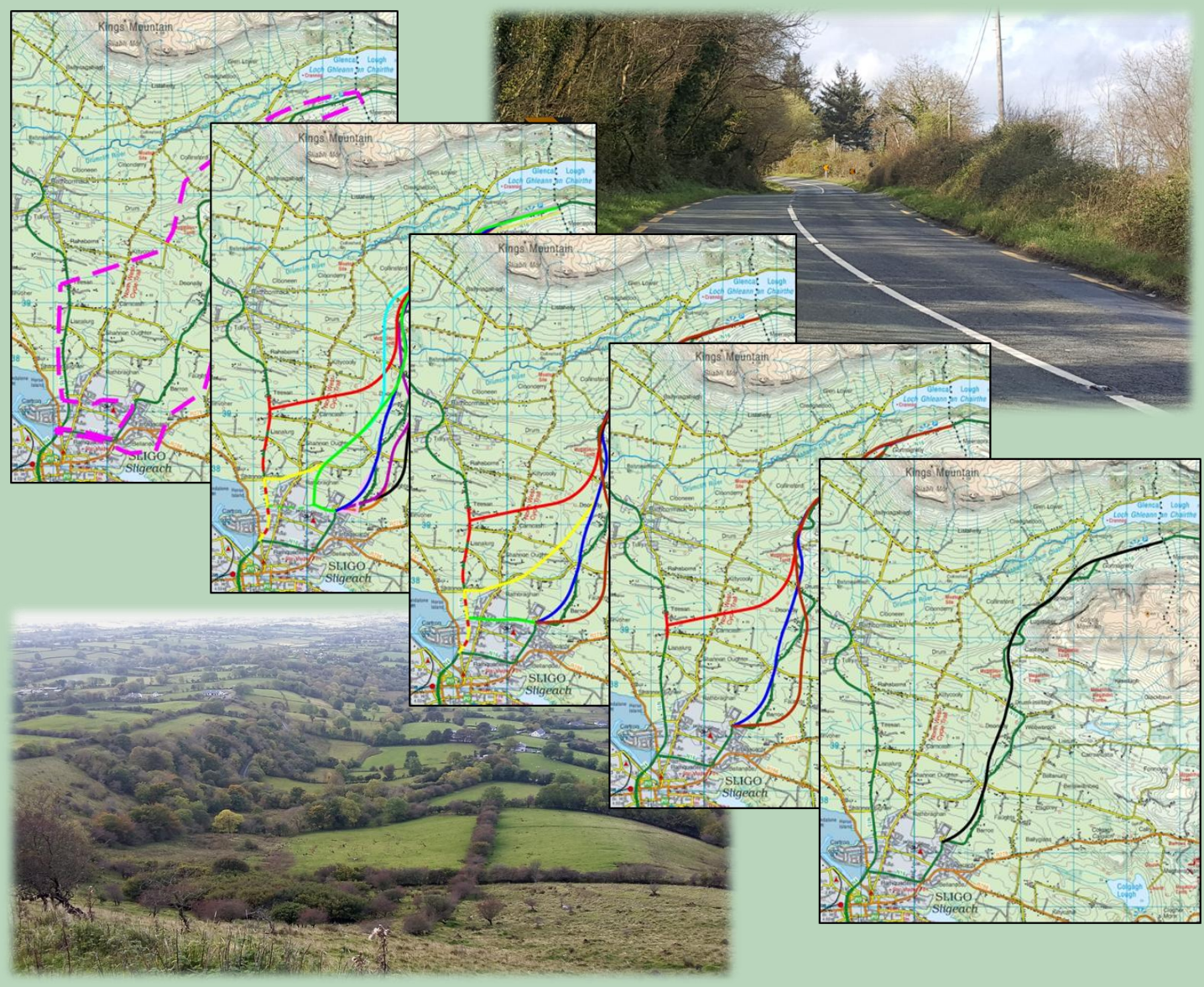
Route Selection Report

Volume 3: Environmental Appendices

PART B: The Natural Environment

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

N16 Sligo to County Boundary



Land of Hearts Desire

SLIGO COUNTY COUNCIL

TII
Bonneagar Iompair Éireann
Transport Infrastructure Ireland

i. PREFACE

THIS ROUTE SELECTION REPORT CONSISTS OF THE FOLLOWING DOCUMENTS:

Volume 1

- Main Report;

Volume 2

- Engineering appendices:
  - PART A: Traffic & Transport Assessment;
  - Part B: Road Engineering, Road Safety Impact Assessment and Options Comparison Estimate);

Volume 3

- **Environmental appendices**
  - PART A: Human Environment (including Urban Planning);
  - **PART B: Natural Environment;**
  - PART C: Landscape & Visual, and Cultural Heritage;

Volume 4

- Road Safety Audit Stage F

Volume 5

- Figures;

Volume 6

- Stage 2, Project Appraisal, Multi Criteria Analysis;

Document Control

Status	Issued For	Signed	Date	Approved
DRAFT	*TII Peer Review*	*Fergus Meehan*[1]	*April 2017*	*Emer Concannon*[2]
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This Route Selection Report (RSR) has been prepared and coordinated by Sligo County Councils National Roads Project Office, under the auspices of Transport Infrastructure Ireland and with the assistance of specialist engineering, planning and environmental sub-consultants as outlined below.

Table 8-1: N16 Sligo to County Boundary Route Selection Team

Study/Element	Body Responsible
Engineering	SCC National Road Design Office
Assessment Coordination, Multi Criteria Analysis and Report Compilation.	
Project Liaison.	
Road Safety Impact Assessment	
Traffic Modelling	Jacobs Engineering
Stage F Road Safety Audit	Kerry and Donegal NRDO's
Economic Appraisal (Stage 2 – Project Appraisal)	Jacobs Engineering
Landscape & Visual	RPS Ireland Ltd.
Flora, Fauna & Fisheries	RPS Ireland Ltd. With input from Denyer Ecology.
Agricultural and Non-Agricultural Property	John Bligh & Associates
Noise & Vibration	Envest Environmental
Air Quality & Climate Change	Envest Environmental
Hydrology & Hydrogeology	Hydro Environmental (Galway)
Soils & Geology	Roughan & O'Donovan
Socio Economic	Optimize Consulting
Archaeology & Cultural Heritage	ASCU
Architectural Heritage	ASCU
Impacts on Sligo & Environs Development Plan	The Planning Partnership

Design

Sligo County Councils National Roads Project Office is responsible for the design of the various route options contained within this Route Selection Report.

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8 Flora, Fauna and Fisheries

8.1 Appraisal Methodology

The following guidelines were used for the flora, fauna and fisheries assessment –

- TII 2010 Project Management Guidelines (NRA, 2010);
- TII Environmental Planning Guidelines, and in particular –
    - Environmental Impact Assessment of National Road Schemes – A practical guide (Rev 1, 2008);
    - Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes (2008);
    - Guidelines for Assessment of Ecological Impacts of National Road Schemes (Rev 2, 2009);
- A Guide to Habitats in Ireland (Heritage Council, 2000);
- Best Practice Guidance for Habitat Survey and Mapping (Heritage Council, 2011);
- BS40202:2013 Biodiversity - Code of practice for planning and development (British Standards Institution, 2013); and
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition (Chartered Institute of Ecology and Environmental Management, 2016).

The approach taken in this report is based on the TII Guidelines for Assessment of Ecological Impacts of National Road Schemes (NRA, 2009) and in particular Section 5.3 dealing with a Route Corridor Selection Study.

The guidelines advise that where a large number of route options are still being considered (or during the earlier stages of the process), it is not appropriate to investigate the full length of each route in the field, but rather to restrict field surveys to key sites, features or route sections that appear to be of particular ecological value, to assess the potential impacts of the route(s) upon them.

The principal objective of this report is to provide a robust flora, fauna and fisheries appraisal of the various route options for the proposed scheme that will assist in the preparation of a Route Corridor Selection Report leading to the selection of an emerging preferred route. This assessment should be read in conjunction with drawings no. N16-RS-074 to N16-RS-076 (Feasible Route Options – Ecological Assessment) and N16-RS-102 to N16-RS-104 (Refined 'Feasible' Route Options - Ecological Assessment).

Another objective of this stage of assessment is to identify any specific or targeted and seasonally dependant ecological surveys to prevent significant programme delays in the latter stages of scheme design.

This approach is also signposted in paragraph 3.2 of the TII guidelines on Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes, which states –

"Survey effort will vary significantly depending upon the target species or group and the complexities of the habitats concerned. The 'Ecology Guidelines' provide details on scoping

ecological surveys, based on the spatial and temporal limits of the impacts in question, including setting survey parameters such as corridor width."

Application of this approach allows RPS ecologists to use their judgment in determining which portions of the route options be subject to targeted survey, to a sufficient level to allow evaluation and comparison of the alternative route corridor options from a flora, fauna and fisheries perspective, such that the ecological impacts for each of the options can be identified so that those with unacceptably high levels of impact can be avoided to the extent feasible as part of the overall route assessment within RCS stage.

CIEEM (2016) advises that and discourages use of a matrix approach for ecological assessment. It notes that "*in circumstances where ecologists are required to fit an assessment into a different format than that outlined in these Guidelines, it is recommended that the approach set out here is applied as far as possible to enable decision-makers to understand the evidence base*".

TII procedures require a matrix approach at route selection stage. This assessment is based upon a source-pathway-receptor model, where the source is defined as the individual elements of the proposed development that have the potential to affect identified ecological features. The pathway is defined as the means or route by which a source can affect the ecological features. An ecological feature is defined as the species, habitat or ecologically functioning unit of natural heritage importance. Each element can exist independently however an effect is created where there is a linkage between the source, pathway and feature. A level of significance must then be assigned to any such effects upon features of ecological value.

8.1.1 Significance

A significant effect is defined in CIEEM (2016) as –

> *"an effect that is sufficiently important to require assessment and reporting so that the decision maker is adequately informed of the environmental consequences of permitting a project. A significant effect is a positive or negative ecological effect that should be given weight in judging whether to authorise a project: it can influence whether permission is given or refused and, if given, whether the effect is important enough to warrant conditions, restrictions or further requirements such as monitoring".*

BS 42020:2013 (Biodiversity - Code of practice for planning and development) states that if an effect is sufficiently important to be given weight in the planning balance or to warrant the imposition of a planning condition, e.g. to provide or guarantee necessary mitigation measures, it is likely to be "significant" in that context at the level under consideration. The converse is also true: insignificant effects would not warrant a refusal of permission or the imposition of conditions.

NRA (2009) notes that –

> *"In the context of ecological impact assessment of national road development projects, conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within a given geographical area. Thus, an impact will be significant if it would affect the long-term distribution, structure or function of the habitat in question as well as the long-term survival of its associated species, at the appropriate geographical scale.*
>
> *Similarly, the conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the appropriate geographic scale. Thus, an impact will be significant if it would affect the long-term distribution or abundance of the species' populations at the appropriate geographic scale".*

In this assessment, habitats have been classified in accordance with section 9 (Flora, Fauna and Fisheries: Appendix 1 - Habitat Classification Scheme), and subsequent ecological evaluation has been undertaken in accordance with section 10 (Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme) which attributes a geographical context to a feature of ecological value. Effects or impacts are identified as being significant if they result in conflict with applicable planning policies, which can occur across a range of geographic scales from European sites (SPAs, SACs and Ramsar sites) and Natural Heritage Areas (NHAs) through to local habitats and populations of protected species. This approach aligns both CIEEM (2016) and NRA (2009) guidance whereby adverse effects upon features of ecological importance are described as significant.

8.1.2 Flora and Fauna

A desktop review of the specialist ecology report (Constraints Study, Woodrow, 2015) of the proposed road scheme was carried out to identify features of ecological importance along the route option corridors and surrounding area. Aerial photography and Ordnance Survey maps (1:50,000, 1:10,560 or 6"and 1:2,500 scale) were utilised, and information contained in National Parks and Wildlife Service (NPWS) databases was extracted to assist in the appraisal process.

A specialist desktop review and walkover survey in sensitive areas of groundwater dependent habitats and protected flora species was also undertaken due to the possibility of Habitats Directive Annex I alkaline fen or priority Annex I petrifying spring habitat occurring.

The following Development Plans have been considered and reviewed in the preparation of this report –

- Sligo County Development Plan 2011-2017
- Pre-Draft Consultation Paper of the Sligo County Development Plan 2017–2023
- Sligo and Environs Development Plan 2010-2016
- County Sligo Heritage Plan 2007-2011
- Draft County Sligo Heritage Plan for 2016-2020

The following legislation has been reviewed as part of this report –

- European Communities (Birds and Natural Habitats) Regulations 2011 to 2015
- Wildlife Acts 1976 to 2012
- Flora Protection Order 2015

S.I. No. 355 of 2015 provides that The Wildlife Act 1976, the Wildlife (Amendment) Act 2000, the Wildlife (Amendment) Act 2010, the Wildlife (Amendment) Act 2012, the European Communities (Birds and Natural Habitats) (Restrictions of the Use of Poison Bait) Regulations 2010 (S.I. 481 of 2010), the European Communities (Birds and Natural Habitats) Regulations 2011, the European Communities (Birds and Natural Habitats) (Amendment) Regulations 2013, and the European Communities (Birds and Natural Habitats) (Amendment) Regulations 2015 shall be construed together as one.

The European Communities (Birds and Natural Habitats) Regulations give effect to requirements relating to the designation of protected sites under the Birds Directive and Habitats Directive. The Regulations provide for the protection and management of European Sites and place obligations on all competent authorities to have regard to the requirements of the Habitats Directive. The Regulations also provide for the protection of species of European importance.

The Wildlife Acts 1976 to 2012 provide for *inter alia* the protection of wildlife and for the designation of NHAs. The Acts prohibit the intentional killing, taking or injuring of certain wild birds or wild animals; or the intentional destruction, uprooting or picking of certain wild plants.

Taken as a whole, nature conservation legislation is of key importance in undertaking ecological appraisal for proposed development as it shapes planning policy.

After desktop appraisal and review of relevant documents was complete, the study area comprising each of the feasible route options was walked over 7 no. field days in March and April 2016. The specialist desktop review of groundwater dependent habitats and protected flora species was undertaken in April 2016 in tandem with general extended phase 1 habitat surveys. The output report of that specialist desktop review is included at section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites.

8.1.3 **Fisheries**

The Fisheries assessment considered river catchments traversed by each of the Feasible Route Options. River catchments include both river and lake waterbodies as defined under the Water Framework Directive (WFD). The study focussed in particular on potential watercourse crossings with regard to each route option and river reaches where route options are situated in close proximity to watercourses.

Relevant waterbodies within the study area were identified primarily through review of the Ordnance Survey 1:50,000 Discovery Series (Sheet 16), and verified through the EPA online Map Viewer facility in order to identify all waterbodies within the study area on a rising scale in terms of WFD River/Lake Waterbody, WFD River Sub-basin, WFD River Sub-catchment, and WFD Catchment.

The National Parks and Wildlife Service (NPWS) database was consulted regarding information on designated sites, and to check for records of protected aquatic species within the study area. Official copies of statutory designated site boundary maps were provided by the Planning Authority and reviewed. Consultation with Inland Fisheries Ireland (IFI) was undertaken to discuss the route options and their potential effects on the relevant waterbodies lying within the route corridor of each option.

An outline field study was conducted to evaluate each watercourse in terms of its fisheries status based on the Life Cycle Unit method (Kennedy, 1984) and set out in the guidance document 'The Evaluation of Habitat for Salmon and Trout ' (DANI, 1995). Potential crossing points visited are illustrated in 'Aquifer classification' maps (N16-RS-079 and N16-RS-107) contained within Volume 5.

8.2 Description of the Existing Environment

8.2.1 **Flora and Fauna**

8.2.1.1 Southern Section

Habitats through this section are illustrated in drawings no. N16-RS-074 to N16-RS-075 (Ecological Assessment) contained within Volume 5. The vast majority of land parcels are improved agricultural grassland (GA1) enclosures. The remaining grasslands are wet grassland (GS4) occupying entire enclosures parts of improved fields. The wet grasslands were typically species poor. Many hedgerows along are in poor condition, marred by sheep poaching. Few hedgerows are managed and the majority are more accurately lines of unmanaged trees as opposed to hedgerows, usually ash or old hawthorn.

Some hedgerows, principally along townland boundaries, are an exception containing a suite of hedgerow herbs such as primrose, violet, lords and ladies, lesser celandine, pignut and golden saxifrage as well as an array ferns and bryophytes.

The first scrub - woodland habitats in this section occur at the inverted 'T' section (referring to Feasible Route Option 03, 04, 10 & 11) at Rathbraghan. The footprint here includes mixed broadleaved woodland (WD1) and immature woodland (WS2) south of AbbVie Ireland. A very large

main badger sett occurs in this area within 150m of the footprint. The inverted 'T' junction overlies a large area re-colonising spoil that includes naturally immerging scrub - woodland, mostly willows and alder. To the west is a reed and large sedge swamp (FS1) and wet grassland (GS4) mosaic. Vegetated drainage ditches with frogspawn also occur. Waders were seen leaving this site. This area also contains one of the wetland sites (No.2) considered in the desktop review of groundwater dependant habitats (section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites).

A potential main badger sett occurs within 10m of the land take of option 2 at Shannon Eighter.

Japanese knotweed occurs along the N15 within the footprint of option 1.

Scrub (WS1) - broadleaved woodland (WD1) occurs along the Doonally River that abuts the L-7422-0. Option 2 twice cross this watercourse and scrub (WS1) - broadleaved woodland (WD1) corridor. Feasible Route Options 3 and 4 cross it once. Trees and shrubs include hazel, alder and snowberry. Pockets of woodland herbs occur just south of Rathbraghan Bridge. Giant Hogweed (or what appears to be) was noted offline near the riverbank.

Further north options 2, 3 and 4 sever a meandering old Earth bank (BL2) (a townland boundary) with mature ash and assemblages of woodland herbs. This linear feature travels south (as broadleaved woodland - WD1) then gradually turning east into Faucets Bridge. This area also contains one of the wetland sites (No.6) considered in the desktop review of groundwater dependant habitats (section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). The linear woodland before this bridge along the L-3407-0 resembles wet willow-alder ash woodland (WN6). Between Faucets Bridge and Doonally Bridge mature beech dominate the canopy. Linear woodland continues along the L-3407-22 namely mixed broadleaved/conifer woodland (WD2) but is of lower ecological value than the aforementioned woodland habitats. A potential subsidiary badger sett lies approx. 70m from options 5 and 6 immediately west of the Regional veterinary laboratory (illustrated in drawing no. N16-RS-075).

Further north at Doonally, mixed broadleaved/conifer woodland (WD2) occurs on both sides of the N16. The Dunally River travels south along the N16 at this location. West of the road (the larger woodland) plantation abuts broadleaved woodland with mature beech. Both woodlands have lush assemblages of woodland herbs despite deeper shade. Options 7 and 8 travel over the northern end of this habitat. Planted conifers and mature broadleaved trees occur here in the opposing side of the road through which options 7 and 8 travel. Mature broadleaved trees occur here on the ring fort. Sheep poaching/trampling mar the woodland flora here.

A main badger sett was found between options 01 and 04 in the townland of Doonally, as illustrated in drawing no. N16-RS-075).

In summary, linear features in the form of woodland, earth banks and / or hedgerows are the most noteworthy habitats in this lower section. Many of these habitats are marred by unrestricted access by cattle and in particular, sheep. With respect to wetland habitats the only area of note in the inverted 'T' junction at Rathbraghan. This is confirmed badger territory as well as being frequented by waders (birds). Common frog is also present.

8.2.1.2 Central Section

Habitats through this section are illustrated in drawings no. N16-RS-075 to N16-RS-076 (Ecological Assessment). There are no habitats of note north of the L-3406-0 for approx. 700m. The small exception is the treelined (broadleaved woodland - WD1) watercourse east and west of Castlegal Bridge through which all options travel. These habitats east of Castlegal Bridge are marred by sheep trampling - poaching.

Approx. 200m north of L-74151-0 are a cluster of small field enclosures through which option 4 travels, some of which are abandoned and beginning to scrub over. These old boundaries have particularly rich assemblages of woodland herbs. Outlier badger setts occur. A probable main badger sett occurs in this area just beyond the option 1 footprint. Some wet grassland fields are less improved. Herbs such as devil's bit scabious and sedges appear. A rich flush (PF1) occurs containing *Philonotis calcarea* occurs immediately west of the option 4 footprint. This is one of the wetland sites (No.13) considered in the desktop review of groundwater dependant habitats (section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites).

A tufa spring was identified in woodland in the bad U-shape bend just off the existing N16. This is another one of the wetland sites (No.14) considered in the desktop review of groundwater dependant habitats (section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). No option footprints overlay this feature. All options merge immediately west of this woodland with the exception of options 1 and 4 which are more outlying.

The route options converge between Lugatober and Collinsford, to the northeast of the L-7413-0 into the broad existing N16 corridor. The outer option (option 4) travels through some wet grassland (GS4) enclosures and passes through an area with moderate potential to support small Annex I priority habitat Petrifying spring/ Annex I habitat Alkaline fen (Refer to wetland site No.13 at section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). These have less 'improved' appearance and may warrant further survey in summer. A less pronounced rich flush (PF1) occurs just outside the option 4 footprint. Refer to wetland site No.12 at section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites).

Upslope towards the existing N16 the field enclosures are dry improved agricultural grassland (GA1).

Where all routes options merge approaching the division between the central and northern sections broadleaved woodland is developing on abandoned marsh grassland. This new woodland is an extension or older woodland alongside a watercourse that travels east west at this location.

The hedgerows along this section are largely open, defunct boundaries with unmanaged or mature willows (in wetter areas), hawthorn, ash and occasionally sycamore. Traditional woodland - hedgerow flora are scarce. Many of these boundaries again are more accurately trees and no longer hedgerows.

In summary, the outer route option (option 4) appears to encroach more upon the more semi natural habitats namely the less improved examples of wet grassland (GS4) and the exceptionally lush field boundaries approx. 200m north of L-74151-0. A probable main badger lies between the Option 4 and option 1 footprints.

