Fisheries Ireland requirements publication" Guidelines on protection of fisheries during construction works in and adjacent to waters" (2016) All instream works in watercourses identified as having to support fish species will be undertaken in accordance with the IFI Guidelines 2016 which state: "*To minimise adverse impacts on the fisheries resource works in rivers, streams, watercourses, lakes, reservoirs and ponds should normally (except in exceptional circumstances with the agreement of IFI) be carried out during the period July-September.*" **Electrofishing and Translocation of Aquatic Fauna** This mitigation is applicable to works at the following watercourses: Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream. Where dewatering of channels is required (i.e. for stream diversions) Inland Fisheries Ireland (IFI) or a suitably qualified contractor will conduct an electrofishing operation and white-clawed crayfish survey to remove any fish/crayfish from the channel prior to dewatering. Such surveys and translocation operations shall be conducted under license from IFI and the NPWS. **No Net Loss Principle (Shannon Regional Fisheries Bord 2009)** The no net loss principle is fundamental to the habitat conservation goal. The principle takes into consideration the habitat and water quality requirements of fish, in the context of site-specific evaluations, in order to avoid losses of habitats or habitat components that can limit the production of fisheries resources. There will be no net loss of fish habitat or in the ability or potential for the fisheries and aquatic habitat to maintain fish stocks or the food of fish. All culverts and diversions on the Lugatober Stream, Collinsford Stream and Lugnagall Stream have been designed to ensure that will be no net loss of fisheries habitat occurs. **Structures** The Tully Stream will be crossed by a Clear Span Structure. The Lugatober Stream, Collinsford Stream and Lugnagall Stream will be crossed by a box culvert. All other crossing point (i.e. drainage ditches) will be crossed by pipe culverts.	

No.	Stage	Description	Main Report (Volume 2) Reference
		The culverts have been designed so that velocities through them will allow the passage of fish at any time. The original bed material will be reinstated or where imported will consist of rounded washed gravels which will be either placed upstream of the culvert or will be placed in the culvert before it becomes live. Where a box culvert is proposed, the invert of the culvert will be set at least 500mm (or 300mm where agreed with IFI) below the existing bed level, and at the same gradient or near the same gradient as the existing bed. Over sized culverts will be designed with rock armour training from the inside of the headwalls back to natural channel width to form a low flow channel. The screening of temporary or permanent culverts to prevent trash build up can cause an obstruction to fish passage and will not be permitted on the Lugatober Stream, Collinsford Stream or Lugnagall Stream. **Diversions** Where a temporary/permanent stream diversion is required (i.e. Tributaries of Drumcliff River), the design, construction and operation of the channel will require the provision of artificial geotextile membrane sheeting or rock armour, on the side and base of the temporary channel. This will minimise erosion and potential surface water runoff. The new channels shall be constructed in dry conditions. Channels shall also be constructed in a fish friendly manner following IFI best practice (Shannon Regional Fisheries Board (2009) *Protection and Conservation of Fisheries Habitat with Particular Reference to Road Construction. Shannon Regional Fisheries Board, Clonmel* and *Guidelines on protection of fisheries during construction works in and adjacent to waters*, IFI 2016). Newly created channels shall incorporate instream structures, features and meanders that will give rise to flow type variation as found in fish bearing waters. The channel base widths have been designed to match the width of the diverted channels. Watercourse diversions will be subject to channel stabilization works, which consist of lining the new channel with rounded washed gravel to a maximum depth of 300mm below finished bed level and bank scour protection in the form of rock armour, along the channel. These works will be undertaken in consultation with IFI. 16.4.1.3.2 *Tree Felling and Hedgerow* The removal of vegetation shall be undertaken in line with the provisions and exemptions described in the Wildlife Act 1976-2017.	

No.	Stage	Description	Main Report (Volume 2) Reference
		The Landscape mitigation proposals associated with the *Proposed Road Development* is set out in Chapter 12 of this EIAR and will involve the planting of native hedgerow, treeline and woodland to mitigate for losses associated with the *Proposed Road Development*. **16.4.1.4 Flora and Fauna Mitigation** **16.4.1.4.1 *Badger*** **Pre-construction Badger survey** Prior to any works being carried out, a pre-construction Badger survey will be undertaken to ensure badger has not taken up residence within or close to the road footprint. Previously identified sett locations will be revisited to determine any changes in the intervening period between planning and construction. **16.4.1.4.2 *Otter*** Evidence of Otter was recorded along the Tully Stream and Willsborough Stream and suitable habitat was recorded at the additional watercourses within the study area. No breeding or resting sites were recorded and direct impact on the species is not anticipated. **Pre-construction Otter survey** Prior to any works being carried out, a pre-construction Otter survey will be undertaken to ensure that Otter has not taken up residence within or close to the road footprint. **16.4.1.4.3 *Bats*** **Landscape Features** Mature tree-lines and hedgerows provide good potential for foraging and commuting and individual trees were considered to have potential to support smaller roosts (i.e. single Bats). The *Proposed Road Development* involves specific prescriptions for tree planting to ensure that habitat connectivity is not severed by the *Proposed Road Development*. Proposals include: ➢ Tree planting to provide commuting habitat along the *Proposed Road Development* and to guide Bats to other linking treelines/hedges, woodland, bridges, culverts or underpasses that may be used to cross the road. A network of vegetation	