8.2.1.3 Northern Section

Habitats through this section are illustrated in drawing no. N16-RS-076. The section begins with an area of linear semi-natural woodland at Lugnagall through which all routes travel. This woodland best resembles Oak-ash-hazel woodland (WN2) described by in Fossitt (2000). It travels in a west-northwest direction and is dissected by the N16 just short of the junction of L-3404-0. The semi-natural woodland to the west of the road is has a particularly rich array of woodland flora and one of the few woodland habitats along the entire study area not damaged by livestock. In contrast, the same woodland community on the opposing side of the road is badly poached, in this instance by cattle.

Option 11 abuts a Natural Heritage Area (Crockauns/Keelogyboy Bogs NHA) whose boundary runs coincident to the N16 roadbed and Option 11 for approximately 100m (Ch5150 – 5200). Option 11 also occurs within a European site (Ben Bulben, Gleniff and Glenade Complex SAC) at its County Boundary terminus (Ch7800). Designated sites are illustrated in drawings no. N16-RS-074 to N16-RS-076 (Ecologial Assessment).

A possible petrifying spring with tufa formation occurs approx. 50m northbound from the L-3404-0 junction. The footprints of options 10 and 11 overlay this spring feature. Refer to wetland site No.10 at section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). Northwest of this feature some dense continuous scrub (WS1) occurs to the rear of a property on the L-3404-0. The route options abut the Crockauns/Keelogyboys Bogs NHA here where the boundary runs coincident to the N16 roadbed.

Where route option 10 leaves the N16 at Gortnagrelly it encounters another wooded watercourse. Woodland flora indicative of continuous tree cover are common to all of these watercourses. The adjoining fields are improved agricultural grassland (GA1) enclosures. A wooded watercourse - shallow ravine travels east west between the L-7411-0 and the N16. This watercourse is fed by a petrifying spring in an adjacent field. Seepage areas occur in the field and a large tufa mound (at IG 172978 342204) was identified on the side of this watercourse. 'Petrifying springs [7220]' are a priority Annex I habitat. Refer to wetland site No.11 at section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). The ground here is uneven and soils are slipping into the watercourse. The footprints of all options overlay this feature.

Travelling to the Leitrim County Boundary, the enclosures along the north of the road are mostly improved agricultural grasslands (GA1) grazed by sheep. Root option 11 travels through these enclosures. Exceptions are some wet grassland (GS4) fields. Rushes and common bryophytes were the dominate species. The last four enclosures abut steep enclosures facing Glencar Lough. Here scattered trees grade into continuous cover broadleaved woodland (WD1) with abundant willows with intermittent ash, hazel and hawthorn. The field or herb layer is again badly damaged by sheep. The area of continuous tree cover may represent old semi-natural woodland. At the Leitrim border, this woodland abuts mixed broadleaved / conifer woodland (WD2) with mature beech and mature conifers. A ravine and waterfalls occur at this boundary, and this area (Site No.16) has also been considered in the desktop review of groundwater dependant habitats (section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites).

South of the road, the land begins a gradual ascent to the base of Cope's Mountain. Option 10 travels through this habitat. The habitat is undulating improved agricultural (GA1) on shallow mineral soils with natural gullies. There were no species indicative of Annex I priority habitat 'species rich *Nardus* upland grassland [6230]' although mat grass *Nardus stricta* was occasionally present. On the contrary, many negative indicator species occur notably creeping buttercup *Ranunculus repens* and white clover *Trifolium repens*. Further upslope this habitat tends to grade into more wet or flushed wet grassland (GS4) communities. However, some areas of continuous wet grassland occur along the existing N16. Only common species were observed in these wet grassland (GS4) swards. There were no overwintering or dead stems indicative of more species rich communities. Hedgerows scarcely occur except for intermittent hawthorn on earth banks and some lines of ash trees. Some elongated stands of conifer plantation occurs along these slopes through which option 9 travels. Badger activity was reported in the larger of these (landowner *pers. comment*) but no setts were found.

In Summary, improved agricultural grassland (GA1) almost exclusively grazed by sheep is the dominant grassland habitat in this section. Areas of naturalness are the wooded watercourses and the remaining grassland habitats that are wet grassland (GS4). A complex of seepages including a tufa mound was found at one location feeding into a wooded watercourse. The footprint of all options impact upon this priority Annex I habitat. All route options terminate at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

8.2.2 Fisheries

8.2.2.1 Overview

The proposed N16 road scheme extends northwards from northern side of Sligo town to the County boundary with Leitrim. The defined study area lies within the Western River Basin District and the WFD catchment delineated as Sligo Bay & Drowes – the study area includes a series of WFD river waterbodies located in five WFB Sub-basins.

The main river waterbody in the study area is the Bellanurly, or Willsborough Stream, known locally as the Doonally River, which flows through the southern section of the study area and in close proximity to a number of the route options with a series of potential river crossings.

The study area also includes a number of small watercourses, mostly un-named but including the Tully River and Magheragillerneeve (Springfield) River. The northern section of the study area is drained by seven small streams which flow into the Drumcliff sub-catchment.

The southern section incorporates a small area of the Garvogue Sub-basin in the form of the Copper River which connects to the Garvogue River.

There are two European Designated Areas (Natura 2000 sites) incorporating freshwater habitats which are hydrologically connected the study area:

- Ben Bulben, Gleniff and Glenade Complex SAC (includes Glencar Lough)
- Lough Gill SAC (includes the Garvogue River)

Included in the features of interest for Lough Gill SAC are a number of Annex II fish/aquatic species:

- *Salmo salar* (Atlantic salmon)
- *Austropotamobius pallipes* (White-clawed crayfish)
- *Petromyzon marinus* (Sea lamprey)
- *Lampetra planeri* (Brook lamprey)
- *Lampetra fluviatilis* (River lamprey)

The rivers of significant fisheries status connected to the study area are the Drumcliff and Garvogue rivers, respectively located to the north and south of the area. Both rivers contain populations of salmon and trout, and are popular recreational fisheries. The Doonally River is known to contain brown trout and sea trout although there are no organised angling interests on the river.

8.2.2.2 WFD Waterbodies

The WFD waterbodies within or connected to the study area are listed in Table 8-1, in the context of the relevant WFD River Sub-basin and WFD Sub-catchment, and also noting WFD Status and assessed fisheries status. River catchments are illustrated in N16-RS-079 (Volume 5).

Table 8-1: WFD waterbodies within or connected to the Study Area indicating relevant WFD River Sub-basin and WFD Sub-catchment along with WFD Status and assessed fisheries status.

WFD River Sub-catchment	WFD River Sub-basin	WFD Status 2010-12	WFD Waterbody River / Lake	Fisheries status
Drumcliff_SC_010	Drumcliff_010	Moderate	Glencar Lough	Important recreational fishery for salmon, sea trout & brown trout. Eels also likely to be present.
			Upper Drumcliff River	Important recreational fishery

WFD River Sub-catchment	WFD River Sub-basin	WFD Status 2010-12	WFD Waterbody River / Lake	Fisheries status
	Drumcliff_020	Good	Lower Drumcliff River	for salmon, sea trout & brown trout. Eels & lamprey also likely to be present.
	Cregg_35_010	Unassigned	Tully River	Small coastal stream; trout and eels likely to be present; no angling interest.
			Magheragillerneeve (Springfield) River	Small coastal stream; trout and eels likely to be present; limited angling in lower reaches.
Bonet_SC_030	Willsborough_010	Good	Willsborough Stream (Bellanurly/Doonally) River	Significant river with brown trout & sea trout present; salmon possible. Eels & lamprey also likely to be present. Some casual local angling interest.
	Garavogue_010	Good	Copper River	Small stream; trout and eels likely to be present; no angling interest.
			Garvogue River	Important recreational fishery with salmon, sea trout & brown trout. Eels & lamprey also likely to be present.

8.2.2.3 Importance of Individual Waterbodies

A description and evaluation of each waterbody within the study area in terms of aquatic ecology and fisheries is shown presented in Table 8-2.

Table 8-2: Waterbody Description and Evaluation (Fisheries and aquatic ecology).

Waterbody	Townland	Crossing location etc	Aquatic Ecology & Fisheries Assessment	Significant Aquatic Species	Evaluation
Copper River	Bellanode	N/A	Ecology unknown; no angling.	Annex II species: Unlikely Brown trout present.	High Value, Locally Important
Doonally River	n/a	N/A	Good quality river with significant gradient in upper & middle reaches; extensive cobble/ boulder/gravel substrates with much exposed bedrock in upper reach. salmon possible. Eels & lamprey also likely to be present. No organised angling.	Annex II species: Atlantic salmon possible Lamprey possible Brown trout & sea trout present; eels likely	Very High Value, Nationally Important
Doonally trib	Barroe	570057E 837450N	Possible spring rising in Barroe area; high ecological quality in upper reaches deteriorating through suburban section; 500m lower section enclosed in culvert.	Annex II species: Very unlikely Brown trout possible	Low Value, Locally Important
Doonally trib	LIsnalurg	569509E 837650N	Small spring-fed stream; good ecological quality in upper section, deteriorating to sand/silt bed with overgrown banks. Fish access from main river obstructed by inappropriate culvert at outfall	Annex II species: Very unlikely Brown trout possible	Low Value, Locally Important
Doonally trib	LIsgorey	571711E 838147N	Good quality stream in lower reach; upstream section previously dredged but moderate quality. Likely to be significant spawning stream.	Annex II species: Atlantic salmon possible Lamprey possible Brown trout present; eels likely	High Value, Locally Important
Doonally trib	Lisduff	571906E 838924N	Good quality small stream with extensive trout spawning/ nursery habitat.	Annex II species: Unlikely Brown trout likely; eels possible	High Value, Locally Important
Magheragillerneeve River trib	Teesan	569293E 839174N	Trib is low grade silty ditch with little flow; no fisheries interest. Connects with main channel M'neeve River after 360m – moderate quality stream; sand/ gravel/ cobble substrate & good flow.	M'neeve River – Annex II species:	Moderate Value, Locally Important

Waterbody	Townland	Crossing location etc	Aquatic Ecology & Fisheries Assessment	Significant Aquatic Species	Evaluation
				Unlikely Brown trout likely; eels possible	
Tully River	Drum East	571743E 840296N	Good quality small stream with extensive trout spawning/ nursery habitat.	Annex II species: Unlikely Brown trout likely; eels possible	High Value, Locally Important
Lower Drumcliff trib	Lugatober	570763E 840937N	Moderate quality stream (possibly spring-fed); sand/ gravel/ cobble substrate	Annex II species: Very unlikely Brown trout possible	Moderate Value, Locally Important
Lower Drumcliff trib	Lugnagall	572250E 841483N	Small good quality stream; v steep gradient	Annex II species: Very unlikely Brown trout possible in lower reaches	Low Value, Locally Important
Upper Drumcliff trib	Lugnagall	572539E 841930N	Small good quality stream; steep gradient	Annex II species: Very unlikely Brown trout possible in lower reaches	Low Value, Locally Important
Upper Drumcliff trib	Gortnagrelly	572955E 842244N	Good quality stream with gravel/ cobble/ sand/boulder substrate & good flow; extensive trout spawning/ nursery habitat.	Annex II species: Unlikely Brown trout likely; eels possible	High Value, Locally Important
Upper Drumcliff trib	Gortnagrelly	573558E 842493N	V small low quality stream with little flow; no fisheries interest.	Annex II species: Very unlikely Brown trout possible in lower reaches	Low Value, Locally Important
Glencar Lough trib	Gortnagrelly	576780E 842565N	Open field drain; low quality; no fisheries interest but connects to Glencar (SAC)	Annex II species: Very unlikely Brown trout possible in lower reaches	Low Value, Locally Important
Glencar Lough trib	Gortnagrelly	573977E 842610N	Very small steep gradient stream; good quality; no fisheries interest but connects to Glencar (SAC)	Annex II species:	Low Value, Locally Important

Waterbody	Townland	Crossing location etc	Aquatic Ecology & Fisheries Assessment	Significant Aquatic Species	Evaluation
				Very unlikely Brown trout possible in lower reaches	
Glencar Lough trib	Meenaphuill	574682E 842798N	Good quality stream; exposed bedrock but some adjacent nursery habitat; connects to Glencar (SAC)	Annex II species: Very unlikely Brown trout possible	Moderate Value, Locally Important

8.3 Assessment of Route Corridor options

8.3.1 **Outline**

In terms of potential impacts, there is little significant difference in the route options within the Central and Northern Sections of the Study Area as they are located so close together. This is where most routes pass through alkaline fens (or springs) and woodland habitats and terminate within the SAC. There is a greater divergence in the route options within the Southern Section and therefore a divergence in the level of potential impacts on habitats, flora, fauna and fisheries.

8.3.2 **Route 01A/B**

8.3.2.1 Flora and Fauna

Option 1B is a southerly extension of option 1A towards the Town to the junction with the N4/N15, to include improvements to the existing N15. The only notable feature along this N15 section of the option is the occurrence of Japanese knotweed, a non-native invasive alien species scheduled to the European Communities (Birds and Natural Habitats) Regulations 2011. It is an offence under Regulation 50 to cause this species to spread. Option 1A commences once this route moves offline away from the N15 corridor.

Moving eastwards away from the N15 road corridor, Option 1A/B passes through improved agricultural grassland habitat and managed hedgerows. On townland boundaries, more mature vegetation is crossed. Nothing about the routeing of this option is likely to result in significant ecological effects until Lugnagall and Gortnagrelly, and that prospect is shared by all route options. At Lugnagall, the route crosses through mixed broadleaf woodland, oak-ash-hazel woodland and narrowly avoids two wetland sites (No's 8 and 10); the latter being a site known to support Annex I Alkaline Fen/ calcareous spring habitat..

At Gortnagrelly, all routes pass through mixed broadleaf woodland and an Annex I priority petrifying spring habitat. This is discussed further in Section 8.4.

The route also passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 1A/B on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.2.2 Fisheries

In the Southern Section the route passes through the catchments of the Doonally and Magheragillerneeve (Springfield) rivers but there are no proposed crossings of significant channels. The route is also spatially remote from these channels, which will reduce the potential for any run-off of sediments. It also avoids any potential connectivity with Lough Gill SAC. Further north, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology: Neutral to Slight.

8.3.3 **Route 2A/B**

8.3.3.1 Flora and Fauna

Option 2B is a southerly extension of option 2A towards the Town to the junction with the N4/N15, to include improvements to the existing N15. The only notable feature along this N15 section of the option is the occurrence of Japanese knotweed, a non-native invasive alien species scheduled to the European Communities (Birds and Natural Habitats) Regulations 2011. It is an offence under Regulation 50 to cause this species to spread. Option 01A commences once this route moves offline away from the N15 corridor.

Moving eastwards away from the N15 road corridor, Option 2A/B passes through improved agricultural grassland habitat and managed hedgerows. It passes in close proximity (circa 10m) to badger setts in Shannon Eighter. In Rathbraghan, it crosses the L-3407-0 and pockets of mixed broadleaf woodland. Further north, it crosses wet grassland habitat and mature hedgerow on a townland boundary. A wetland site occurs here which was considered in section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites) as site No.6, but Annex I habitat does not occur. The route then moves north passing mainly agricultural grasslands but crosses mature hedgerow and treelines as it crosses the existing N16. This route merges with option 1A/B in Castlegal. From here, the route crosses the same key ecological receptors in Lugnagall and Gortnagrelly discussed above and described further in Section 8.4.

The route also passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 2A/B on flora and fauna would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats and species of high value and for which policies of the CDP seek to protect. Further survey and alignment re-design is required.

8.3.3.2 Fisheries

In the southern section, a significant section of this route is located in the Doonally catchment and there is close interaction with the main channel over a 500m section in the Rathbraghan area with two crossings of the main channel in this reach and a crossing of Lisnalurg tributary. There is therefore the potential for run-off of sediment to the Doonally River. However, this route avoids any potential connectivity with Lough Gill SAC.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be

considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology are moderate to large (notably the Doonally River and its tributaries).

8.3.4 **Route 3**

8.3.4.1 Flora and Fauna

Option 3 differs from those previously described. It commences in Rathbraghan, strategically placed between the existing N15 to the West and the existing N16 to the East. It crosses areas of both immature and mixed broadleaf woodland. Here there is also a reed and large sedge swamp (FS1) and wet grassland (GS4) mosaic with vegetated drainage ditches and wading birds. This route merges with option 2A/B at the L-7422-0 local road in Rathbraghan. From here, the route crosses the same key ecological receptors as option 2A/B discussed previously and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 3 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.4.2 Fisheries

In the southern section, this route is generally remote from the Doonally river corridor apart from a single crossing of the main channel in the Rathbraghan area and one of the Rathbraghan tributary; the route also avoids any potential connectivity with Lough Gill SAC.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway

for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

The potential impact on fisheries & aquatic ecology is Slight to Moderate.

8.3.5 **Route 4**

8.3.5.1 Flora and Fauna

Option 4 mirrors the alignment of option 3 from Rathbraghan, diverging from it at wetland site No.6 in Doonally. It traverses agricultural grasslands as it travels north towards Collinsford, passing through mixed broadleaf woodland and a watercourse on the Drumkilsellagh / Drum East townland boundary. It again passes through mixed broadleaf woodland on the next townland boundary, and a flush feature with moderate to high potential to support small Annex I priority habitat Petrifying spring/ Annex I habitat Alkaline fen immediately north of here (wetland site No.13 at section 11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). It then turns east through Lugatober and enclosures of wet grassland habitat, crossing another wetland site (No.12) with moderate to high potential to support small Annex I priority habitat Petrifying spring/ Annex I habitat Alkaline fen.

From here the route charts approximately the same path as option 3 and crosses the same wetland sites at Lugnagall and Gortnagrelly (No's. 10 and 11 respectively) as discussed previously and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 4 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.5.2 Fisheries

In the southern section, this route is generally remote from the Doonally river corridor apart from a single crossing of the main channel in the Rathbraghan area and one of the Rathbraghan tributary; this route avoids any potential connectivity with Lough Gill SAC.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a

noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology: Slight to Moderate.

8.3.6 **Route 5**

8.3.6.1 Flora and Fauna

Option 5 passes further west than the routes previously appraised from Rathbraghan, passing through Barroe and northward through Doonally. It crosses mixed broadleaf and conifer woodland where it crosses the N16 crossroads with the L-3407-0 and L-3407-22 local roads. It passes through a mature treeline in Doonally before broadly merging with the alignment of option 3. From here, the route crosses the same key ecological receptors as option 3 discussed previously and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 5 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.6.2 Fisheries

In the southern section, a significant section of the route is located in the Doonally catchment and there is close interaction with main channel river corridor over a 300-400m section in the Doonally area (behind the vet lab) There is one proposed crossing of the main channel and one crossing of a key tributary (Lisgorey). The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the central section the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Moderate to Large (notably the Doonally River and its tributaries).

8.3.7 **Route 6**

8.3.7.1 Flora and Fauna

Option 6 commences at the same point as option 5, but takes a different and longer alignment until it merges with that option again at the Barroe / Doonally townland boundary where It crosses mixed broadleaf and conifer woodland as it crosses the N16 crossroads with the L-3407-0 and L-3407-22 local roads. From here, its alignment footprint is the same as that described for option 5 previously, including the constraints at Lugnagall and Gortnagrelly discussed above and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 6 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.7.2 Fisheries

In the southern section, a significant section of the route is located in the Doonally catchment and there is close interaction with main channel river corridor over a 300-400m section in the Doonally area (behind the vet lab) There is one proposed crossing of the main channel and one crossing of a key tributary (Lisgorey). The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology: Moderate to Large (notably the Doonally River and its tributaries).

8.3.8 **Route 7**

8.3.8.1 Flora and Fauna

Option 7 commences at the same point as options 5 and 6 but traverses through Barroe and further east again into Faughts. Here it is routed on top of two badger setts. North of here, it crosses mixed broadleaf conifer woodland at the townland boundary, and a small stand of conifers in Bellanurly

before passing through mixed broadleaf conifer woodland again on the existing N16 corridor. The route criss-crosses the existing N16 passing through predominantly agricultural improved grasslands before merging with the alignment of option 6 in Castlegal. Here it narrowly avoids broadleaf woodland each side of the route and potential wetland site No.14 with moderate to high potential to support small Annex I priority habitat Petrifying springs.

From here, its alignment and impacts are very similar to those described for option 6 including the constraints at Lugnagall and Gortnagrelly discussed above and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 7 on flora and fauna would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats and species of high value and for which policies of the CDP seek to protect. Further survey and alignment re-design is required.

8.3.8.2 Fisheries

In the southern section, a significant section of the route is located in the Doonally catchment with one crossing of the main channel and crossings of two key tributaries (Lisduff & Lisgorey); it also crosses a third tributary near to its source in Barroe area. The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Moderate (notably the Doonally River and its tributaries).

8.3.9 **Route 8**

8.3.9.1 Flora and Fauna

Option 8 commences at the same point as option 7 but takes an even wider arc through Barroe and into Faughts, avoiding the two badger setts mentioned above. It crosses wet grassland habitat and an area of scrub before merging with the alignment of option 7 to cross the existing N16 corridor and mixed broadleaf coniferous woodland as described previously. From here, the route criss-crosses the existing N16 as described above. It's alignment and impacts are very similar to those described for option 6 including the constraints at Lugnagall and Gortnagrelly discussed above and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 8 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Further survey and alignment re-design is required.

8.3.9.2 Fisheries

In the southern section, a significant section of the route is located in the Doonally catchment with one crossing of the main channel and crossings of two key tributaries (Lisduff & Lisgorey); it also crosses a third tributary near to its source in the Barroe area. The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Moderate (notably the Doonally River and its tributaries).

8.3.10 **Route 9**

8.3.10.1 Flora and Fauna

Option 9 takes a similar alignment to option 7 after commencing eastward through Barroe along a different trajectory. The options converge in Barroe to the south of the badger setts discussed under Route 7 above, and option 9 is routed over these badger setts. From here and travelling northward, its alignment and impacts are very similar to those described for option 7 including the constraints at Lugnagall and Gortnagrelly discussed above and described further in Section 8.4.

The route passes through wet grassland at Gortnagrelly before terminating at the County Boundary with earthworks inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 9 on flora and fauna would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats and species of high value

and for which policies of the CDP seek to protect. Further survey and alignment re-design is required.

8.3.10.2 Fisheries

In the southern section, a significant section of the route is located in the Doonally catchment with one crossing of the main channel and crossings of two key tributaries (Lisduff & Lisgorey). The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Moderate (notably the Doonally River and its tributaries).