No.	Stage	Description	Main Report (Volume 2) Reference
		will be created around the *Proposed Road Development* that in many sections of the study corridor will provide additional biodiversity within the landscape. Details of planting are provided in the landscape design. (See Figures 12.2.1 and 12.2.2 contained within Volume 3 of this EIAR); ➢ Planting of riparian trees to allow continued use of river corridors; ➢ Planting of tall (semi mature) trees on opposite sides of the road will be provided where connectivity is severed to provide Bat flyovers (or hop overs). This planting is done in association with strong guiding tree lines on both sides of the road to provide a safe crossing point for bats. These will be provided at *Castlegal*, where the *Proposed Road Development* severs tree lines in proximity to the identified roost site; ➢ Planting will utilise native species as these have a greater range of insects associated with them that provide an additional source of food for bat species. A pre-construction Bat survey will be required by suitably qualified Bat ecologists prior to any felling being undertaken. If the presence of roosting Bats in a tree is suspected, a close up inspection by a suitably trained ecologist is required prior to felling. Felling of mature broadleaved trees during winter months (November – March) should be avoided as this increases risk to hibernating Bats. If there is a requirement to fell trees in these sensitive areas during this period, any trees with significant roosting features will be subject to a detailed inspection undertaken by a suitably qualified professional. **Buildings** Identified roosting site at *Castlegal* House will not be directly impacted upon by the *Proposed Road Development*. The building to be demolished at *Lugatober* does not currently support roosting Bats. This building will be subject to pre-construction survey (as per TII/NRA, 2005b) prior to demolition to ensure Bats have not taken up residence. If bats are found to be present, exclusion measures will be followed under licence from the NPWS.	

16.4.1.5 Mitigation through Best Practice

The following best practice control measures will be implemented in the prevention of ecological impacts. In addition, the measures outlined below will limit artificial lighting and noise emanation during the construction phase.

16.4.1.5.1 *Site Set Up*

- Prior to the outset of any excavation, the works area will be assessed and clearly delineated with boundary fencing. The minimum area necessary will be identified and there will be no access to works vehicles outside the fenced off areas;
- Adjacent to watercourses and identified Annex I habitat areas, a silt fence will be attached to the fencing and buried beneath the ground to filter any run-off that may occur as a result of the proposed works;
- All works will be located within the confines of these fences. No works will take place outside the fences to prevent damage to areas outside the necessary development footprint;
- The construction compound and storage area will be located within the land acquisition boundary and is located more than 30m away from watercourses. The storage of fuels, other hydrocarbons, and other chemicals within the construction compounds will take place on the south side of the compound, and will as a minimum not be within 100m of the Tully Stream .

16.4.1.5.2 *Disturbance Limitation Measures*

Full details of the disturbance limitation measures to be employed to minimise noise and vibration during the construction and operational phases are described in Chapter 7 of this EIAR. Measures relevant to biodiversity are outlined below

- The best means practical, 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 of the “sound reduced” 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.
- Machines which are used intermittently will be shut down or throttled back to a minimum during those periods when they are not in use.
- Any plant such as generators or pumps which are required to work outside of normal working hours will be surrounded by an acoustic enclosure.
- Throughout the contract the supervision of the works will include ensuring compliance with the limits using the methods set out in BS 5228.

16.4.1.6 Pollution Prevention Measures

No.	Stage	Description	Main Report (Volume 2) Reference
		This project has potential to cause pollution of the surrounding environment. Pollution could take a number of forms and could occur during a number of the operations involved in the construction process. Listed below are the activities during which pollution may arise and the type of pollution that may occur along with prescribed best practice construction measures. In addition, an Outline Erosion and Sediment Control (OESC) Plan has been prepared as a method of water quality preservation to offset potential construction stage pollution impacts from the *Proposed Road Development* to adjacent watercourses including various tributaries of the Drumcliff River. **16.4.1.7 Mitigation to Prevent the Spread of Invasive Species** Due to the legislative requirements to control the spread of noxious weeds and non-native invasive plant species, it is important that any activities associated with the planning, construction and operation of national road schemes comply with the requirements of the Wildlife Acts, 1976-2012. Regulations 49 and 50 of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011) include legislative measures to deal with the dispersal and introduction of Invasive Alien Species (IAS), which are listed in the Third Schedule of the regulations. Regulation 49 deals with the Prohibition on introduction and dispersal of certain species while Regulation 50 relates to Prohibition on dealing in and keeping certain species (Regulation 50 has not yet been commenced). Invasive species are listed under the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). The introduction and/or spread of invasive species such as Himalayan Balsam, Giant Rhubarb or Rhododendron for example, could result in the establishment of invasive alien species and this may have negative impacts on the surrounding environs. The non-native invasive species Japanese Knotweed (*Fallopia japonica*) was recorded on the *Proposed Road Development* in the townlands of *Lugatober* and *Lugnagall*. There was also signage present at the Southern tie-in (Grid Ref 571723, 839775) which indicated that Japanese knotweed had been recorded and treated in the past (as part of the TII IAPS eradication program). No evidence of Knotweed was recorded at this location during the 2017 and 2018 surveys. A pre-construction survey for Knotweed will be conducted to determine if there has, or has not been an additional spread of Japanese knotweed/ or introduction of any other invasive species post the undertaking of this EIAR. An IAS Management Plan has been prepared (included as an appendix contained with Volume 4 of this EIAR) in relation to the treatment of the identified stands of Japanese Knotweed (*Fallopia japonica*) pre-construction. General appropriate spread prevention measures are outlined below.	

No.	Stage	Description	Main Report (Volume 2) Reference
		Control measures for the management of Invasive Species The following measures address potential impacts associated with the construction phase of the project: ➢ Any plant or equipment that may have worked in environments where invasive species are present (including but not restricted to zebra mussel *Dreissena polymorpha*, Japanese knotweed *Fallopia japonica,* Indian balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, rhododendron *Rhododendron ponticum*), 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. ➢ All fill and material sourced or relocated within the site shall 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. 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. ➢ All planting and landscaping associated with the proposed development shall avoid the use on invasive shrubs such as Rhododendron; ➢ The treatment and control of invasive alien species will follow guidelines issued by the National Roads Authority – The Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads (NRA 2010). **16.4.1.8 Monitoring** The construction works will be monitored at several levels to ensure that the environmental best practice prescribed in this document is fully adhered to and is effective. The following system will be put in place to ensure compliance. ➢ The contractor will assign a member of the site staff as the environmental officer with the responsibility for ensuring the environmental measures prescribed in this document are adhered to. A checklist will be filled in on a weekly basis to show how the measures above have been complied with. Any environmental incidents or non-compliance issues will immediately be reported to the project team; ➢ The project managers (client representatives) will be continuously monitoring the works and will be fully briefed and aware of the environmental constraints and protection measures to be employed. The works will be periodically monitored, as required by the Employers' Representative, during the construction phase by a suitably qualified ecologist. Following completion of the works, the ecologist will complete a final audit report to show how the works complied with the environmental provisions described in this Chapter.	