8.3.11 Route 10

8.3.11.1 Flora and Fauna

Option 10 follows an identical alignment to option 3 until the Lugnagall wetland site. Here, the route abuts Crockauns/Keelogyboy Bogs NHA where its boundary runs coincident to the N16. From the Gortnagrelly wetland-woodland feature, it diverges and remains south of the existing N16 passing through agriculturally improved grassland fields and some coniferous plantation stands.

This route does not have a footprint inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 10 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats and species of high value and for which policies of the CDP seek to protect. A significant effect upon the NHA is not likely, however as with all options further survey and alignment re-design is required.

8.3.11.2 Fisheries

In the southern section, this route is generally remote from the Doonally river corridor apart from a single crossing of the main channel in the Rathbraghan area and one of the Rathbraghan tributary; the route also avoids any potential connectivity with Lough Gill SAC.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway

for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Slight to Moderate.

8.3.12 Route 11

8.3.12.1 Flora and Fauna

Option 11 follows a very similar alignment to option 3 and option 10 until the Gortnagrelly wetland-woodland feature, except that it is a little to the south and abuts Crockauns/Keelogyboy Bogs NHA where its boundary runs coincident to the N16. From here, it diverges and remains north of the existing N16 passing through a series of wet grassland fields before terminating at the County boundary.

The full alignment of this route also has a footprint inside Ben Bulben, Gleniff and Glenade Complex SAC, in contrast to only earthworks for options 1-9.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016) and encroaches into two designated sites, a NHA and a SAC. The potential ecological impact of progressing route option 11 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats and species of high value and for which policies of the CDP seek to protect. A significant effect upon the NHA is not likely, however as with all options further survey and alignment re-design is required. The route does not impact upon any identified badger setts.

8.3.12.2 Fisheries

In the southern section, this route is generally remote from the Doonally river corridor apart from a single crossing of the main channel in the Rathbraghan area and one of the Rathbraghan tributary; the route also avoids any potential connectivity with Lough Gill SAC.

In the central section, the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the northern section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC. Potential impact on fisheries & aquatic ecology: Neutral to Slight.

8.4 Key Ecological Receptors

NRA (2009) requires that a principal output of ecological research, survey and analysis at Route Corridor Selection stage is to select 'key ecological receptors' for which more detailed survey will likely be required to underpin an ecological impact assessment.

8.4.1 Lugnagall woodland – wetland feature

All route options converge at the Collinsford/Lugatober/Lugnagall townland boundaries in an area of native woodland with flush features, just beyond the site boundary of Crockauns/Keelogyboy Bogs NHA. All options require a working width of circa 50-60m to construct the new mainline, and there are local roads which need to be diverted also, so side road alignments will result in additional footprint.

All options avoid a direct impact upon the Alkaline Fen/calcareous spring habitat feature, but equally all will result in loss of native woodland. This groundwater dependent habitat is illustrated in drawing no. N16-RS-076.

This site is listed as 'Lugnagall Flush' in Appendix C, County Sligo Biodiversity Sites of the Sligo County Development Plan 2011-2017, and it is considered to be of County Importance (refer to section 10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme). It is thus considered to represent a 'key ecological receptor' in accordance with NRA (2009) for which detailed assessment is required.

8.4.2 Gortnagrelly woodland - wetland feature

Approximately 700m further along the route options towards the Leitrim County Boundary, another valuable habitat feature occurs in Lugnagall (refer to Figure 8-2). This is a tufa mound (an Annex I priority habitat 'petrifying springs') within mixed broadleaf woodland (No.11) with adjacent flushes with the potential to support Petrifying springs/ Annex I habitat Alkaline fen. This flush site has been ranked as national value in the County Sligo Wetlands Survey.

All options except for option 1 will result in a direct footprint on this wetland feature and associated loss of native woodland. This groundwater dependant habitat is illustrated in drawing no. N16-RS-076.

This site contains habitats annexed to the Habitats Directive 92/43/EEC, and the woodland 'ravine' has exposed limestone rock and calcareous soil and has the potential to support bryophytes species of interest. This site is ranked as national value in the Sligo Wetland Survey. It is considered to be of County if not National Importance (refer to section 10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme) and is thus considered to represent a 'key ecological receptor' in accordance with NRA (2009) for which detailed assessment is required.

8.4.3 Badger setts

Route option 2 passes within 10m of two badger setts at Shannon Eighter.

Route options 7 and 9 pass over two badger setts at Barroe near the townland boundary with Faughts. These locations are the resting place of protected species. They benefit from protection under the Wildlife Acts 1976-2010 and also enjoy protection under policies of the Sligo County Development Plan 2011-2017, and they are considered to be of County Importance (refer to section 10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme), and thus considered to represent 'key ecological receptors' in accordance with NRA (2009) for which detailed assessment is required.

8.4.4 Crockauns/Keelogyboy Bogs NHA

This is principally a peatland NHA, but the NPWS site synopsis also notes that "*on the north-west side of the site, at the base of cliffs and scree slopes, small areas of broadleaved woodland occur supporting Hazel (*Corylus avellana*), Ash (*Fraxinus excelsior*), Hawthorn (*Crataegus monogyna*), Rowan (*Sorbus aucuparia*) as well as the scarce species Irish Whitebeam (*Sorbus hibernica*). This area also supports a diverse community of mosses*."

This appraisal concludes that the woodland type referred to above grows here both within and beyond the NHA. All options cut through this woodland, and would result in direct loss of woodland outside the NHA. The NHA boundary runs coincident to the N16 roadbed at this location.

A Natural Heritage Area receives statutory protection under the Wildlife Act 2000 and also enjoys protection under policies of the Sligo County Development Plan 2011-2017. It is considered to be of National Importance (refer to section 10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme), and is thus considered to represent a 'key ecological receptor' in accordance with NRA (2009) for which detailed assessment is required if any options result in direct or indirect impacts upon its features.

8.4.5 Ben Bulben, Gleniff and Glenade Complex SAC

All but one of the options has a footprint within Ben Bulben, Gleniff and Glenade Complex SAC. Route option 10 passes to the south of the existing N16 and the European site. Route Option 11 passes to the north of the existing N16 and the European site, and has the largest footprint within the SAC of all options. The remaining options have a very small earthworks footprint within the European site which extends to the N16 road verge, as illustrated in Figure 8-3.

A Special Area of Conservation receives statutory protection under the European Communities (Birds and Natural Habitats) Regulations 2011, as amended and also enjoys protection under policies of the Sligo County Development Plan 2011-2017. It is considered to be of international Importance (refer to section 10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme), and is thus considered to represent a 'key ecological receptor' in accordance with NRA (2009) for which detailed assessment is required if an option progresses which is not restricted to the road boundary.

Figure 8-1: Lugnagall woodland-wetland feature

Figure 8-2: Gortnagrelly woodland-wetland feature

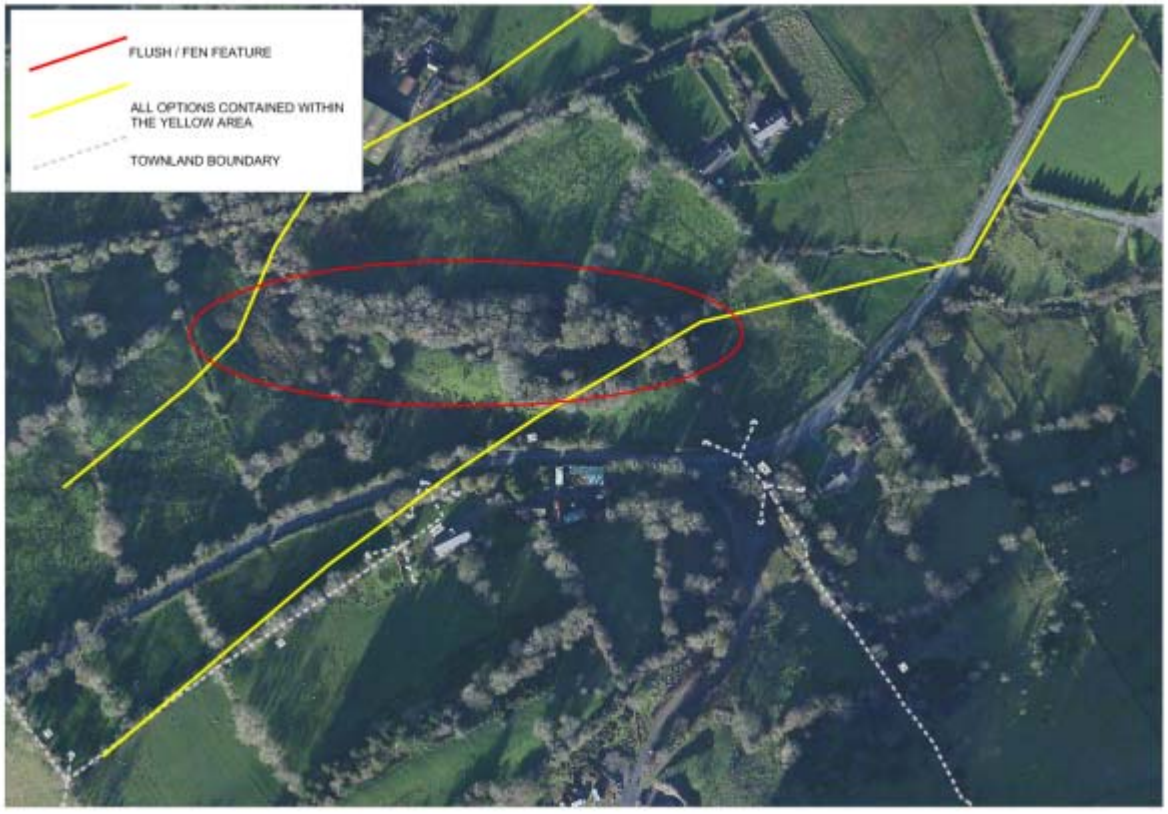


Figure 8-3: Ben Bulben, Gleniff and Glenade Complex SAC

8.5 Discussion

8.5.1 **Designated sites**

Natural heritage policies of the Sligo and Environs Development Plan 2010-2016 and Objectives of the Sligo County Development Plan 2011-2017 (CDP) (Refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016) seek to *inter alia,* maintain and enhance the conservation values of European sites and NHAs, and require appropriate assessment of all proposed development likely to have a significant effect upon a European site.

Option 10 is the only option which does not have a direct impact upon a SAC. All remaining options have a very small earthworks footprint within the SAC, except for option 11 which passes entirely through the SAC.

All feasible route options pass immediately adjacent to the NHA and also result in direct loss of high value native woodland habitat providing (albeit fragmented) connectivity between woodland on the northern slope of Cope's Mountain and the Drumcliff River corridor to the north of Lugnagall.

The option selected as an emerging preferred route should avoid any direct footprint and impact upon natural habitats within a NHA or a SAC. The direct footprint impacts highlighted in this report occur principally within the roadbed of the N16 in the case of Crockauns/Keelyogyboy Bogs NHA and within roadside vegetation and grassland habitat in the case of Ben Bulben, Gleniff and Glenade Complex SAC. Alignment re-design to avoid a direct footprint within the SAC is feasible.

8.5.2 Other Key Ecological Receptors

CDP policies in relation to sites of local nature conservation importance such as Annex I alkaline fen flushes and calcareous spring features seek to minimise the impact of new development on habitats of natural value that are key features of the County's ecological network. Developments likely to have an adverse effect on recognised sites of local nature conservation importance will be required to demonstrate the impacts on the ecological value of the site and will not be approved unless it can be clearly demonstrated that there are reasons for the development that outweigh the need to safeguard the nature conservation value of the site.

The policies require adverse effects as a result of development upon such features to be subject to ecological impact assessment, and to ensure that proposed developments do not adversely affect groundwater resources and groundwater-dependent habitats and species.

Policies in relation to woodland, tress and hedgerows seek to protect and conserve them, to prevent disruption to woodland and hedgerow connectivity in the landscape, and to mitigate by planting additional vegetation to offset any adverse effects of loss of such habitats.

Policies in relation to streams and watercourses seek to protect them and maintain them in an open state, capable of providing suitable habitats for fauna and flora; to discouraging culverting or realignment; and to ensure that an ecological assessment is undertaken for developments with the potential to impact on inland waters.

All feasible route options will likely result in direct or indirect impacts upon groundwater-dependent habitats and species, woodlands, watercourses and hedgerows. Hedgerow loss is unavoidable, and will be mitigated by replacement planting in accordance with TII policy. Alignment re-design is recommended to minimise impacts upon features of ecological connectivity in the landscape.

8.5.3 Protected species

Woodland habitats, particularly when located in proximity to watercourses and when linking townland boundaries, may be of local value for foraging bats. Individual trees conflicting with the emerging preferred alignment may serve as bat roosts.

Otters were not recorded in field survey associated with the preparation of this report, but will likely use watercourses in the study area.

Bat and otters are European protected species and they are protected by the European Communities (Birds and Natural Habitats) Regulations 2011, as amended. Assessment prior to a consent decision being issued is required if any evidence of use of the zone of influence of the proposed road is established.

Badger setts are protected by law. Section 23(5)(d) of the Wildlife Act, 1976 as amended makes it an offence to wilfully interfere with or destroy the breeding place of any protected wild animal, including badger.

The fisheries assessment notes the presence of salmonids in some watercourses. Mtigation to protect the water environment and retain riparian corridors for movement of salmonid species will be required, and is entirely consistent with TII policy.

CDP policies seek to ensure that development does not have a significant adverse impact, incapable of satisfactory mitigation, on any plant, animal or bird species protected by law.

Preliminary design of the emerging preferred route will seek to minimise adverse effects on protected sites and species; and natural habitats including bats, badgers, otters, fens, woodlands, trees and hedgerows, and to seek adequate mitigation and/or compensation for any adverse effects as a result of proposed development.

This approach will avoid significant adverse residual effects upon these ecological features and keep the design of the proposed road scheme in conformity and compliance with County Development Plan policies.

8.6 Refined Options Assessment

Following a multi-disciplinary workshop, to discuss the outcome of the initial Preliminary Options Assessment relating to the Feasible Route Options; a refinement and localised modification of designs was applied. These 'Refined Route Options' were then subjected to a further stage of Preliminary Options Assessment as outlined below.

8.6.1 **Route 01A/B (v2)**

8.6.1.1 Flora and Fauna

Option 01A/B v2 is a southerly extension of option 01A v2 towards the Town to the junction with the N4/N15, to include improvements to the existing N15. The only notable feature along this N15 section of the option is the occurrence of Japanese knotweed, a non-native invasive alien species scheduled to the European Communities (Birds and Natural Habitats) Regulations 2011. It is an offence under Regulation 50 to cause this species to spread. Option 01A v2 commences once this route moves offline away from the N15 corridor.

Moving eastwards away from the N15 road corridor, Option 01A/B v2 passes through improved agricultural grassland habitat and managed hedgerows. On townland boundaries, more mature vegetation is crossed. Nothing about the routeing of this option is likely to result in significant ecological effects in the southern section. The route does not impact upon any identified badger setts. Effects upon flora and fauna are expected to be minor to moderate in magnitude.

Option 01A/B-v2 is broadly commensurate with Option 8-v2 (See section 8.6.4) north of Drum East.

8.6.1.2 Fisheries

In the Southern Section the route passes through the catchments of the Doonally and Magheragillerneeve (Springfield) rivers but there are no proposed crossings of significant channels. This route is also spatially remote from these channels, which will reduce the potential for any run-off of sediments. It also avoids any potential connectivity with Lough Gill SAC.

Potential impact on fisheries & aquatic ecology: Neutral to Slight.

8.6.2 **Route 02A/B v2**

8.6.2.1 Flora and Fauna

Option 02A/B v2 is a southerly extension of option 02A v2 towards the Town to the junction with the N4/N15, to include improvements to the existing N15. The only notable feature along this N15 section of the option, as described above is the occurrence of Japanese knotweed, a non-native invasive alien species scheduled to the European Communities (Birds and Natural Habitats) Regulations 2011. It is an offence under Regulation 50 to cause this species to spread. Option 02A v2 commences once this route moves offline away from the N15 corridor.

Moving eastwards away from the N15 road corridor, Option 02A/B v2 passes through improved agricultural grassland habitat and managed hedgerows. It passes in close proximity (~10m) to badger setts in Shannon Eighter. In Rathbraghan, it crosses the L-3407-0 and pockets of mixed broadleaf woodland. Further north, it crosses wet grassland habitat and mature hedgerow on a townland boundary.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 02A v2 or 02A/B v2 on flora and fauna would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to species of high value and for which policies of the CDP seek to protect. Effects upon flora and fauna are expected to be of moderate magnitude.

Option 02A-v2 ties in with Options 05 in the townland of Drum East.

8.6.2.2 Fisheries

In the Southern Section a significant section of this route is located in the Doonally catchment and there is close interaction with the main channel over a 500m section in the Rathbraghan area with two crossings of the main channel in this reach and a crossing of the Lisnalurg tributary. There is therefore the potential for run-off of sediment to the Doonally River. However this route avoids any potential connectivity with Lough Gill SAC.

Potential impact on fisheries & aquatic ecology: Moderate to Large (notably the Doonally River and its tributaries).

8.6.3 **Route 5**

8.6.3.1 Flora and Fauna

Option 05 passes further west than the routes previously appraised from Rathbraghan, passing through Barroe and northward through Doonally. It crosses mixed broadleaf and conifer woodland where it crosses the N16 crossroads with the L-3407-0 and L-3407-22 local roads. It passes through a mature treeline in Doonally. Further north, it crosses wet grassland habitat and mature hedgerow on a townland boundary. A wetland site occurs here which was considered in section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites) as site No.6, but Annex I habitat does not occur. The route then moves north passing mainly agricultural grasslands but crosses mature hedgerow and treelines as it crosses the existing N16.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply (refer to section 12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016). The potential ecological impact of progressing route option 5 on flora would be significant at a County scale, as outlined in the approach set out at Section 8.1.1, in that adverse effects are likely to occur to habitats of high value and for which policies of the CDP seek to protect. The route does not impact upon any identified badger setts. Effects upon flora and fauna are expected to be minor to moderate in magnitude.

Option 05 ties in with option 08-v2 in the townland of Collinsford,

8.6.3.2 Fisheries

In the Southern Section a significant section of the route is located in the Doonally catchment and there is close interaction with main channel river corridor over a 300-400m section in the Doonally area (behind the vet lab) There is one proposed crossing of the main channel and one crossing of a key tributary (Lisgorey). The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the Central Section the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to

be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

Potential impact on fisheries & aquatic ecology: Moderate to Large (notably the Doonally River and its tributaries).

8.6.4 **Route 8-v2**

8.6.4.1 Flora and Fauna

Option 08 v2 avoids two badger setts at Faughts, as it did originally. It crosses wet grassland habitat and an area of scrub before crossing the existing N16 corridor and mixed broadleaf coniferous woodland as described previously. From here, the route criss-crosses the existing N16 as described above. At Lugnagall, the route crosses through mixed broadleaf woodland, oak-ash-hazel woodland and has been modified to bridge the N16 over the L-3404-0 and avoid direct impacts upon Annex I priority habitat.

Notwithstanding the design modifications, route 08-v2 crosses a number of discrete habitats of natural value for which County Development Plan policies apply but direct impacts on Annex I habitats are no longer as great a risk. This route does not impact upon any identified badger setts. Effects upon flora and fauna are expected to be of moderate magnitude.

8.6.4.2 Fisheries

In the Central Section the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the Northern Section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology: Moderate (notably the Doonally River and its tributaries).

8.6.5 **Route 12**

8.6.5.1 Flora and Fauna

ROA Option 12 traverses through Barroe and further east again into Faughts. It is modified at the crossing point with the L-3407-22 to reduce impacts on a protected structure. North of here, it crosses mixed broadleaf conifer woodland at the townland boundary, and a small stand of conifers in Bellanurly before passing through mixed broadleaf conifer woodland again on the existing N16 corridor. From the Lugnagall wetland site the route runs flush with Crockauns/Keelogyboy Bogs NHA along the existing N16 alignment. From the Gortnagrelly wetland-woodland feature, it continues

along the existing N16 route as an amalgamated design option of POA Options 2A, 2A/B, 3 and 10. This option does not have a footprint inside Ben Bulben, Gleniff and Glenade Complex SAC.

The route crosses a number of discrete habitats of natural value for which County Development Plan policies apply. Effects upon flora and fauna are expected to be minor to moderate in magnitude.

8.6.5.2 Fisheries

In the Southern Section a significant section of the route is located in the Doonally catchment with one crossing of the main channel and crossings of two key tributaries (Lisduff & Lisgorey); it also crosses a third tributary near to its source in Barrroe area. The route avoids any potential connectivity with Lough Gill SAC but there is potential for run-off of sediment to the Doonally River.

In the Central Section the route interacts with a series of small streams with proposed crossings of the Tully River and two tributaries of the Lower Drumcliff River. Some of these streams are likely to be inhabited by brown trout in the area of proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches or the Drumcliff River, a noted salmon river.

In the Northern Section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Potential impact on fisheries & aquatic ecology: Moderate (notably the Doonally River and its tributaries).

8.6.6 **Route 12 (v2)**

8.6.6.1 Flora and Fauna

ROA Option 12 v2 is as described previously for Option 12 but with an alternative junction arrangement provided in Collinsford/Lugnagall; and an alternative alignment at Gortnagrelly. As above, the route crosses a number of discrete habitats of natural value for which County Development Plan policies apply. Effects upon flora and fauna are expected to be minor to moderate in magnitude.

8.6.6.2 Fisheries

In the Northern Section, this route option includes proposed crossings of three tributaries of the Upper Drumcliff River and three tributaries of Glencar Lough. Some of these streams are likely to be inhabited by brown trout in the area of the proposed crossings and therefore fish passage should be considered in the design of culvert or bridge structures. These streams are also a potential pathway for sediment run-off to reach more productive downstream reaches including the Drumcliff River, a noted salmon river discharging from Glencar Lough which forms part of Ben Bulben, Gleniff and Glenade Complex SAC.

Version 2 will require a more radical realignment and bridging (culvert) of the Gortnagrelly stream to facilitate the new road alignment and its associated embankments.

Potential impact on fisheries & aquatic ecology: Moderate to Large (in the Gortnagrelly stream, a tributary of the Drumcliff River, and the superior stream of those traversed in the Northern Section).

8.7 Conclusions

8.7.1 Preliminary Option Assessment (Feasible Route Options)

8.7.1.1 Flora and Fauna

The emerging preferred route should avoid significant effects on a European site. Any direct habitat loss within a European site or a NHA should be minimised if avoidance is not feasible.

Several key ecological receptors have been identified including woodland and flush habitats. More detailed survey and subsequent evaluation is required to (i) inform the preliminary design of the emerging preferred route; and (ii) facilitate a comprehensive ecological impact assessment upon the preferred project at EIA stage.

There are a number of potential groundwater fed wetland sites of interest where it is considered there is a moderate to high likelihood of an Annex I habitat (e.g. Alkaline fen) or Annex I priority habitat (e.g. petrifying spring) being present. Where these are located within 100m of the route options, it is recommended that a survey be undertaken by a botanical wetland specialist to assess the presence of Annex I habitats/ priority habitats and rare/ protected flora species and to assess their conservation value. There are 6 sites recommended for further survey (depending on the route selected) at the next stage of the design process and these are identified in Table 8-3. The full report is included at section 11 (Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites). Maps illustrating the location of the six survey sites is included within section 11 (Appendix 3 to this report).

Table 8-3: Wetland site survey recommendations

Site.	Site name	Grid Ref	Further survey	Feature
10	Lugnagall Flush	G725416	Yes	Site known to support Alkaline Fen/ calcareous spring habitat and rare/ protected bryophytes recorded from vicinity.
11	NE of Lugnagall	G729422	Yes	RPS survey recorded tufa mound (Annex I priority habitat Petrifying springs) and potential calcareous springs. Woodland has potential to support rare/protected bryophytes.
12	S of Collinsford	G718413	Yes	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation
13	E of Drum	G713409	Yes	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation.
14	W of Castlegal	G718409	Yes	RPS survey found potential calcareous spring within area of woodland.
16	Leitrim border	G746428	Yes	Potential for calcareous springs and/ or rare/ protected bryophytes within north-facing wooded ravine. Located within SAC.

In terms of Flora, at Preliminary Option Assessment (Feasible Route Options), route option 5 emerges as a very high preference option, followed by option 6 being a high preference option. Route options 1, 2, 7, 8 and 9 were considered to be of medium preference, while route option 3 was of low preference. Route options 4, 10 and 11 emerged as very low preferences.

These conclusions are summarised in Table 8-4.

Several key ecological receptors have been identified including badger setts online with some route options. More detailed survey and subsequent evaluation is required to (i) inform the preliminary design of the emerging preferred route; and (ii) facilitate a comprehensive ecological impact assessment upon the preferred project at EIA stage.

A protected mammal survey focusing on bats, badgers and otters should be conducted upon the emerging preferred route.

In terms of Fauna, At Preliminary Option Assessment (Feasible Route Options), route option 5 emerges as a very high preference option, followed by option 6 being a high preference option. Route options 3 and 9 were considered to be of medium preference, while route options 4, 7, 9 and 10 emerged as being of low preference. Route options 1, 2 and 11 emerged as very low preferences.

These conclusions are summarised in Table 8-5.

8.7.1.2 Fisheries

The Doonally River is the most vulnerable receptor as the waterbody in which the river corridor is encroached upon by several route options, both in the form of channel crossings and proximity to the river channel.

In this regard routes 1A/1B emerge as the preferred options with routes 2A/2B, 5 and 6 being the least favoured options. Routes 3, 4, 10 and 11 were considered to be of medium preference, while routes 7, 8 and 9 were of low preference.

At Preliminary Option Assessment (Feasible Route Options), route option 1 emerges as a very high preference option. Route options 3, 4, 10 and 11 were considered to be of medium preference, while route options 7, 8, and 9 were of low preference. Route options 2, 5 and 6 emerged as very low preferences.

These conclusions are summarised in Table 8-6.

Table 8-4: POA Preference (Flora)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	3	4	4	4	4	2	3	4	4	1	5	5
Central	2	2	1	1	3	5	1	1	3	3	4	4	4
North	3	3	3	3	3	3	2	2	1	1	1	4	5
Overall	3	3	3	3	4	5	1	2	3	3	3	5	5

Table 8-5: POA Preference (Fauna)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	4	4	5	5	3	3	1	2	5	3	5	3	3
Central	5	5	1	1	2	4	1	1	3	3	3	4	5
North	3	3	4	4	3	3	2	2	1	1	1	3	5
Overall	5	5	5	5	3	4	1	2	4	3	4	4	5

Table 8-6: POA Preference (Fisheries)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	1	5	5	3	3	5	5	4	4	4	3	3
Central	3	3	3	3	3	4	3	3	3	3	3	3	3
North	2	2	3	3	3	3	3	3	3	3	3	3	3
Overall	1	1	5	5	3	3	5	5	4	4	4	3	3

8.7.2 Refined Option Assessment (Refined Route Options)

8.7.2.1 Flora and Fauna

The refined route options sought to reduce the possibility of adverse effects upon high value ecological receptors at locations where Annex I habitats occurred. At these locations, modified design options have resulted in a refined prediction that no major adverse effects of significance are likely in terms of conflict with County Development Plan policies.

Route option 01A/B-v2 (or 01A-v2) and 12-v2 emerge as High preference options, while route options 02A/02B-v2, (or 02A-v2), 05 and 08-v2 were of Medium preference. These conclusions are summarised in Table 8-7.

8.7.2.2 Fisheries

The Doonally River is the most vulnerable receptor as the water body in which the river corridor is encroached upon by several route options, both in the form of channel crossings and proximity to the river channel.

Route option 01A/B v2 (or 01A-v2) emerges as a High preference option. Route options 02A/02B-v2, 05 8-v2 and 12 were considered to be of medium preference, while route option 12 v2 was of Low preference.

These conclusions are summarised in Table 8-8.

Table 8-7: ROA Preference (Flora and Fauna)

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	3	3	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Middle	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	1
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	2	2

Table 8-8: ROA Preference (Fisheries)

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	4	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	4
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	4

9 Flora, Fauna and Fisheries: Appendix 1 - Habitat Classification Scheme

Taken from Heritage Council publication '*A Guide to Habitats in Ireland*' (2000) [pp14-15]

Available at: http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Wildlife/Guide_to_Habitats.pdf

SUMMARY OF THE CLASSIFICATION

NON-MARINE

F Freshwater	FL Lakes and ponds	FL1 Dystrophic lakes		17
		FL2 Acid oligotrophic lakes		18
		FL3 Limestone/marl lakes		18
		FL4 Mesotrophic lakes		19
		FL5 Eutrophic lakes		19
		FL6 Turloughs		19
		FL7 Reservoirs		20
		FL8 Other artificial lakes and ponds		20
	FW Watercourses	FW1 Eroding/upland rivers		21
		FW2 Depositing/lowland rivers		22
		FW3 Canals		22
		FW4 Drainage ditches		23
	FP Springs	FP1 Calcareous springs		23
		FP2 Non-calcareous springs		24
	FS Swamps	FS1 Reed and large sedge swamps		25
		FS2 Tall-herb swamps		25
G Grassland and marsh	GA Improved grassland	GA1 Improved agricultural grassland		27
		GA2 Amenity grassland (improved)		28
	GS Semi-natural grassland	GS1 Dry calcareous and neutral grassland		28
		GS2 Dry meadows and grassy verges		30
		GS3 Dry-humid acid grassland		30
		GS4 Wet grassland		31
	GM Freshwater marsh	GM1 Marsh		32
H Heath and dense bracken	HH Heath	HH1 Dry siliceous heath		35
		HH2 Dry calcareous heath		36
		HH3 Wet heath		36
		HH4 Montane heath		37
	HD Dense bracken	HD1 Dense bracken		38
P Peatlands	PB Bogs	PB1 Raised bog		41
		PB2 Upland blanket bog		42
		PB3 Lowland blanket bog		43
		PB4 Cutover bog		44
		PB5 Eroding blanket bog		44
	PF Fens and flushes	PF1 Rich fen and flush		45
		PF2 Poor fen and flush		46
		PF3 Transition mire and quaking bog		46
W Woodland and scrub	WN Semi-natural woodland	WN1 Oak-birch-holly woodland		50
		WN2 Oak-ash-hazel woodland		50
		WN3 Yew woodland		51
		WN4 Wet pedunculate oak-ash woodland		51
		WN5 Riparian woodland		52
		WN6 Wet willow-alder-ash woodland		52
		WN7 Bog woodland		53
	WD Highly modified/non-native woodland	WD1 (Mixed) broadleaved woodland		53
		WD2 Mixed broadleaved/conifer woodland		54
		WD3 (Mixed) conifer woodland		54
		WD4 Conifer plantation		54
		WD5 Scattered trees and parkland		54
	WS Scrub/transitional woodland	WS1 Scrub		55
		WS2 Immature woodland		56
		WS3 Ornamental/non-native shrub		56
		WS4 Short rotation coppice		56
		WS5 Recently-felled woodland		56
	WL Linear woodland/scrub	WL1 Hedgerows		57
		WL2 Treelines		57
E Exposed rock and disturbed ground	ER Exposed rock	ER1 Exposed siliceous rock		60
		ER2 Exposed calcareous rock		60
		ER3 Siliceous scree and loose rock		61
		ER4 Calcareous scree and loose rock		62
E (cont.)	EU Underground rock and caves	EU1 Non-marine caves		62
		EU2 Artificial underground habitats		62
	ED Disturbed ground	ED1 Exposed sand, gravel or till		63
		ED2 Spoil and bare ground		63
		ED3 Recolonising bare ground		63
		ED4 Active quarries and mines		64
		ED5 Refuse and other waste		64
B Cultivated and built land	BC Cultivated land	BC1 Arable crops		66
		BC2 Horticultural land		66
		BC3 Tilled land		66
		BC4 Flower beds and borders		67
	BL Built land	BL1 Stone walls and other stonework		67
		BL2 Earth banks		68
		BL3 Buildings and artificial surfaces		68
C Coastland	CS Sea cliffs and islets	CS1 Rocky sea cliffs		70
		CS2 Sea stacks and islets		70
		CS3 Sedimentary sea cliffs		71
	CW Brackish waters	CW1 Lagoons and saline lakes		71
		CW2 Tidal rivers		72
	CM Salt marshes	CM1 Lower salt marsh		73
		CM2 Upper salt marsh		74
	CB Shingle and gravel banks	CB1 Shingle and gravel banks		74
	CD Sand dune systems	CD1 Embryonic dunes		75
		CD2 Marram dunes		75
		CD3 Fixed dunes		76
		CD4 Dune scrub and woodland		77
		CD5 Dune slacks		77
		CD6 Machair		78
	CC Coastal constructions	CC1 Sea walls, piers and jetties		78
		CC2 Fish cages and rafts		78

MARINE

L Littoral (intertidal)	LR Littoral rock	LR1 Exposed rocky shores		82
		LR2 Moderately exposed rocky shores		82
		LR3 Sheltered rocky shores		83
		LR4 Mixed substrata shores		83
		LR5 Sea caves		83
	LS Littoral sediment	LS1 Shingle and gravel shores		84
		LS2 Sand shores		85
		LS3 Muddy sand shores		86
		LS4 Mud shores		86
		LS5 Mixed sediment shores		87
S Sublittoral (subtidal)	SR Sublittoral rock	SR1 Exposed infralittoral rock		90
		SR2 Moderately exposed infralittoral rock		90
		SR3 Sheltered infralittoral rock		91
		SR4 Exposed circalittoral rock		91
		SR5 Moderately exposed circalittoral rock		92
		SR6 Sheltered circalittoral rock		92
	SS Sublittoral sediment	SS1 Infralittoral gravels and sands		93
		SS2 Infralittoral muddy sands		93
		SS3 Infralittoral muds		94
		SS4 Infralittoral mixed sediments		94
		SS5 Circalittoral gravels and sands		94
		SS6 Circalittoral muddy sands		95
		SS7 Circalittoral muds		95
		SS8 Circalittoral mixed sediments		95
M Marine water body		MW1 Open marine water		97
		MW2 Sea inlets and bays		97
		MW3 Straits and sounds		97
		MW4 Estuaries		97

10 Flora, Fauna and Fisheries: Appendix 2 - Ecological Evaluation Scheme

Taken from NRA Guidelines for Assessment of Ecological Impacts of National Road (Rev 2, 2009) [pp16-17]

Available at:

http://www.tii.ie/technical-services/environment/planning/Guidelines-for-Assessment-of-Ecological-Impacts-of-National-Road-Schemes.pdf

International Importance:

- □ 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA), candidate SAC or proposed SPA.
- □ Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended).
- □ Features essential to maintaining the coherence of the Natura 2000 Network[3].
- □ Resident or regularly occurring populations (assessed to be important at the national level)[4] of the following:
  - o Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and/or
  - o Species of animal and plants listed in Annex II and/or IV of the Habitats Directive.
- □ Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971).
- □ World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972).
- □ Biosphere Reserve (UNESCO Man & The Biosphere Programme).
- □ Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979).
- □ Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979).
- □ Biogenetic Reserve under the Council of Europe.
- □ European Diploma Site under the Council of Europe.
- □ Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988)[5].

National Importance:

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

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

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

- □ Site designated or proposed as a Natural Heritage Area (NHA).
- □ Statutory Nature Reserve.
- □ Refuge for Fauna and Flora protected under the Wildlife Acts.
- □ National Park.
- □ Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA);
- □ Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park.
- □ Resident or regularly occurring populations (assessed to be important at the national level)[6] of the following:
  - o Species protected under the Wildlife Acts; and/or
  - o Species listed on the relevant Red Data list.
- □ Site containing 'viable areas'[7] of the habitat types listed in Annex I of the Habitats Directive.

County Importance:

- □ Area of Special Amenity[8].
- □ Area subject to a Tree Preservation Order.
- □ Area of High Amenity, or equivalent, designated under the County Development Plan.
- □ Resident or regularly occurring populations (assessed to be important at the County level)[9] of the following:
  - o Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
  - o Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
  - o Species protected under the Wildlife Acts; and/or
  - o Species listed on the relevant Red Data list.
- □ Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance.
- □ County important populations of species, or viable areas of semi-natural habitats or natural heritage features identified in the National or Local BAP[10], if this has been prepared.
- □ Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county.
- □ Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.

Local Importance (higher value):

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

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

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

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

[10] BAP: Biodiversity Action Plan

- Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared;
- Resident or regularly occurring populations (assessed to be important at the Local level)[11] of the following:
  - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
  - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
  - Species protected under the Wildlife Acts; and/or
  - Species listed on the relevant Red Data list.
- Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality;
- Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.

Local Importance (lower value):

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

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

11 Flora, Fauna and Fisheries: Appendix 3 - Survey of selected wetland sites

11.1 Introduction

A desktop review and preliminary survey for the N16 Sligo to County Boundary Route Selection Report identified several wetland areas that had the potential to support Annex I habitats. Denyer Ecology was commissioned to survey these wetland areas to assess their conservation value and determine whether they are key ecological receptors.

The selected sites are potentially groundwater fed wetlands where it is considered there is a moderate to high likelihood of an Annex I habitat or Annex I priority habitat being present. In addition, sites were only selected where they are located within 100m of the route options.

The wetland survey and report include:

- A botanical and bryological survey of the wetland vegetation at each site.
- Assessment of whether any of the wetland habitats correspond to the priority Annex I habitat '*Petrifying springs with tufa formation*' and/ or Annex I habitat '*Alkaline fens'.*
- Evaluation of the ecological importance (i.e. local/ county/ national/ international importance) as per standard NRA guidelines: *Guidelines for assessment of Ecological Impacts of National Road Schemes* (NRA, 2009).

11.2 Methodology

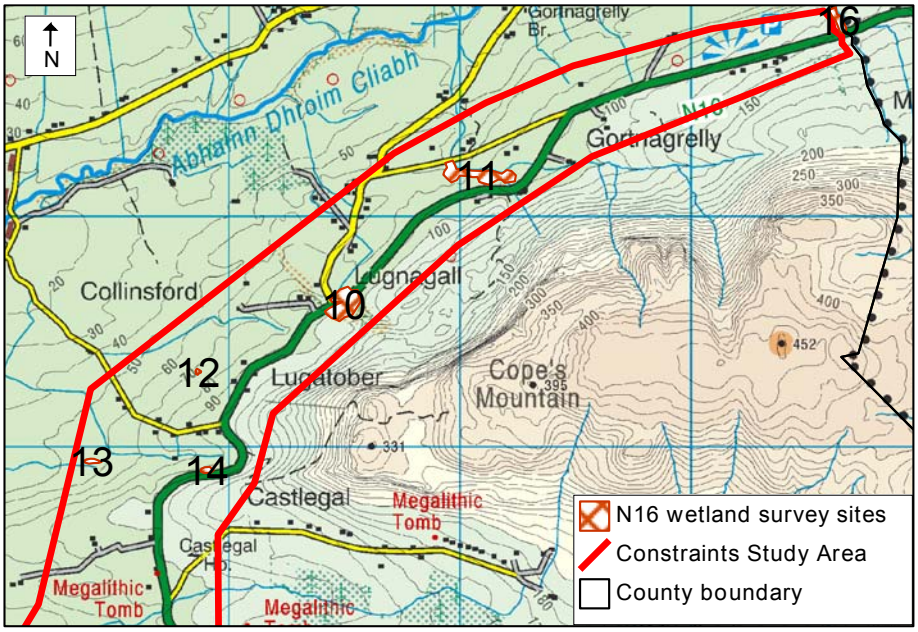
11.2.1 Survey sites

Six sites were recommended for further survey (Table 11.1). At each site the wetland feature of potential interest was visited by an experienced wetland ecologist and botanist. In addition, at Gortnagrelly (site 11), areas within a buffer zone of 200m around the known tufa mound were surveyed to assess whether any additional wetland features of interest were present. The survey area at this site is shown on Figure 11-3 and excludes areas already covered in the route selection survey walkover.

Table 11.1: Potential groundwater fed wetland sites of interest

Site no.	Site name	Grid reference	Source	Feature(s)s of interest
10	Lugnagall Flush	G725416	Sligo Wetland Survey, aerial photography, soil maps, Dr Don Cotton flora and fauna records	Site known to support Alkaline Fen/ calcareous spring habitat. Ranked as national value in the Sligo Wetland Survey. Northern part of site on poorly drained mineral soil, southern area on calcareous mineral soil with exposed rock. Site has suffered some damage but species-rich calcareous springs were known to be present south of the road in 2011. Site overlaps with Crockauns/ Keelogboy Bogs NHA, which describes species-rich semi-natural woodland and a rich bryophyte assemblage in the vicinity of Lugnagall. In addition, there are a number (126) of historic bryophyte records (1963) that give 'Lugnagall' as their location. Most of these are species of limestone cliffs and are likely to be from the NW facing cliffs and turf to the SE of Lugnagall Flush. The records include 3 RDB species and 1 RDB and FPO species (*Didymodon maximus*), for which the Dartry mountains are the only European location.
11	Gortnagrelly	G729422	RPS survey 2016, aerial photography, soil maps	RPS survey found tufa mound (Annex I priority habitat Petrifying springs) within woodland at the site and adjacent flushes with the potential to support Petrifying springs/ Annex I habitat Alkaline fen. Woodland 'ravine' has exposed limestone rock and calcareous soil and has the potential to support bryophytes species of interest.
12	S of Collinsford	G718413	RPS survey 2016, aerial photography, soil maps	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation. Soil map shows acidic poorly drained soil but could be localised spring. Moderate potential to support small Annex I priority habitat Petrifying spring/ Annex I habitat Alkaline fen
13	E of Drum	G713409	RPS survey 2016, aerial photography, soil maps	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation. Soil maps shows site partially on alluvial deposits and the area is associated with the start of a small stream. Moderate to high potential to support small Annex I priority habitat Petrifying spring/ Annex I habitat Alkaline fen.
14	W of Castlegal	G718409	RPS survey 2016, aerial photography, soil maps	RPS survey found potential calcareous spring within area of woodland. Woodland has calcareous soil and exposed limestone rock. Moderate to high potential to support Annex I priority habitat Petrifying spring.
16	Leitrim border	G746428	NPWS protected site data, RPS survey 2016, aerial photography	North-facing wooded ravine with stream flowing into Glencar Lough. As the area is on limestone, there is the potential for springs etc. in the ravine. In addition, the ravine may support a bryophyte assemblage of conservation interest. The boundary of the Ben Bulben, Gleniff and Glenade Complex SAC is extended to include this feature.

Figure 11-1: Location of wetland survey sites of potential conservation interest



Numbers refer to site numbers in Table 11.1

11.2.2 Survey

At each site, wetland habitats of potential conservation interest were walked over and the main vascular plant and bryophyte species present were recorded. The focus was on the most abundant species, indicator species and rare/ protected species and therefore the species lists do not necessarily list all flora species present. All wetland sites of interest were classified using *A Guide to Habitats in Ireland* (Fossitt, 2000) and additional habitat specific classification systems as relevant e.g. *Irish Petrifying Spring Communities* (Lyons, 2015).

11.2.3 Assessment of Annex I habitats

Wetland areas of potential conservation interest were assessed for their affinity to two Annex I groundwater fed wetland habitats: Petrifying springs with tufa formation *(Cratoneurion)* (7220) and Alkaline fens (7230) (

Table 11.2).

Table 11.2: Classification of Annex I groundwater fed wetland habitats

Annex I habitat type (*priority)	Habitat type (Fossitt, 2000)	Indicator species
*Petrifying springs with tufa formation *(Cratoneurion)* (7220)	Calcareous springs (FP1)	*Bryum pseudotriquetrum* *Carex panicea* *Cratoneuron filicinum* *Didymodon tophaceus* *Equisetum telmateia* *Eucladium verticillatum* *Festuca rubra*

Annex I habitat type (*priority)	Habitat type (Fossitt, 2000)	Indicator species
		Palustriella commutata *Palustriella falcata* *Pellia endiviifolia*
Alkaline fens (7230)	Rich fen and flush (PF1)	Brown mosses *Bryum pseudotriquetrum* *Calliergon sarmentosum* *Campylium stellatum* *Ctenidium molluscum* *Drepanocladus revolvens* *Fissidens adianthoides* *Palustriella commutata* *Palustriella falcata* *Scorpidium cossonii* *Scorpidium scorpioides* Small-sedge flushes *Carex panicea* *Carex viridula* *Eleocharis quinqueflora* *Juncus bulbosus* *Pinguicula vulgaris* *Schoenus flush* and *Carex rostrata* fen *Anagallis tenella* *Carex dioica* *Carex lasiocarpa* *Carex panicea* *Carex viridula (Carex lepidocarpa)* *Carex rostrata* *Cirsium dissectum* *Molinia caerulea* *Pinguicula vulgaris* *Schoenus nigricans* *Selaginella selaginoides*

The lists of indicator species used to assess the affinity to these Annex I wetland habitats were taken from the 2013 Article 17 report for Petrifying Springs (NPWS, 2013) and *Guidelines for a national survey and conservation assessment of upland vegetation and habitats in Ireland.* Version 2.0. (Perrin et al., 2014) for alkaline fen. In addition, the phD thesis *The Flora and Conservation Status of Petrifying Springs in Ireland* (Lyons, 2015) was used to assess whether the calcareous springs surveyed are examples of the Annex I habitat Petrifying springs.