No.	Stage	Description	Main Report (Volume 2) Reference
9.2	O	## 16.5 Biodiversity ### 16.5.1 **Operational Phase** #### 16.5.1.1 Emissions associated with the operation of the *Proposed Road Development* Specific measures to offset potential impacts relating to surface water runoff, during the operation of the road, have been incorporated into the design of the *Proposed Road Development*. These include the use of penstocks, attenuation systems and hydrocarbon interceptors. Full details of the measures to be included are provided in Chapters 4 (Description of the *Proposed Road Development*) and Chapter 11 (Hydrology & Hydrogeology) of this EIAR. It is noted that the *Proposed Road Development* will convey traffic diverted off the existing section of N16 road and, given the pollution prevention measures incorporated into the project design will result in a far greater level of ecological protection in relation to water pollution from such traffic during the operational phase of the *Proposed Road Development*. #### 16.5.1.2 Hydrologically Sensitive Habitats The *Proposed Road Development* passes within proximity to a number of hydrologically sensitive habitats that are included as KERs and where potential indirect impacts were identified. Through consultation with the hydrology team on the project, it has been possible to prescribe mitigation to maintain a drainage neutral situation in these areas thereby not altering the existing hydrological situation. Full details of the measures to be included are provided in Chapter 11 (Hydrology & Hydrogeology) of this EIAR. The measures have removed the potential for significant hydrological or hydrogeological effects on Key Ecological Receptors outside the footprint of the *Proposed Road Development* during the operational phase. #### 16.5.1.3 Faunal Mortality, Habitat Fragmentation and Disturbance ##### 16.5.1.3.1 *Mammal Resistant Fencing* Fencing is required to prevent Badgers from crossing road points other than at underpasses. The fencing must extend sufficient distance to ensure that Badgers will not find an easy way around. Underpass entrances should be recessed in fence lines, thereby guiding animals to them.	9.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		The extent of fencing has been determined by the locations at which Badgers are likely to encounter it and the frequency with which they may attempt to cross the *Proposed Road Development*. It will be installed in all areas where Badger signs were recorded and will extend to cover the foraging habitats surrounding the recorded signs. Badger-proof fencing will not be installed asymmetrically and will be installed in parallel on both sides of the road and care will be taken to avoid any gaps or weaknesses even at awkward features such as undulating ground or streams in accordance with CC-SCD-00319. Mammal proof fencing will be provided from Chainage 1,000m-1,400m in proximity to the Lugatober sett. In addition, a minimum of 25m of mammal proof fencing will be provided either side of the crossing points on the Tully Stream, Collinsford Stream and Lugnagall Stream. Otters will often cross road some distance from watercourses. Therefore, mammal proof fencing will also be incorporated on either side of watercourses within potential to support the species (i.e. Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream). The fenced will stretch to 25m either side of the crossing point. The locations of these fences are shown on the mitigation Maps Figures 9.4.1 and 9.4.2 contained within Volume 3 of this. **16.5.1.3.2 *Badger Underpasses*** Badger underpasses significantly reduce the number of Badger casualties and mortalities associated with *Proposed Road Development*s and should be installed where Badger pathways cross a *Proposed Road Development*. A number of trails and latrines have been recorded within the footprint of the *Proposed Road Development* and Badger/mammal underpasses are included in areas of identified badger activity. The underpasses will reduce impacts on Badger communities in the area as a result of the operational phase of the *Proposed Road Development*. The clear span structure over the Tully Stream will allow passage of Otter along the riverbank and no additional underpass/ledges will be necessary at that location. Mammal underpasses will be provided either side of the crossing points on the Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream. The locations of underpasses are shown on the mitigation maps Figures 9.3.1 and 9.3.2 contained within Volume 3 of this EIAR. Badger underpasses will be constructed of 600mm concrete pipes but may form part of a watercourse culvert or bridge, where appropriate. They shall be constructed in accordance with TII Standard Construction Detail (SCD) CC-SCD-02504 and CC-SCD-02505. Mammals will be guided into the underpass by mesh fencing. This will prevent Badgers and other fauna from entering the road carriageway. The fencing design will correspond to CC-SCD-00319. The fencing shall be installed in such a manner as to prevent Badgers and other animals from digging under the fence. Underpasses have been sited as close as possible to existing Badger paths and follow existing wildlife corridors such as watercourses. The underpasses and fencing will be installed at the earliest stage	