11.2.4 Ecological evaluation

The ecological importance of wetland sites was assessed using the criteria listed in the *Guidelines for Assessment of Ecological Impacts of National Roads Schemes* (NRA, 2009). These form a standardised method for assessing site ecological importance in Ireland. Site ecological evaluation:

- International ecological importance
- National ecological importance
- County ecological importance
- Local (higher value) ecological importance
- Local (lower value) ecological importance

11.2.5 Constraints

The best time to survey this type of wetland habitat is between May to September and the surveys were undertaken in late May. However, due to poor spring weather, the flowering plant season is late in 2016 and some species may have been missed.

Every effort was made to access all areas of the survey sites. Some areas were not fully accessible (e.g. steep sides of wooded ravines) and it is possible that small wetland features may have been missed. However, it is all wetland feature of significance will have been recorded.

11.2.6 Plant species nomenclature

Plant nomenclature follows that of the *New Flora of the British Isles* 3rd Edition (Stace, 2010), bryophyte nomenclature follows the *Checklist of British and Irish bryophytes* (BBS, 2009).

11.3Results/ Constraints

11.3.1 Site 10 - Lugnagall Flush

This site was surveyed as part of the Sligo Wetland Survey (SWS) (2011) (Appendix A). The site is located to the north and south of the N15 (see map in SWS site report, Appendix A).

In 2011 it was noted that the site has been damaged by infilling and disturbance: '*This formerly extensive area of petrifying springs have been damaged in recent years as a result of infilling and drainage works. Only a few remnants remain on both side of the road and these are mostly damaged. Areas of former fen on the southern side of the road have reverted to wet grassland/improved grassland as a result of the drainage works. An area of approximately 2m by 8m of springs remain on the southern side of the road which are still intact and species rich.'*

The wetland area mapped in 2011 was re-surveyed for this project. This includes the areas to the south and north of the road (Figure 11-2) and, in addition, the survey area was extended to the east. The site appears to have been further damaged (since 2011) by infilling to the south of the road and improvement to the north of the road.

Figure 11-2: Lugnagall Flush Annex I wetland habitats

11.3.1.1 Lugnagall – North of N15

No signs of fen or springs were recorded to the north of the road. There was a small area of marsh, with *Equisetum telmateia,* just north of the hedgerow in the western corner of the NW field (Figure 11-2 and Photo 11.2) and also the NE field (Photo 11.3). Presumably this is where the areas of former springs/ fen were located. However, apart from *Equisetum telmateia*, there were no typical spring or fen indicator species remaining. The main species present were *E. telmateia, Iris pseudacorus, Ranunculus repens* and *Calliergonella cuspidata* (e.g. Photo 11.2). The NW area showed signs of poaching by grazing animals and the NE area was overgrown with long vegetation. It is concluded that calcareous springs and fen have been lost from the northern part of the site.

11.3.1.2 Lugnagall – South of N15

The survey area south of the road had been subject to historic (and recent) infilling (Photo 11.4). A small area of probably former spring/ fen was found in the south-east of the site (Figure 11-2; Photo 11.5). This was not shown on the 2011 survey map. This area appears to be a remnant of the much larger former fen at this site (shown on older aerial photographs and maps) and was probably overlooked in the previous survey. It is bordered by a fence to the south, trees and scrub to the east and west and infilling to the south (Photo 11.6). The vegetation has some affinity to rich fen and flush (PF1). Vascular plant species recorded include: *Anagallis tenella*, Angelica sylvestris, Cardamine pratensis, Carex dioica*, C. flacca, C. lepidocarpa*, C. nigra, Cerastium fontanum, Cirsium palustre, Equisetum telmateia, Filipendula ulmaria, Glyceria fluitans, Juncus articulatus, J. inflexus, Mentha aquatica, Ranunculus acris, R. flammula, R. repens, Rumex obtusifolius* and *Succisa pratensis* and the mosses *Breutelia chrysocoma, Calliergonella cuspidata, Hylocomium splendens* and *Plagiomnium undulatum.* The wetland is being overgrown by scrub and trees such as *Ulex europaeus, Salix cinerea, Betula pubescens* and *Rubus fruticosus.* No tufa formation was seen, or species indicative of calcareous springs.

No 'brown' fen mosses were recorded. However three indicator* species of *Schoenus flush* and *Carex rostrata* fen were recorded and it is likely that the former fen area comprised one of these

communities. The vegetation therefore has some affinity to the **Annex I habitat Alkaline fen**, although it is a degraded remnant of the former fen area and is likely to continue to degrade due to lack of management/ grazing.

In the south-west of the site there is a small remnant area of calcareous springs/ rich fen and flush (Figure 11-2). This was recorded in the 2011 survey although it may have been further reduced in area since then, due to infilling and growth of coarse vegetation. The 2011 survey (Appendix A) shows a photo with open calcareous springs and tufa formation, the vegetation was found to be much more overgrown in the 2016 survey (Photo 11.7). Some tufa formation was found to be still present with bryophytes typical of petrifying springs such as abundant *Palustriella commutata** (Photo 11.8) with *Bryum pseudotriquetrum*, P. falcata** and *Pellia endiviifolia**. The stonewort, *Chara vulgaris*, which is also indicative of calcareous springs, was present in a few locations. Additional species include the vascular plants: *Agrostis stolonifera, Anagallis tenella, Angelica sylvestris, Apium nodiflorum, Carex lepidocarpa, Cardamine pratensis, Carex dioica, C. flacca, C. panicea*, Cirsium palustre, Deschampsia cespitosa, Epilobium hirsutum, Equisetum telmateia** (locally abundant)*, Eriophorum angustifolium, Festuca rubra*, Juncus articulatus, Mentha aquatica, Potentilla erecta, R. repens, Molinia caerulea, Nasturtium officinale, Scrophularia auriculata* and *Succisa pratensis* and the mosses *Breutelia chrysocoma, Calliergonella cuspidata, Hylocomium splendens, Philonotis fontana* and *Plagiomnium undulatum.* The spring vegetation extends into the wet woodland to the north (*Photo 11.9*) and is bordered by woodland to the east and west and recent infilling to the south (Photo 11.10).

A number of species recorded in the 2011 survey were not refound in 2016 (refer to Appendix A). Some of these species may have been missed due to survey timing, but it is likely that some species have been lost due to ongoing infilling activity and lack of management/ grazing leading to vegetation succession and decline in species richness. However, seven species indicative of the **Annex I priority habitat Petrifying springs** were recorded and the vegetation has affinity with the Irish petrifying springs plant community: Group 4 *Palustriella commutata-Agrostis stolonifera* Springheads (Lyons, 2015). Therefore this area is still considered to be an example of this Annex I priority habitat, despite recent degradation.

There are historic bryophyte records from 'Lugnagall' for a number of rare and protected bryophyte species. However, the site does not contain habitat suitable to support these species and the records are likely to be form the adjacent limestone cliffs and slopes.

The Sligo Wetland Survey ranked this site as 'Site rating B' Nationally important but the site has clearly degraded further since 2011. There has been the loss of any calcareous springs/ rich fen on the northern side of the road and a reduction in size and species richness on the southern side of the road. However, as the site overlaps with Crockauns/ Keelogboy Bogs NHA, it is still considered to be of **National ecological importance**.

Photo 11.1: Field in NW of survey area (view to south). Red arrows marks probable location of former spring

Photo 11.2: Former fen/ spring vegetation in NW of site

Photo 11.3: Field in NW of survey area (view to west). Red arrows marks probable location of former spring

Photo 11.4: Infilling of site, to the south of the N15 (view to west)

Photo 11.5: Alkaline fen in SE of site (view to north)

Photo 11.6: Infilling (road) to south of Alkaline fen (view to west). Red arrow marks the Alkaline fen.

Photo 11.7: Calcareous spring vegetation with tall vegetation becoming dominant

Photo 11.8: Petrifying spring vegetation with Palustriella commutata and Equisetum telmateia

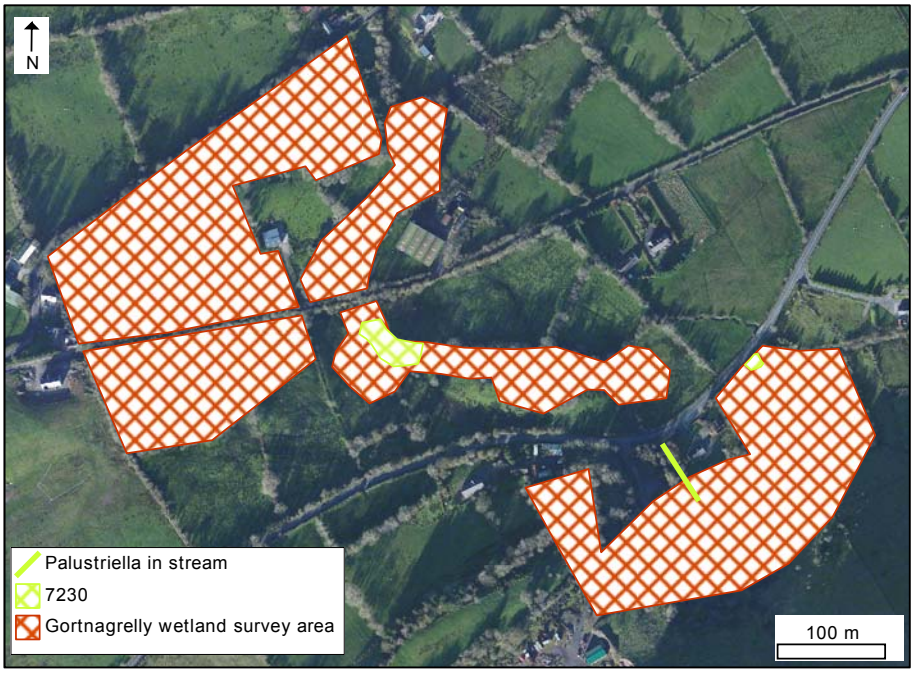
Photo 11.9: Petrifying spring in woodland

Photo 11.10: Recent infilling to the south of the petrifying springs

11.3.2 Site 11 – Gortnagrelly

Two areas of wetland of petrifying springs were recorded, one small area in woodland to the south of the N15 and the main tufa mound and associated springs in the central area. These are shown on Figure 11-3 and described below.

Figure 11-3: Gortnagrelly survey area and Annex I 7230 habitat



11.3.2.1 Gortnagrelly – south of N15

There is a small area of wet Alder woodland south of the N15, in the east of the survey area (Figure 11-3). No tufa formation was seen, however the petrifying spring bryophyte *Palustriella commutata* was very abundant in the woodland ground flora (Photo 11.11 and Photo 11.12). The woodland canopy is dominated by young *Alnus glutinosa.* The ground is very wet with locally deep peat. The ground flora includes *Agrostis stolonifera, Cardamine pratensis, Carex remota, Cirsium palustre, Crepis paludosa, Dryopteris dilatata, Equisetum arvense, Filipendula ulmaria, Iris pseudacorus, Juncus articulatus, Mentha aquatica, Ranunculus flammula* and *R. repens. Palustriella commutata** is the main bryophyte on the woodland floor, with occasional to frequent *Brachythecium rivulare, Calliergonella cuspidata, Conocephalum conicum, Eurhynchium striatum, Hookeria lucens, Kindbergia praelonga, Mnium hornum, Pellia endiviifolia* and *Plagiomnium undulatum.*

Only two species indicative of the **Annex I priority habitat Petrifying springs** were recorded, but *Palustriella commutata* was very abundant. In addition, the vegetation has affinity with the Irish petrifying springs plant community: Group 4 *Palustriella commutata-Agrostis stolonifera* Springheads (Lyons, 2015). Tufa formation in this community was found by Lyons (2015) to be variable, with some samples having either very low or trace tufa cover present. It is currently unclear whether springs dominated by *Palustriella commutata*, but without tufa formation, should be considered to be examples of the **Annex I priority habitat Petrifying springs.** The current recommendation is that these springs should be included as the Annex I priority habitat (Lyons, pers. comm.). Therefore an inclusive approach has been taken here and this area has been mapped as **Annex I priority habitat Petrifying springs.** It is considered to be of **County Ecological Importance.**

Also south of the N15 there is a stream running from north to south, down to the N15 (Figure 11-3), which has occasional patches of *Palustriella commutata* and *Pellia endiviifolia* (Photo 11.13 and Photo 11.14). Other spring species are not present and there is no tufa formation. Although this is clearly a highly calcareous stream, possibly locally spring-fed, it is not considered to be an example of the **Annex I priority habitat Petrifying springs.**

11.3.2.2 Gortnagrelly – central woodland

The woodland strip in the central area of the survey area at Gortnagrelly contains several habitats of conservation interest, forming a habitat complex of ecological importance (Figure 11-4).

In the east of the complex, there is an area of species-rich marsh/ rich fen and flush (Photo 11.15), which was identified in the walk-over survey by RPS. This is dominated by the moss *Calliergonella cuspidata* with the vascular plants *Agrostis stolonifera, Anagallis tenella*, Caltha palustris, Cardamine pratensis, Carex disticha, C. demissa, C. nigra, Cerastium fontanum, Cirsium palustre, Epilobium palustre, Equisetum palustre, Iris pseudacorus, Holcus lanatus, Juncus articulatus, J. effusus, Mentha aquatica, Ranunculus repens* and *Trifolium repens* and additional bryophyte species, *Calliergonella cuspidata, Brachythecium rivulare, Climacium dendroides* and *Conocephalum conicum.* There is locally deep peat and it could be spring-fed, but there is only one fen indicator species and no typical fen bryophytes and this is not considered to be Annex I habitat. However it is part of the overall woodland-wetland complex in this area.

The woodland is located on a slope (west to east), which is steep in some areas (Photo 11.16). This is an example of oak-ash-hazel woodland WN2, the ground flora is species-rich and the woodland appears to be long-established. The river lies at the base of the slope, to the east, and in places has large banks with typical woodland flora. In the west of the woodland there is a seepage area of calcareous springs. There are three main calcareous spring areas here which are described below and marked both as individual springs and a seepage/ spring area on Figure 11-4.

The easternmost calcareous spring is a tufa cascade that runs from the top of the woodland down to the river below (Photo 11.17). There is extensive tufa formation (e.g. Photo 11.18), forming small ledges in the 'cascade'. The spring is dominated by *Palustriella commutata* with occasional woodland plants and *Conocephalum conicum, Equisetum telmateia, Mentha aquatica* and *Ranunculus repens.* This petrifying spring is an example of the **Annex I priority habitat Petrifying springs** and has strong affinity with the Irish petrifying springs plant community: *Group 2 Palustriella commutata-Geranium robertianum* Springheads (Lyons, 2015). These typically form large mounds or tufa cascades of *Palustriella commutata* in woodland on moderately steep slopes and are strongly tufa-forming (Lyons, 2015).

Just west of this (Figure 11-4) there is an open area within the woodland where the hillside has eroded with frequent petrifying springs at the edge of the remaining vegetation (Photo 11.20). The main species present are *Palustriella commutata, P. falcata* and *Equisetum telmateia,* with occasional *Carex lepidocarpa, C. panicea,* and *Juncus articulatus.* These are tufa-forming (Photo 11.21) and have affinity with the Irish petrifying springs plant community: Group 4 *Palustriella commutata-Agrostis stolonifera* Springheads (Lyons, 2015). They represent an unwooded equivalent of the Group 2 plant community to the east (and west). The areas of tufa are smaller (and probably more recent) than those within the woodland but are examples of the **Annex I priority habitat Petrifying springs.**

To the west of these springs is the main tufa mound within the woodland (Figure 11-4 and Photo 11.22). Again this is dominated by *Palustriella commutata* with the bryophytes *Aneura pinguis, Ctenidium molluscum, Palustriella falcata, Pellia endiviifolia, Plagiochila porelloides* and *Rhytidiadelphus triquetrus.* Vascular plant species include *Brachypodium sylvaticum, Fraxinus* excelsior seedling, *Ilex aquifolium, Lonicera periclymenum, Primula vulgaris* and *Taraxacum officinale.* Below the main mound there is a calcareous spring (with tufa formation) with additional species *Equisetum telmateia, Filipendula ulmaria* and the non-native *Petasites hybridus* (Photo 11.23). As with the eastern spring, this petrifying spring is an example of the **Annex I priority habitat**

Petrifying springs and has strong affinity with the Irish petrifying springs plant community: *Group 2 Palustriella commutata-Geranium robertianum* Springheads (Lyons, 2015).

Above this calcareous spring/ seepage area in the woodland (to the south-west) is another area of marsh. This is dominated by *Calliergonella cuspidata* with wet grassland vegetation (Photo 11.24) and does not appear to be influenced by calcareous groundwater.

The Gortnagrelly wetland-woodland complex is of high ecological value as it supports good examples of the **Annex I priority habitat Petrifying springs** within a mosaic of species-rich semi-natural woodland, river and marsh vegetation. It is therefore ranked as being of **National Ecological Importance**.

Figure 11-4: Gortnagrelly woodland area of ecological importance and location of Annex I priority habitat 7230

Photo 11.11: Wet woodland with abundant Palustriella commutata

Photo 11.12: Palustriella commutata *abundant on woodland floor*

Photo 11.13: Stream with occasional patches of Palustriella commutata

Photo 11.14: Palustriella commutata *at edge of stream, possibly spring-fed*

Photo 11.15: Species-rich marsh on eastern edge of woodland

Photo 11.16: Oak-ash-hazel woodland on steep slope with river on eastern edge

Photo 11.17: Eastern tufa cascade dominated by Palustriella commutata

Photo 11.18: Palustriella commutata *with tufa deposits*

Photo 11.19: Lower slopes of tufa cascade merge with river below

Photo 11.20: Petrifying springs on eroded bank

Photo 11.21: Tufa formation in petrifying springs on eroded bank

Photo 11.22: Main tufa mound within woodland

Photo 11.23: Petrifying spring vegetation below main tufa mound

Photo 11.24: Marsh above calcareous spring area in woodland

11.3.3 Site 12 - S of Collinsford

This is a small wetland area in a wet grassland field (Figure 11-5). It appears to be a springhead at the start of a small stream which flows downhill to the west. The peat is locally deep and unstable. The main wetland area comprises species-rich rich fen and flush vegetation (Photo 11.25). This does not have many species indicative of highly calcareous water and it may be that either the spring is not highly calcareous, or there is an influence of nutrient rich surface water from the surrounding grazed grassland. Typical species include abundant *Calliergonella cuspidata, Carex nigra* and *Equisetum palustre* with *Agrostis stolonifera, Brachythecium rivulare, Bryum pseudotriquetrum, Cardamine pratensis, Cerastium fontanum, Cirsium palustre, Cratoneuron filicinum, Dactylorhiza fuchsii, Epilobium palustre, Festuca rubra, Ficaria verna, Iris pseudacorus, Juncus articulatus, Mentha aquatica, Plagiomnium rostratum, P. elatum, P. undulatum, Ranunculus flammula, R. repens, Silene flos-cuculi, Taraxacum officinale* and *Trifolium repens.* There is only one species indicative of alkaline fen. However, in the west of the flush, adjacent to the small area of wet woodland, there was a small area with tufa deposits on the bryophyte *Calliergonella cuspidata* (Photo 11.26). This is not a species typically associated with tufa formation. This vegetation has some affinity to Irish petrifying springs plant community: Group 6 *Carex lepidocarpa* Small Sedge Springs (Lyons, 2015), but no *Palustriella commutata* or *Carex lepidocarpa* were recorded.

The stream flows downhill through a small area of wet willow-alder-ash woodland (WN6) with some mature *Salix cinerea* trees (Photo 11.27). There are more species typical of petrifying springs here (Photo 11.28) with frequent *Palustriella commutata** and *Aneura pinguis, Chrysosplenium oppositifolium, Conocephalum conicum, Dichodontium pellucidum* agg., *Equisetum telmateia**, *Eurhynchium striatum, Juncus articulatus, Jungermannia atrovirens, Mentha aquatica, Pohlia melanodon* and *Ranunculus acris.* Tufa formation is low with occasional patches. This has a slight

affinity with the Irish petrifying springs plant community: *Group 2 Palustriella commutata-Geranium robertianum* Springheads (Lyons, 2015).

As the flush vegetation has some affinity to the **Annex I priority habitat Petrifying springs** and is associated with a small area of mature wet woodland, the site is considered to be of **County Ecological Importance.**

Figure 11-5: Wetland site 12 showing location of small springs

Photo 11.25: Rich fen and flush vegetation showing flushed peat (looking west)

Photo 11.26: Tufa formation on the bryophyte Calliergonella cuspidata

Photo 11.27: Wet willow woodland with petrifying spring/ stream

Photo 11.28: Small area of petrifying spring/ stream in the wet woodland

11.3.4 Site 13 - E of Drum

Site 13 comprises an area of rich fen and flush within a field of wet grassland (Figure 11-6, Photo 11.29). The vegetation is dominated by *Carex nigra* and *Calliergonella cuspidata* (Photo 11.30) with *Agrostis stolonifera, Anthoxanthum odoratum, Cardamine pratensis, Carex flacca, Carex viridula* agg.*, *C. panicea*, Cerastium fontanum, Cirsium palustre, Deschampsia cespitosa, Epilobium hirsutum, Equisetum palustre, Eriophorum angustifolium, Filipendula ulmaria, Galium palustre, Holcus lanatus, Iris pseudacorus, Juncus effusus, J. articulatus, Lotus pedunculatus, Mentha aquatica, Plagiomnium elatum, Ranunculus flammula, R. repens, Rhytidiadelphus squarrosus, Silene flos-cuculi* and *Trifolium repens.* Only two indicator species of **alkaline fen** were recorded and no 'brown mosses'. However the calcareous spring bryophyte *Philonotis calcarea* was locally abundant in depressions (Photo 11.31). The vegetation therefore has a slight affinity to the **Annex I habitat alkaline fen** but is not considered to be a good example. Given this, the site is considered to be of **Local (higher value) ecological importance**.