No.	Stage	Description	Main Report (Volume 2) Reference
		possible during the construction phase so as to encourage Badger use. Where it is unfeasible to create a Badger underpass due to engineering constraints, it will be moved to a more suitable location not more than 250 metres from the original location and guide planting and fencing will be provided. As per SCDs the following measures, as per TII/NRA (2006) will be adhered to when constructing the prescribed Badger underpasses: ➢ Exit and Entrance to tunnels will be flush with badger-proof fencing; ➢ Drainage will be adequate to prevent waterlogging at entrances and within the underpass; ➢ Where stream culverts are being installed, structures greater than one metre diameter will be fitted with a raised mammal ledge. The ledge will be elevated above normal flood levels. Alternatively, a separate pipe culvert (600mm) can be set above flood level adjacent to stream culvert; and ➢ The entrances to the underpass will be planted with appropriate hedgerow planting to encourage Badger use though this will not obscure the entrances. **16.5.1.3.3 *Treatment of Otters at Watercourse Crossings*** The welfare of Otters will be ensured primarily through the provision of continued safe access for Otters to their ranges and foraging habitats. Adequate provision for Otters at affected watercourse crossings is required to allow the species to retain continued access to their foraging areas. Spanning large watercourses typically results in limited disruption to Otter activity. Smaller watercourse crossings require greater attention. The clear span structure over the Tully Stream will allow passage of Otter along the riverbank and no additional underpass/ledges will be necessary at that location. Mammal underpasses will be provided either side of the crossing points on the Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream. The design of the underpasses will be as per that described above in relation to Badger.Ramps will be provided to ensure accessibility, if required. Underpasses have been designed to be as short as possible and daylight will as far as possible be visible through the tunnel. Drainage will prevent waterlogging at entrances and throughout the underpass. The tunnels have been sited as close as possible to watercourses and guiding features such as mammal-proof fencing, walls or natural features such as hedgerows will be installed to guide Otters and other fauna towards the underpass. Otters may cross roads some distance from watercourses. Mammal resistant fencing has been incorporated in parallel on either side of the Tully Stream, Lugatober Stream, Collinsford Stream and Lugnagall Stream . This fencing will extend to a minimum of25 metres. The locations of underpasses and mammal proof fencing are shown on Figures 9.4.1 and 9.4.2 contained within Volume 3 of this EIAR.	

No.	Stage	Description	Main Report (Volume 2) Reference
		16.5.1.3.4 *Bats and Lighting* It is proposed to provide external lighting installations at the location of the proposed roundabout on the southern tie in location. No additional lighting is proposed along the route of the *Proposed Road Development*. The lighting location was not considered to be of significance for bat species and the species recorded in the area are not susceptible to disturbance from street lighting. However, taking a precautionary approach the proposed lighting has been designed to approve standards that minimise light spillage outside the intended target area. (See Chapter 4, Description of the *Proposed Road Development* for further details)	
10.1	C	**16.6 Soils & Geology** 16.6.1 **Mitigation of Construction Impacts** 16.6.1.1 Subsoil and Bedrock Removal To achieve the proposed design levels, approximately 158,000m^3 of material, including soil, starter layers drainage blankets etc. will be required. The earthworks balance for the *Proposed Road Development* has been designed to minimise the requirement for the importation of material and to maximise the reusability of materials within the site. The proposed soil repository/borrow pit will produce approximately 59,000m^3 of material suitable for use within the *Proposed Road Development*, this will reduce the projects fill deficit from 99,000m^3 down to circa 40,000m^3. 16.6.1.2 Soil Repository / Borrow Pit Importation of materials from outside the site will be minimised, in-so-far as possible, by ensuring that materials arising within the site area are used to the greatest extent possible. Where necessary, naturally occurring materials will be processed to reduce moisture content and/or improve grading in order to maximise suitability for use. Inevitably, materials will be encountered which cannot be processed into suitable fill material. Approximately 59,000m^3 of material that cannot be used due to its moisture content will be used to restore ground at the soil repository/borrow pit to its original levels. The proposed soil repository/borrow pit will allow for the deposition of 59,00m^3 of material, any additional surplus material will be used to construct landscaping bunds within the site area. Any surplus material remaining which cannot be incorporated within the	10.6

No.	Stage	Description	Main Report (Volume 2) Reference
		works will be disposed of off-site at suitably licenced facilities. Licenced facilities are identified in Figure 10.6 contained within Volume 3 of this EIAR. Soil Repository/Borrow Pit sites will be enclosed within double erosion control fencing (silt fence) and erosion control features will be installed at the drainage outfalls of the sites prior to works being undertaken. Where required, an access road will then be constructed within the restoration area together with wheel wash facilities. In the unlikely event that contaminated material is encountered on site, it shall be disposed of in accordance with all relevant legislation including the Waste Management Act, 1996 (as amended) and associated regulations and with regard to Best Practice Guidelines on Preparation of Waste Management Plans for Construction and Demolition Projects (DoEHLG., June 2006) and TII guidelines including The Management of Waste from National Road Construction Projects (GE-ENV-01101) December 2017. **16.6.1.3 Karst Features** The following construction karst mitigation measures are proposed if karst is encountered during construction: Exposed rockhead will allow careful treatment of any karst features exposed. A suitably qualified geotechnical engineer/engineering geologist will investigate the exposed surface of the excavation for any possible karst features, investigate these and break out additional rock where required. Where rock head is not exposed, the ground will be inspected by a suitably qualified geotechnical engineer/engineering geologist for the appearance of karst features such as unusually soft ground/disturbed soil. Karst features encountered will be backfilled using a fining up sequence with large clean rock at the base to choke the opening/void, this will be overlain by progressively finer stone and sand to return the site to its original hydraulic conductivity whilst removing the risk of collapse. Following the implementation of these mitigation measures the residual impact is predicted to be imperceptible and neutral. **16.6.1.4 Erosion, Storage and Stockpiles** The principal avoidance measures shall include the following; topsoil stripping and earthworks removal will not be carried out over large areas in advance resulting in these areas being exposed for long periods of time. Similarly, when the design cut level has been achieved, the slopes shall be battered back to a safe angle of repose and topsoiled immediately, the underlying material shall be protected by covering with construction materials or topsoil, as required, and shall not be left exposed.	