Figure 11-6: Location of wetland area at site 13

Photo 11.29: Rich fen and flush vegetation at site 13

Photo 11.30: Calliergonella cuspidata *locally dominant in marsh/ rich fen and flush vegetation*

Photo 11.31: Locally abundant Philonotis calcarea

11.3.5 Site 14 - W of Castlegal

Site 14 is a woodland on a southern facing slope, adjacent to the N15 (Figure 11-7). The lower slopes of the woodland are flushed and peaty and *Alnus glutinosa* is frequent (Photo 11.32). Three petrifying springs were recorded on the lower slopes of the woodland. The easternmost spring (spring 1) had very visible tufa formation, both on the woodland floor (Photo 11.33) and on the moss *Palustriella commutata* (Photo 11.34). The central spring, spring 2 (Photo 11.35) was more vegetated, with typical wet woodland species and was also located on the lower slopes of the woodland. Spring 3, in the west, was on flatter ground (Photo 11.36) and was more diffuse, but tufa formation on *Palustriella commutata* was still obvious (Photo 11.37).

Typical species within the springs include *Palustriella commutata** with *Agrostis stolonifera, Ajuga reptans, Calliergonella cuspidata, Carex flacca, Cirsium palustre, Crepis paludosa, Equisetum palustre, E. telmateia*, Filipendula ulmaria, Fissidens adianthoides, Geum urbanum iris pseudacorus, Juncus effusus, Lophocolea bidentata, Mentha aquatica, Palustriella falcata*, Plagiomnium undulatum* and *Ranunculus repens.* Three indicator species for **Annex I priority habitat Petrifying springs** were recorded and the spring vegetation has affinity to the Irish petrifying springs plant community: *Group 2 Palustriella commutata-Geranium robertianum* Springheads (Lyons, 2015). They are therefore considered to be small examples of the **Annex I priority habitat Petrifying springs** and the site is ranked as being of **County Ecological Importance**.

Figure 11-7: Location of petrifying springs at site 14

Photo 11.32: Woodland at site 14

Photo 11.33: Tufa formation at petrifying spring 1

Photo 11.34: Palustriella commutata *and tufa formation in petrifying spring 1*

Photo 11.35: Petrifying spring 2

Photo 11.36: Petrifying spring 3

Photo 11.37: Palustriella commutata *and tufa formation in petrifying spring 3*

11.3.6 Site 16 - Leitrim border

This site has a north-facing wooded ravine with exposed limestone. The woodland is oak-ash-hazel woodland and appears to be long-established with a species-rich ground flora. The site has the potential to support calcareous springs, but none were recorded during the survey. The lower area was difficult to access due to a series of steep waterfalls flowing down to Glencar Lough. The ravine has the potential to support bryophyte species of interest; none were recorded during the survey but the aim of the survey was to assess the habitat and not to produce a detailed species list. The lower area and waterfalls should be surveyed in detail if any direct impacts are considered likely in this area. The woodland is relatively species-rich including the trees and shrubs *Fraxinus excelsior, Crataegus monogyna, Corylus avellana, Fagus sylvatica* and *Ilex aquifolium;* flowering plants *Allium ursinum, Anemone nemorosa, Arum maculatum, Asplenium scolopendrium, Carex sylvatica, Ficaria verna, Hedera helix, Hyacinthoides non-scripta, Oxalis acetosella, Polypodium vulgare, Polystichum setiferum, Primula vulgaris* and *Urtica dioica*; bryophytes *Conocephalum conicum, Ctenidium molluscum, Dicranum scoparium, Didymodon insulanus, Eurhynchium striatum, Frullania dilatata,*

F. tamarisci, Hypnum cupressiforme, Isothecium alopecuroides, I. myosuroides, Lunularia cruciata, Neckera complanata Pellia endiviifolia, Radula complanata, Plagiochila porelloides, Plagiomnium undulatum, Polytrichum formosum, Rhytidiadelphus triquetrus, Thamnobryum alopecurum, Ulota crispa agg. and the lichen *Lobaria pulmonaria.*

Photo 11.38: Species-rich woodland in ravine

Photo 11.39: Hazel with abundant bryophyte epiphytes

11.4Summary of ecological evaluation

The ecological evaluation of the surveyed wetland sites is shown in Table 11.3.

Table 11.3: Summary of ecological evaluation

Site no.	Site name	Annex I habitats	Ecological evaluation
10	Lugnagall Flush – south of road	Small remnants of alkaline fen and petrifying springs	National Ecological Importance as supports two Annex I habitats and overlaps with Crockauns/ Keelogboy Bogs NHA
11	Gortnagrelly – southern wet woodland	Small area of wet woodland with affinity petrifying spring vegetation	Small area of springs with no/ little tufa formation. County Ecological Importance
11	Gortnagrelly – central woodland area	Three areas of calcareous springs and significant tufa formation	National Ecological Importance as supports good examples of Annex I priority habitat within a mosaic of species-rich semi-natural woodland, river and marsh vegetation.
12	S of Collinsford	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.
13	E of Drum	Rich fen and flush vegetation with some affinity to alkaline fen	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.
14	W of Castlegal	Three petrifying springs 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.

Site no.	Site name	Annex I habitats	Ecological evaluation
16	Leitrim border	No wetland Annex I habitats recorded	North-facing wooded ravine with species-rich woodland vegetation and potential to support rare/ protected bryophyte species, particularly in area of waterfalls. Part of the Ben Bulben, Gleniff and Glenade Complex SAC and therefore of International Ecological Importance.

11.5References

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12 Flora, Fauna and Fisheries: Appendix 4 - Natural Heritage Objectives and Policies contained within the Sligo County Development Plan 2011-2017 and the Sligo and Environs Development Plan 2010-2016

Full text is available as follows:

County Plan: http://www.sligococo.ie/Publications/PlanningPublications/1SligoCDP2011-2017/

Sligo and Environs Plan: http://www.sligococo.ie/sedp/

12.1 Sligo County Development Plan 2011-2017

Natural heritage - general policies

P-NH-1	Protect, sustainably manage and enhance the natural heritage, biodiversity, geological heritage, landscape and environment of County Sligo in recognition of its importance for nature conservation and biodiversity, and as a non-renewable resource, in association with all stakeholders.
P-NH-2	Ensure as far as possible that development does not impact adversely on wildlife habitats and species. In the interest of sustainability, biodiversity should be conserved for the benefits of future generations.
P-NH-3	To promote increased understanding and awareness of the natural heritage and biodiversity of the county.
P-NH-4	Protect and, where possible, enhance the plant and animal species and their habitats that have been identified under the EU Habitats Directive, EU Birds Directive, the Wildlife Act and the Flora Protection Order.
P-NH-5	The polluter pays and the precautionary principles are integral components of planning policies that deal with environmental and heritage matters. Where uncertainty exists regarding the potential impact of a proposed development on the natural heritage resource, full account shall be taken of the precautionary principle.

European and national designated natural heritage sites - objectives

O-NH-1	Protect and maintain the favourable conservation status and conservation value of all natural heritage sites designated or proposed for designation in accordance with European and national legislation and in other relevant international conventions, agreements and processes. This includes sites designated or proposed as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Natural Heritage Areas (NHAs), Ramsar Sites and Statutory Nature Reserves.
O-NH-1a	Promote the maintenance and, as appropriate, the achievement of favourable conservation status of protected habitats and species in association with the NPWS.
O-NH-2	Assess, in accordance with the relevant legislation, all proposed developments which are likely to have a significant effect (directly or through indirect or cumulative impact) on designated natural heritage sites, sites proposed for designation and protected species.
O-NH-3	When considering any plan or project prepared or assessed on the basis of this development plan, the planning authority must comply fully with Article 6 of the EU Habitats Directive (as transposed into Irish Law by the EU Habitats Regulations 1997 and subsequent amendments) and assess whether the plan or project is likely to have a significant impact upon the

	integrity, conservation objectives and qualifying interests of any Natura 2000 site.
O-NH-4	Consult with the relevant prescribed bodies and appropriate agencies when considering undertaking, approving or authorising developments which are likely to affect designated natural heritage sites or those proposed to be designated.
O-NH-5	Establish and maintain an up-to-date planning register of all previously adopted and proposed plans/programmes and all granted and proposed developments which are likely to have a significant effect (directly or through indirect, cumulative or incombination effect) on European Sites within or adjoining the county, to allow for the appropriate assessment of potential ex-situ and cumulative/in combination effects of proposed plans, programmes and projects on such sites.
O-NH-5a	An appropriate assessment screening determination shall be made for all land use plans, related variations and projects in consultation with the National Parks and Wildlife Service of the Department of Environment, Heritage and Local Government.
O-NH-6	Support and co-operate with statutory authorities and others in support of measures taken to manage designated nature conservation sites in order to achieve their conservation objectives. Specific regard shall be had to Conservation Management Plans and their conservation objectives/management practices, where they exist.
O-NH-7	Promote development for recreational and educational purposes that would not conflict with maintaining favourable conservation status and the meeting of the conservation objectives for designated sites.

Nature conservation outside designated sites - policies

P-NH-6	Minimise the impact of new development on habitats of natural value that are key features of the County's ecological network. Developments likely to have an adverse effect on recognised sites of local nature conservation importance will be required to demonstrate the impacts on the ecological value of the site and will not be approved unless it can be clearly demonstrated that there are reasons for the development that outweigh the need to safeguard the nature conservation value of the site.
P-NH-7	Ensure that development proposals, where relevant, improve the ecological coherence of the Natura 2000 network and encourage the management of landscape features that are of major importance for wild fauna and flora as per Article 10 of the Habitats Directive.
P-NH-8	Ensure that proposals for development protect and enhance biodiversity, wherever possible, by minimising adverse impacts on existing habitats and by including mitigation and/or compensation measures, as appropriate, which ensure that biodiversity is enhanced.
P-NH-9	Apply the precautionary principle in relation to development proposals with potential to impact on County Biodiversity Sites or on local nature conservation interest by requiring an ecological impact assessment to ensure that any proposed development will not affect the integrity and conservation value of the site.
P-NH-10	Ensure that no ecological networks, or parts thereof which provide significant connectivity between areas of local biodiversity, are lost without remediation as a result of implementation of this Plan.

Woodlands, trees and hedgerows policies

P-NH-11	Protect trees and hedgerows from development that would impact adversely upon them, and promote the enhancement of existing hedgerows by seeking increased coverage, in conjunction with new development.
P-NH-12	Protect woodlands and hedgerows from damage and/or degradation and work to prevent the disruption of the connectivity of the woodlands and hedgerows of the county.
P-NH-13	Protect and manage existing woodlands, trees and hedgerows which are of amenity or biodiversity value and/or contribute to landscape character, and ensure that proper provision is made for their protection and management when undertaking, approving or authorising development.
P-NH-14	Ensure that, when undertaking, approving or authorising development, sufficient information is provided to enable an assessment of impacts on woodlands, trees and hedgerows.
P-NH-15	Encourage development proposals that enhance the landscape through positive management and additional planting/sensitive replanting of native tree species.
P-NH-16	Ensure, where required, that applications for development include proposals for planting and/or leave a suitable ecological buffer zone between the development works and areas/features of ecological importance.

P-NH-17	Recognise the biodiversity and archaeological importance of townland boundaries, including hedgerows, and promote their protection and retention.
P-NH-18	Encourage the development of proposals for new woodlands utilising funding available through schemes such as the NeighbourWood and Native Woodland Schemes.

Woodlands, trees and hedgerows objectives

O-NH-14	Undertake a study to document and map significant mature trees within the County area within the lifetime of the plan.
O-NH-15	Make Tree Preservation Orders (TPOs) as required in order to ensure the protection of important trees in urban and rural areas that contribute to public amenity, particularly indigenous trees and trees under threat.
O-NH-16	Preserve and conserve trees or groups of trees identified in the Tree Preservation Order (TPO) at Mullaghmore.

Inland waters policies

P-NH-19	Protect rivers, streams and other water courses and their associated Core Riparian Zones (CRZs) wherever possible and maintain them in an open state, capable of providing suitable habitats for fauna and flora.
P-NH-20	Protect and enhance the natural heritage and landscape character of river and stream corridors and valleys, maintain them free from inappropriate development and make provision for public access where feasible and appropriate.
P-NH-21	Protect and enhance biodiversity richness by protecting rivers, stream corridors and valleys by reserving land along their banks for ecological corridors, maintaining them free from inappropriate development and discouraging culverting or realignment.
P-NH-22	Ensure that all proposed greenfield residential and commercial developments use sustainable drainage systems (SUDS) in accordance with best current practice, ensuring protection of the integrity of wetland sites in the adjoining area, including their hydrological regime.
P-NH-23	Ensure that floodplains and wetlands within the Plan area are retained for their biodiversity and flood protection value.
P-NH-24	Ensure that proposed developments do not adversely affect groundwater resources and groundwater-dependent habitats and species.
P-NH-25	Work with landowners, local communities and other relevant groups to protect and manage inland waters, river corridors and their floodplains from degradation and damage, and to recognise and promote them as natural assets of the urban/rural environment.
P-NH-26	Have regard to the County Sligo Wetlands Surveys 2008 and 2009 and subsequent wetland surveys that may be published during the lifetime of this Plan.

Inland waters objectives

O-NH-17	Consult with prescribed bodies prior to undertaking, approving or authorising any works or development that may impact on rivers, streams and watercourses.
O-NH-18	Require that runoff from a developed area does not result in deterioration of downstream watercourses or habitats, and that pollution generated by a development is treated within the development area prior to discharge to local watercourses.
O-NH-19	Ensure that an appropriate ecological assessment is undertaken for developments with the potential to impact on inland waters.

Protected species policies

P-NH-27	Protect plant species and their associated habitats listed in the Flora (Protection) Order 1999.
P-NH-28	Protect species and their associated habitats that require strict protection under the Habitats Regulations (S.I. No. 477/2011 - EC (Birds and Natural Habitats) Regulations 2011).
P-NH-29	Protect animal and bird species and their associated habitats protected under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

P-NH-30	Ensure that development does not have a significant adverse impact, incapable of satisfactory mitigation, on plant, animal or bird species protected by law.

Protected species objectives

O-NH-20	Consult with the National Parks and Wildlife Service (DoEHLG) and take account of any licensing requirements when undertaking, approving and authorising development which is likely to affect plant, animal or bird species protected by law.
O-NH-21	Provide guidance to developers and others in relation to species protected by law and their protection and management in the context of development.
O-NH-22	Undertake surveys, as appropriate, to establish the location of protected flora and fauna in the Plan area through the County Heritage Plan and the County Biodiversity Action Plan.

Invasive species policies

P-NH-31	Prevent the spread of invasive species within the Plan area, including requiring landowners and developers to adhere to best practice guidance in relation to the control of invasive species.
P-NH-32	Seek the control and/or eradication of invasive species, as appropriate, within the Plan area, as opportunities and resources allow. Targeted invasive species control should be informed by current distribution of species, degree of threat posed and resources available to control and/or eradicate them.
P-NH-33	Promote public awareness and engagement with regard to invasive species through awareness campaigns and the provision of targeted information on the role of the general public in the control of invasive species.

Invasive species objective

O-NH-23	Undertake a study through the County Heritage Plan and County Biodiversity Plan to quantify the extent of invasive species within the Plan area, with recommendations of priority species for control and /or eradication, the degree of threat posed and the resources required for effective management.

12.2Sligo and Environs Development Plan 2010-2016

Designated natural heritage sites policies

It is the policy of Sligo Borough and County Councils to:

P-NH-1 Protect natural heritage sites designated in European and national legislation and in other relevant international conventions, agreements and processes. This includes sites designated or proposed as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Ramsar sites and Natural Heritage Areas (NHAs).

P-NH-2 Maintain, and where possible enhance, the conservation value of cSACs (candidate SACs) and SPAs and any other sites that may be proposed for designation during the lifetime of this plan.

P-NH-3 Consult with the relevant prescribed bodies and appropriate agencies when considering undertaking, approving or authorizing developments which are likely to affect designated natural heritage sites or those proposed to be designated.

P-NH-4 Support and co-operate with statutory authorities and others in support of measures taken to manage designated nature conservation sites in order to achieve their conservation objectives.

P-NH-5 Promote areas for appropriate development, primarily for recreational and educational purposes, that would not conflict with maintaining favourable conservation status and the meeting of the conservation objectives for these sites.

Designated natural heritage sites objectives

It is an objective of Sligo Borough and County Councils to:

O-NH-1 Require an appropriate environmental assessment in respect of any proposed development likely to have an impact on a designated natural heritage site or those sites proposed to be designated.

O-NH-2 Ensure that environmental assessments in relation to designated natural heritage sites (or those sites proposed to be designated) are carried out by appropriate professionals.

O-NH-3 Provide guidance to developers in relation to proposed developments which are likely to affect designated natural heritage sites or those sites proposed to be designated.

O-NH-4 Any plan or project not directly connected with or necessary to the management of a Natura 2000 site, but likely to have significant effect thereon, either individually or in combination with other plans or projects, shall be subject to an appropriate assessment in accordance with Art. 6 of Directive 92/43/EEC, of its implications for the Natura 2000 site in view of the site's conservation objectives.

Protected species policies

It is the policy of Sligo Borough and County Councils to:

P-NH-6 Ensure that development does not have a significant adverse impact, incapable of satisfactory mitigation, on plant, animal or bird species protected by law.

P-NH-7 Consult with the National Parks and Wildlife Service, and take account of any licensing requirements, when undertaking, approving and authorising development which is likely to affect plant, animal or bird species protected by law.

Protected species objectives

It is an objective of Sligo Borough and County Councils to:

O-NH-5 Provide guidance to developers and others in relation to species protected by law and their protection and management in the context of development.

O-NH-6 Undertake surveys, as appropriate, to establish the location of protected flora and fauna in the Plan area.

Objectives for nature conservation outside designated sites

It is an objective of Sligo Borough and County Councils to:

O-NH-7 Provide guidance for developers and the general public in relation to the conservation and enhancement of biodiversity and geological heritage.

O-NH-8 Identify and protect, in co-operation with the relevant statutory agencies and other relevant groups, sites of local biodiversity importance, not otherwise protected by legislation.

O-NH-9 Encourage the development of proposals for new woodlands utilising funding available through schemes such as the NeighbourWood and Native Woodland Schemes.

O-NH-10 Undertake a study to document and map significant mature trees and hedgerows within the plan area within the lifetime of the plan.

O-NH-11 Undertake a study to quantify the extent of invasive species with the Plan area, with recommendations of priority species for control and /or eradication, the degree of threat posed and the resources required for effective management.

Policies for nature conservation outside designated sites

It is the policy of the local authorities to:

P-NH-8 Ensure that proposals for development protect and enhance biodiversity, wherever possible, by minimising adverse impacts on existing habitats and by including mitigation and/or compensation measures, as appropriate, which ensure that biodiversity and landscape character are enhanced.

P-NH-9 Protect and conserve ecological networks and prevent loss and fragmentation of ecological corridors where possible.

P-NH-10 Protect and manage existing woodlands, trees and hedgerows which are of amenity or biodiversity value and/or contribute to landscape character, and ensure that proper provision is made for their protection and management when undertaking, approving or authorising development.

P-NH-11 Ensure that, when undertaking, approving or authorising development, sufficient information is provided to enable an assessment of impacts on woodlands, trees and hedgerows.

P-NH-12 Integrate biodiversity considerations into Local Authority plans, programmes and activities.

P-NH-13 Recognise the biodiversity and archaeological importance of townland boundaries, including hedgerows, and promote their protection and retention.

P-NH-14 Seek the control and/or eradication of invasive species as appropriate within the Plan area as opportunities and resources allow. Targeted invasive species control should be informed by current distribution of species, degree of threat posed and resources available to control and/or eradicate them.

Inland waters objectives

It is an objective of Sligo Borough and County Councils to:

O-NH-12 Consult with prescribed bodies prior to undertaking, approving or authorising any works or development that may impact on rivers, streams and watercourses.

O-NH-13 Require that runoff from a developed area does not result in deterioration of downstream watercourses or habitats, and that pollution generated by a development is treated within the development area prior to discharge to local watercourses.

Inland waters policies

It is the policy of Sligo Borough and County Councils to:

P-NH-15 Protect rivers, streams and other water courses and, wherever possible, maintain them in an open state capable of providing suitable habitat for fauna and flora.

P-NH-16 Protect and enhance the natural heritage and landscape character of river and stream corridors and valleys, maintain them free from inappropriate development and make provision for public access where feasible and appropriate.

P-NH-17 Protect and enhance biodiversity richness by protecting rivers and stream corridors and valleys by reserving land along their banks for ecological corridors, maintaining them free from inappropriate development, and discouraging culverting or realignment.

P-NH-18 Ensure that all proposed greenfield residential and commercial developments use sustainable drainage systems in accordance with best current practice.

P-NH-19 Ensure that floodplains and wetlands within the Plan area are retained for their biodiversity and flood protection value.

P-NH-20 Ensure that proposed developments do not adversely affect groundwater resources.

Natural heritage - general policies	
It is the policy of Sligo Borough and County Councils to:	
P-H-21 Require any plans or projects arising from this plan – which are susceptible of having a significant adverse effect on Natura 2000 sites (as per Art. 6 of the Habitats Directive) due to their size or scale, land take, proximity, resource requirements, emissions (disposal to land, water or air), transportation requirements, duration of construction, operation, decommissioning or from any other effects – to comply with the provisions of the Directive.	**P-H-23** Ensure that the findings of habitat mapping projects (when completed) are utilised to inform the development management process.
P-H-22 Subsequent plan-making and adoption of plans arising from this plan shall be screened for the need to undertake Appropriate Assessment under Article 6 of the Habitats Directive.	**P-H-24** Ensure that no ecological networks, or parts thereof which provide significant connectivity between areas of local biodiversity, are lost without remediation as a result of implementation of the Plan.
	Landscape
	P-H-25 Require an appropriate visual impact assessment to be prepared for any proposed development that has potential to cause significant adverse impact on the landscape character in the Plan area and adjoining lands, using agreed and appropriate viewing points and methods.