No.	Stage	Description	Main Report (Volume 2) Reference
		Control measures will involve the immediate use of topsoil wherever practicable after its stripping, if this is not possible, stockpiles of topsoil shall be limited to heights not exceeding 2m. Topsoil shall be battered to a stable slope and shall not be unnecessarily trafficked either before stripping or when in a stockpile. Overburden, where required to be stockpiled prior to use, shall be limited to heights not exceeding 4m, shall be battered to a stable slope and shall not be unnecessarily trafficked either before stripping or when in a stockpile. Other control measures include the protection of these stockpiled materials from erosion, the provision of adequate drainage to limit and control surface water runoff. Following the implementation of these mitigation measures the residual impact is predicted to be imperceptible and neutral. **16.6.1.5 Sealing of topsoil/overburden material** The principal avoidance measures shall include the following; topsoil and overburden shall not be unnecessarily trafficked either before stripping or when in a stockpile. When the design cut level has been achieved, the underlying overburden shall be covered with construction materials or topsoil, as required, and shall not be left exposed. Following the implementation of these mitigation measures the residual impact is predicted to be neutral Imperceptible.	
11.1	C	**16.7 Hydrology & Hydrogeology** **16.7.1 Introduction** Mitigation measures follow the principles of avoidance, reduction and remedy. The most effective measure of avoidance is dealt with during the route selection and design stage, by moving the *Proposed Road Development* either laterally or vertically within the Emerging Preferred Route Corridor, to ensure that it does not traverse or pass near to sensitive hydrological and hydrogeological attributes. Appropriate measures have been incorporated into the design of the *Proposed Road Development* in terms of drainage design so as to avoid impact or minimise impacts where possible. Where avoidance of the feature has not been possible, consideration has been given to locally modifying the *Proposed Road Development* so as to reduce / minimise the extent of the impact. **16.7.2 Construction Phase** As is normal practice the Contractor will be required to prepare a Construction Environmental Management Plan (CEMP) in advance of the commencement of construction and the following measures should be included as part this plan:	11.5.1 11.5.2

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ An Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, logging of non-compliance incidents and any such risks that could lead to a pollution incident, including flood risks; ➢ A Sediment Erosion and Pollution Control Plan (Refer to Outline Erosion and Sediment Control Plan (CESCP) contained within Volume 4 of this EIAR). This shall include water quality monitoring and method statements to ensure compliance with environmental quality standards specified in the relevant legislation (i.e. surface water regulations and Salmonid Regulations 1988); ➢ All necessary permits and licenses for instream construction works associated with the provision of culverts, bridges and outfalls. OPW Section 50 consent will be obtained prior to construction for all culverts and bridges proposed in the EIA Report; ➢ Continue to Inform and consult with Inland Fisheries Ireland (IFI); ➢ Continue to Inform and consult with National Parks and Wildlife Service (NPWS); ➢ Construction activities will be required to take cognisance of the following guidance documents for construction work on, over or near water: o Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016); o Shannon Regional Fisheries Board – Protection and Conservation of Fisheries Habitat with particular reference to Road Construction; o Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board); o Central Fisheries Board Channels and Challenges – The Enhancement of Salmonid Rivers; o CIRIA C793 The SUDS Manual; o CIRIA C624 Development and Flood Risk – guidance for the construction industry; o CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors; o CIRIA C648 Control of Water Pollution from Linear Construction Projects, technical guidance; o CIRIA C649 Control of Water Pollution from Linear Construction Projects, site guide; o Guidelines for the Crossing of Watercourses during the Construction of National Road schemes (NRA, 2006); o Road Drainage and the Water Environment DN-DNG-03065 (TII, June 2015); o Vegetated Drainage Systems for Road Runoff DN-DNG-03063 (TII, June 2015)	

No.	Stage	Description	Main Report (Volume 2) Reference
		Based on the above guidance documents concerning control of construction impacts on the water environment, the following outlines the principal mitigation measures that will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts: ➢ Surface water flowing onto the construction area will be minimised through the provision of temporary berms, diversion channels and cut-off ditches, where appropriate; ➢ Management of excess material stockpiles to prevent siltation of watercourse systems through runoff during rainstorms will be undertaken. This may involve allowing the establishment of vegetation on the exposed soil and the diversion of runoff water off these stockpiles to the construction settlement ponds and avoiding stockpiling of material in vicinity of sensitive watercourses; ➢ Where construction works are carried out adjacent to wetlands, fens, stream and drainage channels, karst features, springs and wells, protection of such aquatic bodies from silt load shall be carried out through use of reserved grassed buffer areas, timber fencing with silt fences or earthen berms. These measures will provide adequate treatment of constructional site runoff waters before reaching the watercourses; ➢ Use of settlement ponds, silt traps and bunds and minimising construction activities within watercourses. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap or sedi-mat; ➢ All drains that occur in areas of land that will be used for site compound/storage facilities will be fenced off at a minimum distance of 5m. In addition, measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound site does not discharge directly to the watercourse.; ➢ Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be contained within bunded areas and set back a minimum of 10m from watercourses; ➢ Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution; ➢ The construction discharge will be treated such that it will not reduce the environmental quality standards of the receiving watercourses; ➢ Riparian vegetation along the identified sensitive watercourses will be fenced off to provide a buffer zone for its protection to a minimum distance of 5m except for proposed crossing points; ➢ The use and management of concrete (which has a deleterious effect on water chemistry and aquatic habitats and species) in or close to watercourses will be carefully controlled to avoid spillage. Where on-site batching is proposed, this activity will be carried out well away from watercourses. Washout from such mixing plants will be carried out only in a designated contained impermeable area;	

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ The Soil Repository/Borrow Pit must be adequately controlled and compartmentalised such that the rainwater outflow from this facility is adequately treated through settlement prior to reaching the receiving surface watercourses. The sediment control requirements are set out in the Outline Erosion and Sediment Control Plan (refer to Volume 4 of this EIAR). The potential for constructional phase impacts on water quality in receiving watercourses and groundwater bodies will be reduced to slight / imperceptible through the implementation of the outline Erosion and Sediment Control Plan. The potential for constructional phase impacts on hydrological regime on the identified sensitive aquatic ecological habitats and on the downstream European site (Cummeen Strand / Drumcliff Bay SAC, SPA and pNHA (000627) has been reduced to imperceptible through the implementation of a Sediment Erosion and Pollution Control Management Plan.	
11.2	O	**16.8 Hydrology & Hydrogeology** **16.8.1 <u>Operational Phase</u>** There are generally no operational Phase Mitigation measures required for this road development as the road design has avoided any significant hydrological / hydrogeological impacts through the engineering design of the road horizontal and vertical alignment and the drainage design that includes sealed drainage system, water quality and stormwater attenuation pond facilities, petrol interceptors and suitable sized and designed outfalls and culverts. A specific mitigation measure to protect a county importance ecological site at the south of *Collinsford* (Site 4) from potential hydrological changes due to possible upstream interception of groundwater and interflow seepages by the upslope cutting between circa Ch. 1,500m and c. Ch. 1,600m is proposed. The southeast side of the main line road is in cut into the hillslope between Ch1500 and 1650 and the northwestern side of the road alignment is in embankment. The base of the cut-slope would generally be drained by a filter drain that outfalls to the *Lugatober* drain at Ch. 1500. An interceptor drain along the upper cut slope will collect and divert overland sheet flow away from the cutting to the *Lugatober* drain at Ch 1500. These measures have the potential to intercept recharge to the aquifer and the wetland habitat site giving rise to a potential impact to the hydrological regime within the ecological site. In order to maintain the seepage flows where encountered by the cut slope the capping layer should be extended to the base of the cut slope and an additional Class 6C crushed rock granular layer shall be provided underneath the capping layer and will extend from the face of the cutting on the east side to the toe of the fill at the west side. This will facilitate seepage flows off the cut face flowing under the road, thereby	11.5.3

No.	Stage	Description	Main Report (Volume 2) Reference
		maintaining flow paths for seepage flows from the up-gradient cut face to travel northwest towards the south of *Collinsford* wetland Site. This mitigation will maintain groundwater seepage flows from the cut slope discharging in a northwest direction towards the habitat. The proposed drainage treatment including the above mitigation will still result in a potential loss of recharge to the immediate downstream area including the habitat site. However this loss of potential recharge is surface water and not the groundwater petrifying seepage flows necessary to maintain Tufa habitat. The impact magnitude on the hydrological regime is rated as a slight impact.	
12.1	O	**16.9 Landscape & Visual** **16.9.1 Aims of Landscape Mitigation** The following are the aims of Landscape Mitigation: ➢ To provide mitigation measures to help avoid, reduce or remedy any significant landscape and visual impacts arising from any elements within the *Proposed Road Development*; ➢ To ensure the physical and visual integration of the *Proposed Road Development* and associated features into surrounding landscape; ➢ To provide screening to avoid, reduce or remedy visual intrusion at residential properties to address any negative aspects regarding the visual impact of the *Proposed Road Development*; ➢ To provide replacement planting for visually significant woodland and hedgerows lost due to widening or other construction works. **16.9.2 General Objectives of Landscape Mitigation** Mitigation should be in keeping with the existing landscape character. Therefore, small copses of woodland will be acceptable and beneficial to the landscape. In instances where small corners of fields are disrupted the intention will be to plant them and provide small wooded clumps to break up the visible mass of the road where appropriate. Plant mixes of native trees and shrubs and wild meadow grass mix will be planted where appropriate.	12.5

No.	Stage	Description	Main Report (Volume 2) Reference
		In line with the NRA Guide to Landscape Treatments of National Road Schemes in Ireland it is a core objective of the landscape mitigation to use native plants and seed from indigenous sources. The implementation of the landscape mitigation measures must be in accordance with the NRA Guide to Landscape Treatments. **16.9.3 Specific Landscape Measures (SLM)** Specific landscape mitigation measures to address significant effects identified in previous sections are summarised in Table 12-8 (contained within Chapter 12 of the EIAR) and outlined in terms of detail with Figures 12.4.1 and 12.4.2 contained within Volume 3 of this EIAR **16.9.4 Planting Specifications** 16.9.4.1 Tree, Hedge and Shrub Planting All trees, shrubs, transplants/whips, hedging material and ground cover planting shall conform fully to the specification, prepared by the landscape consultant, in respect of species, size and quality. All plants shall be well grown, sturdy and bushy according to type and free from all diseases and defects. The plants shall be available for inspection prior to planting works. Any plant material that does not conform to the specification will be automatically rejected and must be removed from site. All trees, shrubs and other plant material shall comply with the standards set out in National Plant Specification (NPS) prepared by the Committee on Plant Supply and Establishment and published with the backing of the Joint Council of Landscape Industries (JCLI, 1989). 16.9.4.2 Defective Plant Material All trees, shrubs, transplants, hedging material and ground cover planting shall be maintained and guaranteed for a period against death, deformation, die-back, or disease other than that caused by malicious damage. 16.9.4.3 Plant Mixes Essentially bank planting will consist of 'bare root transplants', 'whips' and 'feathered trees' which, due to their smaller stock size at time of planting, will adapt more easily to the disturbed ground and exposed site conditions. All plants are to be positioned in the locations and in the required numbers and centres indicated on the agreed planting plan.	

No.	Stage	Description	Main Report (Volume 2) Reference
		16.9.4.4 Screening Woodland Mix Landscape mitigation planting of slopes and as compensation for loss of existing screening and loss of woodland, individual trees and hedgerows along the *Proposed Road Development* will exclusively use Irish native species that reflect the existing vegetation of the area. Core species will include; Hybrid Oak, Scots Pine, Hawthorn, Hazel, Holly, Blackthorn, Goat Willow, Alder, Rowan and Birch. Woodland Mix areas will be planted as whips and feathered transplants at a standard size of 60-90 cm or 90-120 cm augmented by semi-mature individual trees at 10m centres. Species shall be randomly planted in groups. The majority of species used will be quickly maturing species and will have formed dense woodland within ten years. The canopy will reach at least 7 to 10 metres, in places where groups of trees are planted. **16.9.4.5 Individual Tree Planting** Individual semi-mature tree planting using the core native species (Hybrid Oak and Scots Pine) shall include standard (2.5–3.0 m) and heavy standard (3.5–4.25 m) trees to provide specific screening and early effect. **16.9.4.6 Native Shrub Planting** Shrub planting shall consist of native species from the core and additional species listed above to provide woodland understorey, woodland edge and scrub areas. Shrub planting mixes shall complement areas of woodland and be used at locations consistent with the Biodiversity assessment mitigation measures. **16.9.4.7 Grass and Wildflower Mixes** The road verges and unplanted side slopes will be seeded with a general (Grade II) grass seed mix with the exception of where rock cut occurs at *Castlegal* which will be left naturally. Areas away from designated sight lines where mowing regimes are not required to be of a regular nature will be seeded with wild grasses and meadow flowers. Grass and wildflower mixes using seed from Irish native sources shall be employed to provide quality areas of low maintenance, rapid establishment, and visual appearance. The construction contractor will adhere to the NRA's Draft Guidelines on the Implementation of Landscape Treatment on National Road Schemes in Ireland, 2011. Storage areas will be so located to avoid impacting on existing residential properties, trees, hedgerows, drainage patterns etc. and such areas will be fully re-instated prior to or at the end of the construction contract.	