13 Flora, Fauna and Fisheries: Appendix 5 – Constraints Study Report

Constraints Study – Natural Environment Chapter
N16: Sligo City - County Boundary

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July 2015

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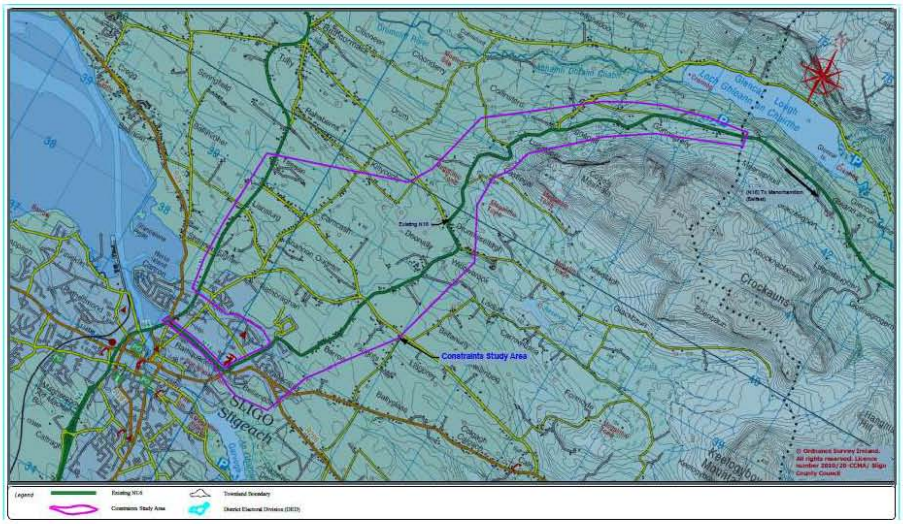
1 Scope and Context

This natural environment chapter of the constraints study for the proposed rerouting of the N16 from Sligo City to the county boundary is produced in line with 'Guidelines for Assessment of Ecological Impacts of National Roads Schemes' NRA (2009). The study highlights important features of the natural environment in the area, gained from desk studies or initial walkovers, including designated areas, habitats and species. It also highlights particular areas where further examination will be required at a later stage, either in order to determine the presence of ecological features in specific locations or areas where choices of approach have the potential to impact on ecological features.

The Constraints Study Area is shown in Figure 1 below.

Figure 1 – Constraints Study Area



2 Methodology

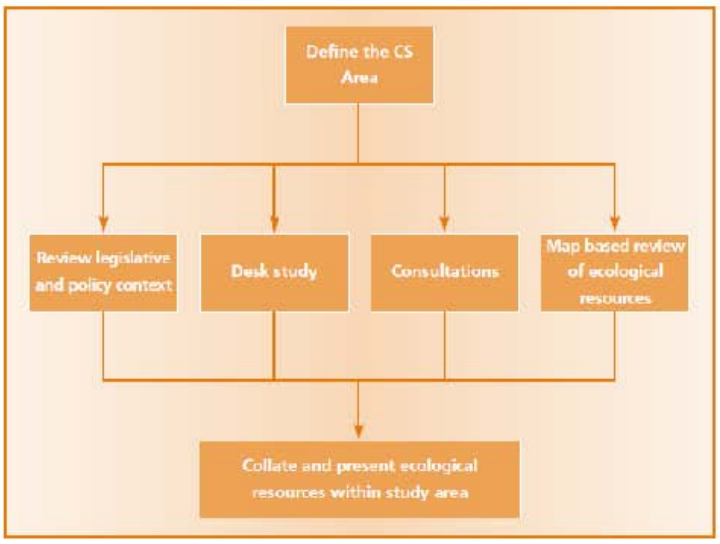
The approach to the natural heritage chapter of the Constraints Study was a combination of desk study and site walkover relating to a defined Constraints Study Area (and incorporating designated areas that may be remote from the Constraints Study Area but potentially affected by any proposal within it). The desk study included searches of on-line databases and consultation with appropriate agencies (Inland Fisheries Ireland and National Parks and Wildlife Service). The site walkover was undertaken from existing roads and public access and was intended to ground-truth, as far as possible, information obtained from desk studies, including examination of ortho-photographs.

Sources of information included:

- Direct consultation with Inland Fisheries Ireland
- Direct consultation with National Parks and Wildlife Service
- Interrogation of NPWS map viewer and species database
- Interrogation of National Biodiversity Data Centre database – using a 2km reporting facility to show all recorded species within the area

The general approach to the Constraints Study is consistent with the recommended approach in 'Guidelines for Assessment of Ecological Impacts of National Roads Schemes' NRA (2009) as shown in figure 2 below.

Figure 2 – Recommended Constraints Study procedure (NRA, 2009)



3 Description of area

The general area is composed largely of farmed land with scattered dwellings, and some small areas of semi-natural habitat, principally woodland and scrub.

Immediately north of Sligo City, the Constraints Study Area (henceforth referred to as "the study area") is situated within undulating lowlands (ca. 50m above sea level), while further north and east it extends onto the higher ground of Cope's Mountain (90-100m).

Much of the farmed land in the study area is composed of improved and semi-improved agricultural pasture. Originally re-seeded, some of these fields are beginning to revert to marshy grassland, often indicated by increasing quantities of soft-rush. There is a continuous network of intact field boundaries, mostly hedgerows composed of mixtures of hawthorn, ash, holly, hazel, alder and willow, but with a substantial number of mature and semi-mature trees.

A number of small copses are scattered through the study area, predominantly composed of semi-mature ash. In the northeastern section of the study area there are several small areas of mixed woodland, composed of birch, ash, alder and other species, and also groups of mature ash and sycamore, most notably to the east, as well as some coniferous shelterbelts. In the southwestern section, there are some small areas of mature woodland, particularly associated with the Doonally-Rathbraghan stream. Among the largest of these is a strip of beech woodland at G 712383. In this part of the study area, mature trees are relatively abundant and many of the boundaries are composed of treelines rather than hedges.

The area is traversed by a number of watercourses. The northeastern part of the study area is crossed by several tributaries of the Drumcliff River, which arise on Cope's Mountain. Some of these are very small, and are usually bordered by woodland and scrub.

The southern part of the study area, comprising undulating lowland, is drained principally by the Doonally-Rathbraghan stream complex, which arises on Keelogyboy Mountain (several tributaries) and enters the sea at Cartron (G 690373). The extreme west of the study area is drained by the Magheragillerneeve (Springfield) stream system, which arises near Teesan (G 701393), and drains into Sligo Harbour at Cregg (G 665392). Further north is the Tully stream, which arises on Copes Mountain and crosses the study area, subsequently flowing through Rathcormack westwards into Drumcliff Bay. Copper River, a stream which arises at Hazelwood very close to the Garvoge River, flows through / adjacent to the extreme southern part of the area.

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Figure 3: Typical habitat within the Constraints Study Area: top - northeast area; bottom – southwest area

4 Ecological Constraints

The sections below set out the main ecological constraints and considerations relating to the study area.

4.1 Designated areas

4.1.1 European Designated Areas (Natura 2000 sites)

Five Natura 2000 sites lie within or immediately adjacent to the study area:

- Benbulben, Gleniff and Glenade Complex Special Area of Conservation (SAC)
- Lough Gill SAC
- Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC
- Sligo / Leitrim Uplands Special Protection Area (SPA)
- Cummeen Strand SPA

A sixth Natura 2000 site, Drumcliff Bay SPA, lies approximately 2.5km distant from the study area, at the mouth of the Drumcliff River. As this river drains the surrounding area, Drumcliff Bay SPA has the potential to be influenced by subsequent works which may be carried out within the study area, i.e. it lies within the zone of influence.

The designated interest of each of these sites is summarised in the table in Appendix 1.

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Figure 4 Special Areas of Conservation (SACs) in the vicinity of the N16 Constraints Study Area

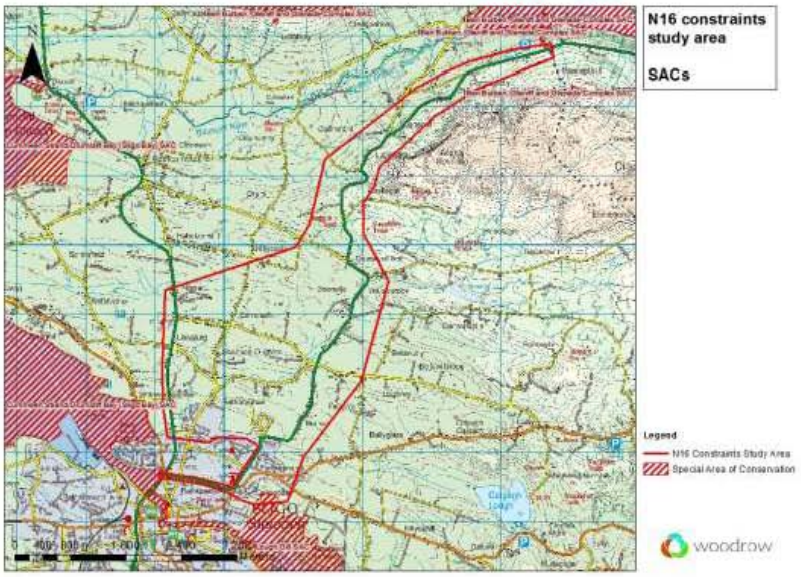
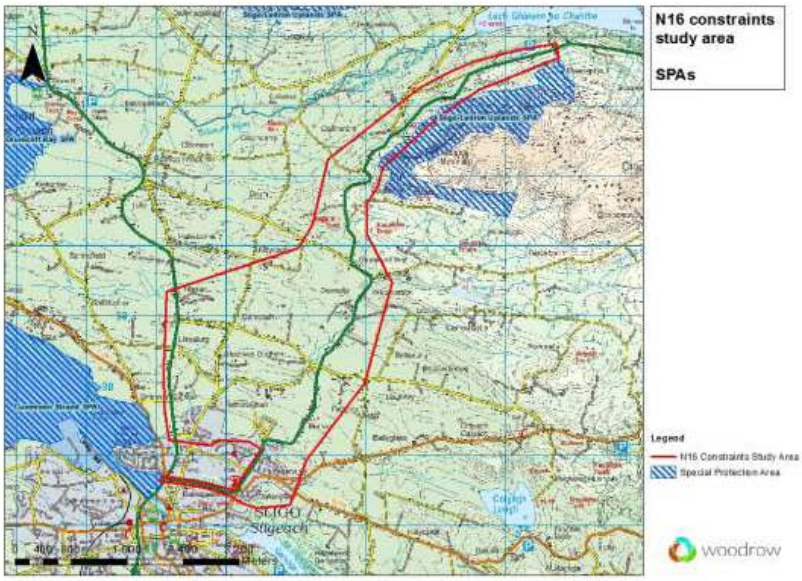


Figure 5 Special Protection Areas (SPAs) in the vicinity of the N16 Constraints Study Area



4.1.1.1 Benbulben, Gleniff and Glenade Special Area of Conservation (SAC)

A small section of the Benbulben, Gleniff and Glenade Special Area of Conservation (SAC), including the small stream flowing north to Glencar Lough and forming the Sligo / Leitrim County boundary, coincides with the extreme eastern point of the study area.

Of the designated interest relating to the Benbulben, Gleniff and Glenade SAC (see Appendix 1), only otter (*Lutra lutra*) is likely to occur within the part of the SAC falling within the study area.

4.1.1.2 Cummeen Strand/Drumcliff Bay (Sligo Bay) Special Area of Conservation (SAC)

This is a coastal SAC which lies to the west of the study area, occupying Sligo Bay to the south, immediately adjacent to the study area, and Drumcliff Bay to the north. The latter part of the SAC is situated 2-3 km from the study area, but has biological connectivity to it via the Drumcliff River which drains the site.

None of the designated features of Cummeen Strand/ Drumcliff Bay (Sligo Bay) Special Area of Conservation are likely to occur within the study area (see Appendix 1). However, the SAC does fall within its zone of influence, through close proximity and drainage into the Sligo Bay / Cummeen Strand area, and also indirectly, as the study area has biological connectivity to Drumcliff Bay via the Drumcliff River.

4.1.1.3 Lough Gill Special Area of Conservation (SAC)

A small part of Lough Gill Special Area of Conservation lies adjacent/just inside the southern edge of the study area, at Bellanode. This area is improved and semi-improved grassland with several small copses, flanking the deciduous woodland of Hazelwood Demesne.

Desk studies indicated a potential connectivity between the study area and Lough Gill SAC via the Copper River / drainage channels although this will need to be confirmed at detailed assessment stage.

4.1.1.4 Sligo / Leitrim Uplands Special Protection Area (SPA)

A section of the Sligo / Leitrim Uplands Special Protection Area (SPA), largely incorporating woodland, quarry and steeply sloping grassy slopes, is included within the northeastern part of the study area, to the southeast of the existing N16 (see Figure 5).

The Sligo / Leitrim Uplands Special Protection Area (SPA) is designated on the basis of its breeding peregrine (*Falco peregrinus*) and chough (*Pyrrhocorax pyrrhocorax*), both Annex I species which are known to nest on Cope's Mountain, just south of the study area. Due to the requirements of these species, features of the SPA have potential to be affected by future works within the study area.

4.1.1.5 Cummeen Strand Special Protection Area (SPA)

This is a coastal SPA, designated on the basis of its assemblage of wetland and waterbird species, which lies immediately to the west of the study area. None of the bird species for

which Cummeen Strand is designated are likely to occur within the study area, due to habitat limitations.

Cummeen Strand SPA and the species for which it is designated are unlikely to be physically affected by works carried out within the study area, despite their close proximity, although there is potential for indirect effects (water quality impacts) as the study area and the SPA are linked by the Copper River.

4.1.1.6 Drumcliff Bay Special Protection Area (SPA)

This is a coastal SPA, designated on the basis of its assemblage of wetland and waterbird species, which lies 2-3 km west of the study area. The bird species for which Drumcliff Bay is designated are not likely to regularly occur within the study area, due to habitat limitations.

The SPA is has connectivity with the study area via the Drumcliff River, which drains the northwestern section of the study area. Therefore, indirectly Drumcliff Bay SPA falls within the zone of influence of any subsequent works which may be carried out within the study area.

Figure 6 – View southwest from Rathbraghan, with Cummeen Strand/ Drumcliff Bay (Sligo Bay) SAC / Cummeen Strand SPA visible in background

4.1.2 Nationally Designated Areas

One designated Natural Heritage Area (NHA) and three proposed Natural Heritage Areas (pNHA) lie partially within, or immediately adjacent to, the study area:

- Crockauns / Keelogyboy Bogs NHA
- Cummeen Strand/Drumcliff Bay (Sligo Bay) pNHA
- Lough Gill pNHA
- Benbulben, Gleniff and Glenade Complex pNHA

A fifth proposed Natural Heritage Area, Colgagh Lough pNHA, lies just over 2km from the study area but is unlikely to fall within its zone of influence, as the areas are not connected by features of drainage or topography.

4.1.2.1 Crockauns and Keelogyboy Natural Heritage Area (NHA)

The study area includes a small section of the Crockauns / Keelogyboy Bogs NHA (situated to the north and east of the study area). The interest of the Crockauns / Keelogyboy Bogs NHA, as described in the site synopsis, includes upland grassland and bog habitats, broad-leaved woodland and chough, hen harrier, peregrine and red grouse. The area included within the study area includes broadleaved woodland. The site synopsis states that the broadleaved woodland on the northern slopes of the NHA supports "*Hazel (Corylus avellana), Ash (Fraxinus excelsior), Hawthorn (Crataegus monogyna), Rowan (Sorbus aucuparia) as well as the scarce species Irish Whitebeam (Sorbus hibernica). This area also supports a diverse community of mosses*".

4.1.2.2 Cummeen Strand/Drumcliff Bay (Sligo Bay) proposed Natural Heritage Area (pNHA)

The main features and conservation interest of Cummeen Strand/Drumcliff Bay (Sligo Bay) pNHA are as described in Section 4.1.1.2.

4.1.2.3 Lough Gill proposed Natural Heritage Area (pNHA)

The main features and conservation interest of Lough Gill pNHA are as described in Section 4.1.1.3.

4.1.2.4 Benbulben, Gleniff and Glenade proposed Natural Heritage Area (pNHA)

The main features and conservation interest of Benbulben, Gleniff and Glenade pNHA are as described in Section 4.1.1.4.

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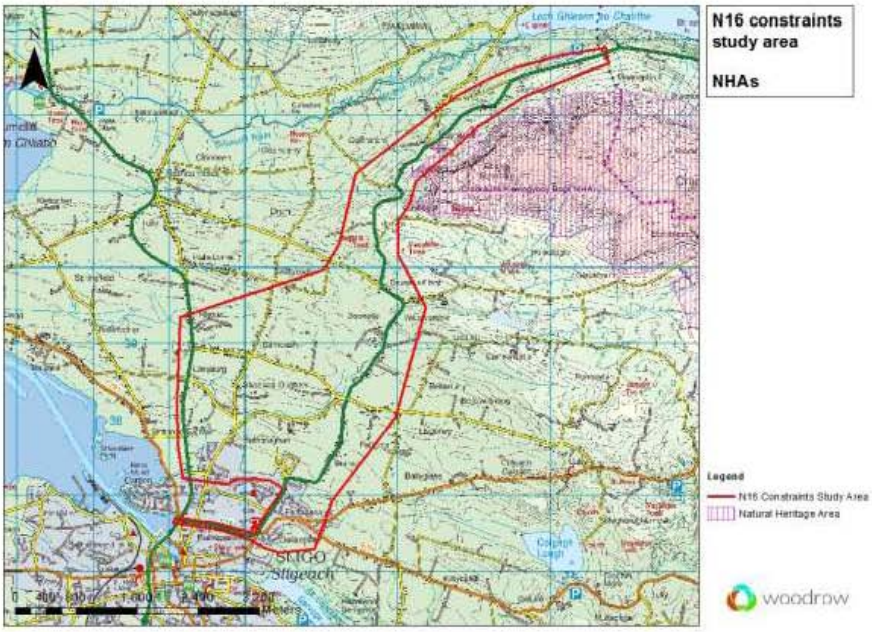
Figure 7 Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs) in the vicinity of the N16 Constraints Study Area



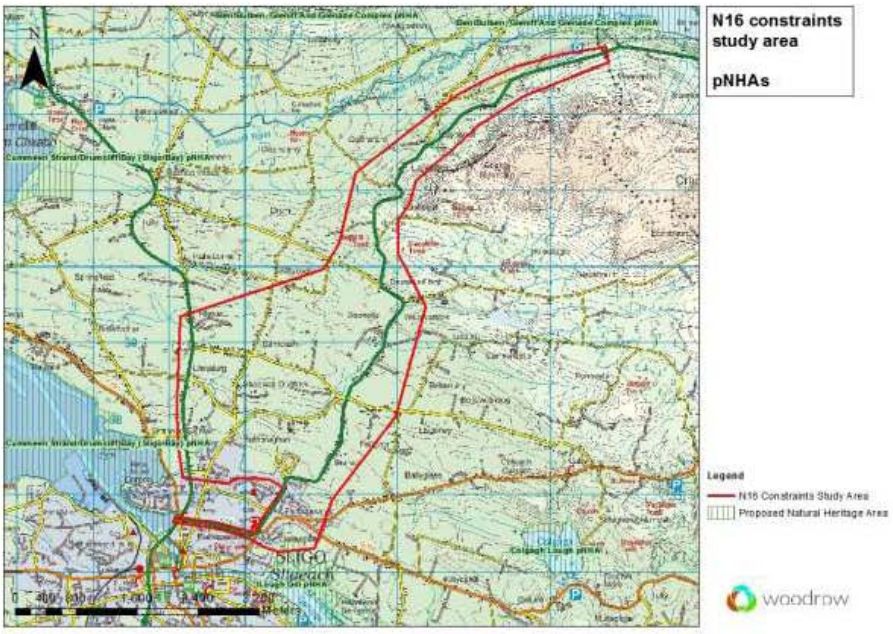


Figure 8 View east from Lugnagall towards Cope's Mountain, showing woodland within Crockauns and Keelogboy NHA and Sligo/Leitrim Uplands SPA in the background

4.2 Rare and protected species

A desk study was undertaken to obtain all nationally submitted species records for the study area. This involved an interrogation of the National Biodiversity Data Centre (NBDC) database and also the online National Parks and Wildlife Service (NPWS) database. The NBDC database provides records for a minimum resolution of 2km square. The NPWS database provides records for a minimum resolution of 10km square. The Table 4.2 shows rare and protected species recorded either at a 2km square (NBDC) or 10km square (NPWS) resolution, with those considered to have potential to occur within the study area highlighted in green.

Data was collected for all 2km squares overlapping the study area (outlined in red) in Figure 4.2, taking into account the habitat requirements of the species recorded. Specific locations for species were not always available; where possible to determine, only those species recorded within or immediately adjacent to the study area have been included below.

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Figure 9 2km squares for which records were obtained from NBDC

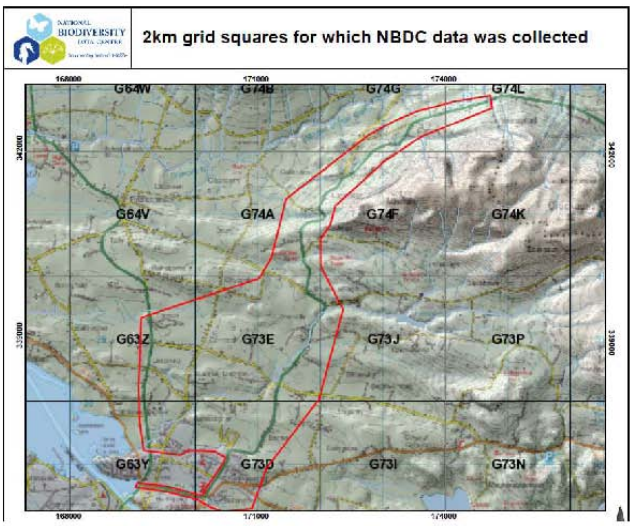

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Table 4.2. Summary of protected species and red listed or endangered species recorded in the immediate locality, from the NBDC and NPWS databases (more detailed information appears in Appendix 3)

(Those species having potential to occur within the study area because of their habitat requirements are highlighted in green.)