No.	Stage	Description	Main Report (Volume 2) Reference
13.1	C	**16.10 Archaeology and Cultural Heritage** This report illustrates the extent to which specific archaeological heritage constraints may be impacted on the *Proposed Road Development*. In addition to the identified archaeological sites, there may be previously unidentified sub-surface archaeological remains surviving. In order to mitigate for the potential impact that construction of the *Proposed Road Development* would have on the surviving and potential archaeological and cultural heritage, the following measures were considered, and specific mitigation measures are proposed for predicted impacts. Mitigation measures are summarised in Table 13-13. **16.10.1.1 Consultation** Consultation has taken place at various stages of the project development to date, these include consultations with the National Monuments Service of the Department of Culture, Heritage and the Gaeltacht in August 2017, who upon review of the route selection report and the emerging preferred route selected, responded with ‘no comment’ on the proposal. The Development Applications Unit of the aforementioned government body, were also contacted at various other stages of the project development, including the informal scoping period described in Chapter 5 of the EIAR. Further consultation will be undertaken with stakeholders with statutory roles including: the National Monuments Service and the Built Heritage and Architectural Policy Section of the Department of Culture, Heritage and the Gaeltacht. **16.10.1.2 Ministerial Direction** Subject to approval by An Bord Pleanála, the *Proposed Road Development* will be subject to the National Monument Act 2004 Amendment and all works with potential archaeological implications on or adjacent to the construction works will be subject to Directions given by the Minister for Culture, Heritage and the Gaeltacht in consultation with the National Museum of Ireland. **16.10.1.3 Avoidance** The first option for mitigation is the avoidance of known or suspected archaeological sites, monuments and features by redesign of the development. The *Proposed Road Development* has been designed so as to minimise the potential impact on archaeological sites listed in the Record of Monuments and Places. Three sites included in the Record of Monuments and Places are located within 50m of the CPO line but will not be impacted directly by construction (CHC 01 – RMP SL009-028, CHC 02 – RMP SL009-027 and CHC 12 – RMP SL009-035). One RMP site CHC 11 - SL009-026 is partially within the CPO, for severance reasons, however it will be	13.6

No.	Stage	Description	Main Report (Volume 2) Reference
		excluded from the Lands Made Available (LMA) for construction, thus preserving the site in situ. The mass rock CHC 84 will be preserved in situ, it will be cordoned off during construction in order to avoid potential damage. **16.10.1.4 Archaeo-geophysical Survey** Geophysical investigation embraces non-invasive methods of investigating the subsurface for monumental and artefactual remains. The use of archaeo-geophysical prospection is effective at detecting a wide variety of archaeological features. For archaeological investigative purposes, it is used to identify areas of archaeological potential which can then be target tested. Archaeo-geophysical investigations are proposed for the off-line greenfield sections of the route where suitable. The archaeo-geophysical survey will take into consideration the location of areas of archaeological potential identified in the field survey and the proximity of recorded archaeological monuments. **16.10.1.5 Topographical and Photographic Survey** Topographical survey will be carried out in order to make an accurate record in plan, of an individual site and will be supplemented by a photographic survey. Topographical survey is required for the following townland boundaries TB 05, TB 08 and TB 20 and the old road CHC 72. Where suitable, a section of each feature will also be recorded during blanket test excavations (see below). **16.10.1.6 Wade Survey** The *Proposed Road Development* crosses a number of small, shallow watercourses, two of which correspond with townland boundaries. A wade survey will be undertaken for impacted sections of each watercourse including AAP 07/TB 06, AAP 15 and AAP 16/TB 09. **16.10.1.7 Photographic Survey and Written Record** A photographic survey and written record will be undertaken for the following sites AAP 07/TB 06, TB 07, AAP 15 and AAP 16/TB 09. **16.10.1.8 Targeted Test Excavations** Targeted test excavation takes place where there is an indication that archaeological remains are likely to occur. Evidence from cartographic, historical or photographic sources may point to areas of archaeological significance. Targeted testing then allows an	

No.	Stage	Description	Main Report (Volume 2) Reference
		assessment to be made on the extent of any surviving archaeology before any further mitigation is decided upon. Should any archaeological material be uncovered, excavation will then be required. Targeted test excavation will be undertaken within the CPO/LMA at the following sites: AAP 17, AAP 19, AAP 20, AHC 42, CHC 01, CHC 11, CHC 12, CHC 80, CHC 82, CHC 83, CHC 84, CHC 85, TB 05, TB 08 and TB 20. Pending the results of the targeted test excavations further mitigation measures, including full excavation (see below) may be required. **16.10.1.9 Blanket Test Excavation** It is considered best practice by the Department of Culture, Heritage and the Gaeltacht and TII to identify and record previously unknown archaeological sites in advance of the main contractor beginning construction. Blanket testing is typically implemented on all large-scale road developments and has proven to be an effective mitigation strategy for identifying archaeological features not identified at earlier phases of the assessment. The intention is to identify previously unknown archaeological sites at an early enough stage to minimise archaeological involvement with the development by the time the contractor is on site. Phase 1 of the archaeological investigations will take the form of test trenches excavated by machine under archaeological supervision. The testing layout may vary from one area to another, to take account of the varying width of the development, local topographical features and the presence of potential archaeological features. The blanket testing will be undertaken within and to the edge of the CPO line including areas required for compounds, attenuation ponds and soil repository/borrow pits. The overall aim will be to perform an adequate amount of archaeological testing in all areas subject to this method. The total amount of testing in any one area investigated by this method – or by a combination of methods – will amount to a consistent percentage of the land area. **16.10.1.10 Archaeological Excavation** Archaeological excavation is the preservation by record of archaeological remains. It would normally be undertaken following the discovery of archaeological material that cannot be preserved by being left in-situ in the ground. Archaeological excavation may be required pending the results of archaeological testing. Any archaeological sites identified during the course of advance archaeological investigations or uncovered during road construction will be excavated in full, following consultation with the National Monuments Section of the Department of Culture, Heritage and the Gaeltacht.	

No.	Stage	Description	Main Report (Volume 2) Reference
		16.10.1.11 Preservation In Situ The possible mass rock (CHC 84) will be cordoned off during construction to allow for its preservation in situ and to avoid potential damage. **16.10.1.12 Publication** Publication of the results of all archaeological investigation will be undertaken as part of the archaeological mitigation for the construction of the *Proposed Road Development*, in order to ensure that the knowledge gained from the investigation is collated and assessed within the context of current archaeological theory. In addition, publication should ensure the dissemination of the knowledge gained to the widest audience, both general and professional. It is envisaged that publication will take place in a number of media; suitable formats may include the TII monograph series, Seanda, Archaeology Ireland and local historical and archaeological journals. **16.10.1.13 Project Archaeologists and the Code of Practice** A Code of Practice was agreed between the Minister for Arts, Heritage, Regional, Rural and Gaeltacht Affairs and Transport Infrastructure Ireland (2017) to provide a structured and strategic framework for the management of all archaeological aspects of road planning and construction. Project Archaeologists have been appointed to ensure the proper management of the archaeological work and that mitigation strategies are in keeping with best practice and policies. **16.10.1.14 Construction Impacts and Mitigation Measures** Archaeological and cultural heritage issues will be resolved where possible at the pre-construction stage of the development. In any areas where this is not possible archaeological test excavation or archaeological monitoring will take place at construction stage. There are four recorded archaeological monuments, wholly or partially outside of but, in close proximity to the *Proposed Road Development* (CHC 01 – RMP SL009-028, CHC 02 – RMP SL009-027, CHC 11 - RMP SL009-026, and CHC 12 - RMP SL009-035). Their location and the requirement to avoid impacting them will be communicated to advance work contractors and to the construction contractors.	

No.	Stage	Description	Main Report (Volume 2) Reference
14.1	C&O	**16.11 Material Assets: Agricultural Property** This section describes the measures that when implemented will mitigate the adverse impact on agriculture. The assessment does not consider at this stage measures such as compensation for land acquisition and disturbance. These matters will be agreed with landowners or their representative(s) once planning approval for the *Proposed Road Development* has been granted. If agreement is not possible, such compensation will be decided upon by a property arbitrator. The following general mitigation measures are recommended: ➢ Access will be restored to lands where it is removed or restricted. The location of such access will be at a suitable location and, where possible, with the agreement of the landowner; ➢ Access will be possible for pedestrians and small livestock only, through the combined usage of the Vulnerable Road Users Underpass Public Facility (2.7m headroom) which is being provided at c. Ch. 1,300m; ➢ In general, permanent fencing will comprise of timber post and tension mesh fencing in accordance with CC-SCD-00320. Where permanent fencing is erected on the boundary of the *Proposed Road Development* or the associated attenuation ponds, it will be maintained by TII; ➢ In general, on side road tie-ins with the *Proposed Road Development* the permanent fencing will comprise of timber post and tension mesh fencing in accordance with CC-SCD-00320 unless otherwise agreed with the landowner and will be maintained by the landowner. ➢ All existing land drains and watercourses severed by the *Proposed Road Development* will be incorporated into a new drainage system as outlined in Figure 4.7.1 to 4.7.2 contained within volume 3 of this EIAR. The new drainage system has been designed to ensure that the current drainage situation will not be made any worse and there will be no increased risk of flooding to adjoining lands; ➢ Any services that are interfered with as a result of the *Proposed Road Development* will be repaired / replaced without unreasonable delay; and	14.5

No.	Stage	Description	Main Report (Volume 2) Reference
		➢ Ducting for the restoration of water and power supply services will be provided, as necessary, at a suitable location with the agreement of the landowner. Details of mitigation measures for individual farms affected by the *Proposed Road Development* are presented in Table 14-8 of this EIAR	
15.1	C	**16.12 Material Assets – Non-Agricultural Property** This section describes the measures that when implemented will mitigate the adverse impact on property. The assessment does not consider at this stage measures such as compensation for land acquisition and disturbance. These matters will be agreed with landowners or their representative(s) once planning approval for the proposed development has been granted. If agreement is not possible, such compensation will be decided upon by a property arbitrator. The following general mitigation measures are recommended: ➢ Access will be maintained to all affected property. ➢ Where part of the curtilage of a property is to be permanently acquired, the acquiring authority will hold discussions with the property owner and generally agree to replace boundaries on a like for like basis, subject to safety considerations, or it will be treated as a compensation issue. ➢ Prior to construction and subject to written agreement of the relevant property owners, property condition surveys will be undertaken in relation to all buildings / structures in use located within 50 metres of the extents of the CPO boundary. ➢ Any services that are interfered with as a result of the *Proposed Road Development* will be repaired / replaced without unreasonable delay. Details of mitigation measures for individual property affected by the proposed development are presented in Table 15-7 of this EIAR.	15.6