Scientific name	Common name	Conservation Status	Resolution
Leiocolea fitzgeraldiae	Fitzgerald's Notchwort (a liverwort)	•Irish Red List: Near Threatened	2 km
Dumortiera hirsuta	Dumortier's Liverwort	•Irish Red List: Near Threatened	10 km
Marchantia polymorpha	Common Liverwort	•Irish Red List: Endangered/Least concern (subspecies not specified)	10 km
Metzgeria leptoneura	Hooked Veilwort	•Irish Red List: Near Threatened	10 km
Didymodon maximus	Irish Beard-moss	•Irish Red List: Near Threatened	2 km
Mnium thomsonii	Short-beaked Thyme-moss	•Irish Red List: Near Threatened	2 km
Orthothecium rufescens	Red Leskea (a moss)	•Irish Red List: Near Threatened	2 km
Plagiobryum zieri	Zieran Hump-moss	•Irish Red List: Near Threatened	2 km
Tortella densa	Clint Crisp-moss	•Irish Red List: Near Threatened	2 km
Rhizomnium pseudopunctatum	Felted Thyme-moss	•Irish Red List: Near Threatened	2 km
Seligeria patula		•Irish Red List: Near Threatened	2 km
Dicranella grevilleana	Greville's Forklet-moss	•Irish Red List: Near Threatened	2 km
Hymenostylium recurvirostrum	Hook-beak Tufa-moss	•Irish Red List: Near Threatened	2 km
Eurhynchium speciosum	Showy Feather-moss	•Irish Red List: Near Threatened	10 km
Fissidens monguillonii	Atlantic Pocket-moss	•Irish Red List: Near Threatened	10 km
Leucobryum glaucum	Large White-moss	•Irish Red List: Least Concern	10 km
Platydictya jungermannioides	Spruce's Leskea	•Irish Red List: Near Threatened	10 km
Tortula marginata	Bordered Screw-moss	•Irish Red List: Near Threatened	10 km
Saxifraga aizoides	YellowSaxifrage	•Protected in Northern Ireland •IUCN: Vulnerable	2 km
Pseudorchis albida	Small-White Orchid	•Flora Protection Order •IUCN: Endangered	10 km
Monotropa hypopitys	YellowBird's-Nest	•Protected in Northern Ireland •IUCN: Vulnerable	10 km
Arianta arbustorum	Copse Snail	•Irish Red List: Vulnerable	2 km
Hydrobia acuta	A snail	•Irish Red List: Endangered	2 km
Pupilla (Pupilla) muscorum	Moss Chrysalis Snail	•Irish Red List: Endangered	2 km
Vertigo (Vertigo) pygmaea	Common Whorl Snail	•Irish Red List: Near Threatened	2 km
Vertigo (Vertigo) substriata	Striated Whorl Snail	•Irish Red List: Near Threatened	2 km
Vertigo (Vertigo) antivertigo	Marsh Whorl Snail	•Irish Red List: Vulnerable	2 km
Vertigo (Vertigo) geyeri	Geyer's Whorl Snail	•EU Habitats Directive: Annex II •Protected Species: Wildlife Acts •Irish Red List: Vulnerable	2 km
Acicula fusca	Point Snail	•Irish Red List: Vulnerable	2 km
Leiostyla (Leiostyla) anglica	English Chrysalis Snail	•Irish Red List: Vulnerable	2 km
Oxyloma (Oxyloma) sarsii	Slender Amber Snail	•Irish Red List: Data deficient	2 km
Nebrioporus (Nebrioporus) depressus	A diving beetle	•Irish Red List: Data deficient	2 km
Bombus (Bombus) cryptarum	A bumblebee	•Irish Red List: Data deficient	2 km
Bombus (Bombus) magnus	A bumblebee	•Irish Red List: Data deficient	2 km

Scientific name	Common name	Conservation Status	Resolution
Bombus (Psithyrus) campestris	Field Cuckoo Bee	•Irish Red List: Vulnerable	2 km
Bombus (Thoracombus) muscorum	Moss Carder-bee	•Irish Red List: Near Threatened	2 km
Bombus (Melanobombus) lapidarius	Large Red Tailed Bumble Bee	•Irish Red List: Near Threatened	2 km
Andrena (Oreomelissa) colcana	A solitary bee	•Irish Red List: Vulnerable	2 km
Anguilla anguilla	European Eel	•Threatened Species: OSPAR Convention •Irish Red List: Critically Endangered	2 km
Lampetra fluviatilis	River Lamprey	•EU Habitats Directive: Annex II and V •Irish Red List: Least Concern	10 km
Lampetra planeri	Brook Lamprey	•EU Habitats Directive: Annex II and V •Irish Red List: Least Concern	10 km
Petromyzon marinus	Sea Lamprey	•EU Habitats Directive: Annex II •Threatened Species: OSPAR Convention •Irish Red List: Near Threatened	10 km
Salmo salar	Atlantic Salmon	•EU Habitats Directive: Annex II and V •Threatened Species: OSPAR Convention •Irish Red List: Vulnerable	2 km
Rana temporaria	Common Frog	•EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	2 km
Lissotriton vulgaris	Smooth Newt	•Protected Species: Wildlife Acts •Irish Red List: Least Concern	10 km
Zootoca vivipara	Common Lizard	•Protected Species: Wildlife Acts •Irish Red List: Least Concern	10 km
Gavia immer	Great Northern Diver	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	2 km
Falco peregrinus	Peregrine	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	10 km
Larus argentatus	Herring Gull	•Protected Species: Wildlife Acts •Birds of Conservation Concern: Red List	2 km
Larus ridibundus	Black-headed Gull	•Protected Species: Wildlife Acts • Birds of Conservation Concern : Red List	2 km
Cygnus cygnus	Whooper Swan	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	2 km
Tringa totanus	Common Redshank	•Protected Species: Wildlife Acts •Birds of Conservation Concern: Red List	2 km
Vanellus vanellus	Northern Lapwing	•Protected Species: Wildlife Acts •EU Birds Directive: Annex II(II) •Birds of Conservation Concern: Red List	2 km
Numenius arquata	Eurasian Curlew	•Protected Species: Wildlife Acts •EU Birds Directive: Annex II (II) •Birds of Conservation Concern: Red List	2 km
Calidris alpina	Dunlin	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I, II(II) and III(III) •Birds of Conservation Concern: Amber List	2 km
Pluvialis apricaria	Golden Plover	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I •Birds of Conservation Concern: Red List	10 km

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Scientific name	Common name	Conservation Status	Resolution
Limosa lapponica	Bar-tailed Godwit	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I •Birds of Conservation Concern: Amber List	2 km
Anthus pratensis	Meadow Pipit	•Birds of Conservation Concern:Red List	2 km
Motacilla cinerea	Grey Wagtail	•Birds of Conservation Concern: Red List	2 km
Pyrrhocorax pyrrhocorax	Red-billed Chough	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	2 km
Pipistrellus pipistrellus sensu lato	Pipistrelle	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Pipistrellus pygmaeus	Soprano Pipistrelle	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Plecotus auritus	Brown Long-eared Bat	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Nyctalus leisleri	Lesser Noctule	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Myotis daubentonii	Daubenton's Bat	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Myotis mystacinus	Whiskered Bat	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	2 km
Phoca vitulina	Common Seal	•EU Habitats Directive: Annex II and V •Protected Species: Wildlife Acts	2 km
Meles meles	Eurasian Badger	•Protected Species: Wildlife Acts	2 km
Martes martes	Pine Marten	•EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	2 km
Mustela erminea ssp. hibernica	Irish Stoat	•Protected Species: Wildlife Acts	10 km
Lutra lutra	European Otter	•EU Habitats Directive: Annex II and IV •Protected Species: Wildlife Acts	2 km
Sciurus vulgaris	Eurasian Red Squirrel	•Protected Species: Wildlife Acts	2 km
Lepus timidus ssp. hibernica	Irish Hare	•EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	10 km
Sorex minutus	Eurasian Pygmy Shrew	•Protected Species: Wildlife Acts	2 km
Ennaceus europaeus	West European Hedgehog	•Protected Species: Wildlife Acts	2 km

4.2.1 Plants

The wider area is of significant botanical importance, mainly because of the profusion of alpine and arctic-alpine vascular plants which occur on the cliffs in the vicinity of the northeast end of the study area, some of which occur nowhere else in Ireland. These cliffs and slopes also support a diverse range of bryophytes, many of which are highly restricted in their range. The cliffs of the Gleniff, Glenade and Glencar valleys and those on the north side of Arroo Mountain are of particular botanical significance. Glencar Lake and the numerous waterfalls in the wider area are also of significant botanical interest, in particular for their bryophyte flora (Site synopses, Benbulben, Gleniff and Glenade SAC and Sligo/Leitrim Uplands SPA).

The study area naturally lies outside the area of highest botanical interest, since the habitats which support the arctic-alpine communities are mountain tops and cliffs, while many of the significant bryophytes occur on rocks outcrops, cliffs and montane flushes. These habitats do not occur within the study area. However, several red-listed bryophyte species (Short-beaked Thyme-moss *Mnium thomsonii;* Clint Crisp-moss *Tortella densa* and Greville's Forklet-moss *Dicranella grevilleana*) have to potential to occur within the woodland and upland grassland areas within the northeast part of the study area, on the lower slopes of Cope's Mountain. No other protected or endangered plants species are known to occur within the study area.

4.2.2 Invertebrates

Molluscs

Ten red-listed species of mollusc have been recorded in the vicinity of the study area, of which six species are considered as possibly occurring within the study area, given the nature of their habitat requirements. Some of these species are widespread in their Irish distribution, but all are declining due to habitat loss and fragmentation.

Copse snail (*Arianta arbustorum*) was been recorded from Lugnagall, within the study area, in 1984. This species favours woodland in limestone areas but may also be found in unimproved pasture and scrub or on limestone rocks.

The remaining five species were all recorded in 2000 from Glencar, just outside the study area, with two species also recorded from Lough Gill in 1972. Other older records exist, but are not considered here. Habitat requirements for these species suggest that they could occur within the study area. These species are likely to be under-recorded, and it is possible that that they were recorded in this area not only because of their habitat requirements, but also because specialist survey work was carried out in this location.

Point snail (*Acicula fusca*), favours shaded deep litter in base-rich areas, while in the west of Ireland Striated whorl-snail (*V. substriata*) which usually favours transition mire, may occupy wet woodland. English chrysalis snail (*Leiostyla anglica*), for which Ireland supports at least 50% of the global population, is common in wet, shaded habitats on neutral to base-rich soils. Marsh whorl-snail (*Vertigo antivertigo*) occupies marshes, lakeshores, riverbanks and wet pastures, while common whorl-snail (*V. pygmaea*) is a species of calcareous grasslands. Therefore there is a possibility that any or all of these species could occur within the study area.

Hymenoptera

Four red-listed species of bumblebee have been recorded from within the study area, at Lugnagall: *Bombus cryptarum*, *B. magnus*, *B. campestris* and *B. muscorum*. These species have all undergone substantial decline in recent years due to general habitat fragmentation and loss, but are all widespread in their distribution, feeding on a broad range of common flowering plants. It is considered likely that these species have been recorded within the study area because specialist survey work has been carried out here, rather than because of their specific habitat requirements. .

The solitary ground-nesting bee *Andrena coitana* was recorded from Glencar, just outside the study area, in 1934, one of only three records from the northwest of Ireland. Many solitary bees have undergone serious decline, often for unknown reasons (Paxton, 2009). There may well be suitable habitat for this species within the study area; however, this is an old record and there are no other records in the vicinity, the closest being from Portnoo in Co Donegal (2004 and 2005).

4.2.3 Fish and aquatic species

Atlantic salmon (*Salmo salar*) and European eel (*Anguilla anguilla*) both occur within the study area. Populations of both species have declined significantly in recent years and both are protected under international law through the OSPAR convention; Atlantic salmon is also protected under Annex II and Annex V of the EU Habitats Directive. Both species are listed on the Irish Red List of Irish Amphibians, Reptiles and Freshwater Fish because of their unfavourable conservation status in Ireland.

Consultation with Inland Fisheries Ireland (IFI) also confirmed some watercourses within the study area to hold populations of sea trout and brown trout (*Salmo trutta*).

Several lamprey species occur in the wider area although they have not been recorded from within the study area. Sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*) are designated features of both the Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC and the Lough Gill SAC. In addition, brook lamprey (*Lampetra planeri*) also occurs within Lough Gill SAC. All three species are included within the Irish Red List of Amphibians, Reptiles and Freshwater Fish; sea lamprey occurs at very low population densities and is considered "near threatened", while the other two species are classed as "of least concern" due to apparently relatively stable populations.

Freshwater white-clawed crayfish (*Austropotamobius pallipes*) has not been recorded within the study area but is a designated feature of Lough Gill SAC. It is listed on Annex II and Annex V of the EU Habitats Directive and categorised as Endangered by the IUCN, as well as being protected under the Wildlife Acts (1976 and 2000). Because of its habitat requirements and close proximity, it is considered possible that this species may occur within the study area and has been previously overlooked or records have not submitted to national databases.

4.2.4 Birds

Chough

Chough (*Pyrrhocorax pyrrhocorax*) is known to nest in certain years just outside the boundary of the study area, on the cliffs within the Sligo / Leitrim Uplands SPA and

Crockauns/Keelogyboy NHA. Chough is a Red Data Book species and is listed in Annex 1 of the EU Birds Directive. It is one of two Annex I bird species for which the Sligo / Leitrim Uplands SPA was designated.

Chough forages mainly in unimproved grazed pasture. A study carried out in 2004 in south west Ireland, observing chough at 12 sites, found that birds spent 95% of their time within 1.3 km of the nest (Gray et al., 2004). It is therefore likely that the fields in the northern end of the study area, at the foot of the cliffs at Cope's Mountain, are an important foraging area. As stated in the Site Synopsis for Sligo/Leitrim Uplands SPA, "The suitable grassland [for foraging chough] occurs mainly on the steep slopes below the cliffs".

Peregrine

Although peregrine (*Falco peregrinus*) was not recorded in the database search, the species is known to nest on the cliffs within the Sligo / Leitrim Uplands SPA and the Crockauns / Keelogyboy NHA, close to the study area. Peregrine is protected under Annex 1 of the EU Birds Directive and, with chough, is the Special Conservation Interest for the adjacent Sligo/Leitrim Uplands SPA.

Waders

Northern lapwing (*Vanellus vanellus*) and Eurasian curlew (*Numenius arquata*) are both recorded from the vicinity of the study area. Both species appear on the Red list of "Birds of Conservation Concern in Ireland" (Colhoun and Cummins, 2013).

Other bird species

Meadow pipit (*Anthus pratensis*) and grey wagtail (*Motacilla cinerea*) are both on the Red list of "Birds of Conservation Concern in Ireland" (Colhoun and Cummins, 2013). Meadow pipit breeds in upland areas, bogs, pasture and scrub, tending to move to lowland areas in winter Grey wagtail breeds near rivers, often under bridges. Both species are common and widespread and are likely to occur throughout the study area.

4.2.5 Mammals

The following mammals, all recorded within the study area, are given legal protection under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000, which protects both the breeding and resting places of each species. Several species are also protected under European law, as detailed below.

Bats

Six species of bat have been recorded within the study area. Four of these species have been identified as roosting either within the study area or in the immediate vicinity (see Appendix 3).

The study area contains habitat that is likely to be used by bats, in particular to the west and southwest where lowland agricultural land is intersected by a network of intact hedgerows and treelines. This is illustrated by the Bat Landscapes map in Figure 10, which assigns a "habitat suitability index" to each 5km grid square. This index ranges from zero to 100, with 100 being most suitable for bats, and zero least suitable. The area shaded in orange is

judged most suitable for bats, with an overall habitat suitability index of approx. 36.4-58.6. This figure takes into account the varying habitat requirements of different Irish bat species, and is higher for some species, such as brown long-eared bat, and lower for others.

Bats rely on continuous lines of trees and scrub for feeding and commuting purposes, so in addition to field boundaries and streams, tree-lined stretches of the existing N16 are also likely to be used by bats.

All bats, along with their breeding and resting places, are protected by the Wildlife Acts and by Annex IV of the Habitats Directive.

Pine marten

Pine marten (*Martes martes*) is protected by Annex V of the Habitats Directive, as well as under the Wildlife Acts 1976 and 2000 (as amended). Pine Marten is generally associated with woodland, although it also occurs in a range of more open habitats, so the study area, with its network of small woodland areas, treelines and hedgerows situated within a wider area of farmland provides suitable habitat for this species.

Otter

Otter (*Lutra lutra*) is protected by Annex II and Annex IV of the Habitats Directive and is also given legal protection under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

Suitable habitat for otter exists within the study area, and there are a number of records for otter within this area.

Red squirrel

Red squirrel (*Sciurus vulgaris*) is protected under Schedule III of the Bern Convention. It is also given legal protection under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

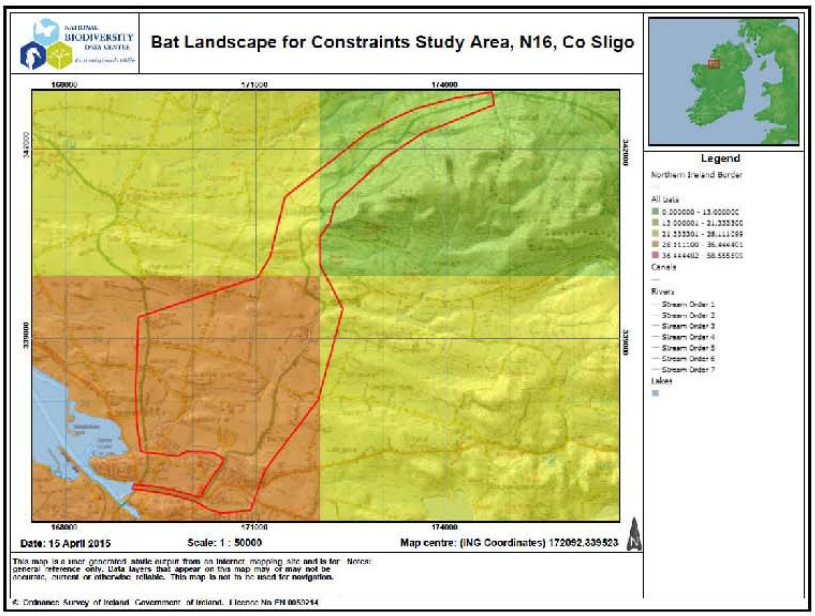
Red squirrel is exclusively a woodland species and can be found in a range of woodland habitats across Ireland. The study area, with its network of intact field boundaries interconnecting numerous small copses and areas of woodland, is likely to provide suitable feeding and commuting habitat for red squirrel and there are several areas of mature trees that might provide suitable breeding habitat. Red squirrel has been recorded from a number of locations in the vicinity of the study area.

Other mammals

Badger (*Meles meles*), pygmy shrew (*Sorex minutus*) and hedgehog (*Erinaceus europaeus*) have been recorded within or close to the study area, and are also all protected under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

All are widespread and common in Ireland and are widely distributed across a range of habitat types, in particular hedgerows, farmland, scrub and woodland edges.

Figure 10 Bat Landscape of the Constraints Study Area, illustrating habitat suitability for bats



4.3 Invasive species

A full list of the invasive species that have been recorded in the study area and its immediate vicinity (i.e. in the area delineated in Figure 4.2) is reproduced in Appendix 4.

4.3.1 Legislative requirements: invasive species

Three invasive plant species recorded within the study area, giant hogweed (*Heracleum mantegazzianum*), rhododendron (*Rhododendron ponticum*) and Japanese knotweed (*Fallopia japonica*) are listed under Part 1 of the Third Schedule of the European Communities (Birds and Habitats) Regulations 2011 as a 'non-native species subject to restrictions under Regulations 49 and 50.

Two invasive animal species recorded within the study area, zebra mussel (*Dreissena polymorpha*) and brown rat (*Rattus norvegicus*), are listed under part 2A of the Third Schedule of the European Communities (Birds and Habitats) Regulations 2011, "animals to which Regulations 49 and 50 apply throughout the State or in particular places or categories of places".

Regulation 49(2) of the Regulations states that any person who plants, disperses, allows or causes to disperse, spreads or otherwise causes to grow in any place specified in relation to such plant in the third column of Part 1 of the Third Schedule, any plant which is included in Part 1 of the Third Schedule, shall be guilty of an offence. Regulation 49(3) states that it shall be a defence to a charge of committing an offence under paragraph (2) to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence.

Regulation 50(2) of the Regulations states that, save in accordance with a licence granted under *paragraph (7)*, a person shall be guilty of an offence if he or she imports or transports - (*a*) an animal or plant listed in *Part 1* or *Part 2* of the *Third Schedule*, (*b*) anything from which an animal or plant referred to in Part 2 of the Third Schedule can be reproduced or propagated, or (c) a vector material listed in Part 3 of the Third Schedule. Regulation 50(4) states that, subject to paragraph (5), it shall be a defence to a charge of committing an offence under paragraph (1), (2) or (3) to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence.

4.4 Important habitats

4.4.1 Pasture and semi-improved grassland

As stated above, much of the area comprises improved or semi-improved pasture, holding little ecological interest. It appears that there are unlikely to be ecologically significant pasture areas within the study area, although landowner access has not yet been obtained and the area has not been fully surveyed. Grazed woodland is dealt with separately, in section 4.4.3.

Figure 11 – Typical pasture and hedgerows within the Constraints Study Area

4.4.2 Watercourses

A number of watercourses run through the site. These vary from small watercourses running along field boundaries to large streams bordered by woodland and scrub.

A number of the streams in this area are of particular importance for Atlantic salmon (*Salmo salar*) as well as a number of other fish species (see section 4.2.3 and 4.6.1). They also have a wider ecological significance, providing corridors of semi-natural habitat for species such as otters, feeding bats and breeding birds within an otherwise agricultural landscape.

Figure 4.4.2 – Watercourse at the extreme north-east of the Constraints Study Area

4.4.3 Woodland

Northeast section: Castlegal to Glencar

There are two main woodland areas in the northeastern part of the site, in the townlands of Lugatober and Lugnagall, where the existing N16 extends along the foot of Cope's Mountain. Access was not obtained to either area, but peripheral viewing of Lugnagall woodland suggests that birch, ash, alder and hazel dominate, with a significant fern understorey in places.

This area comprises part of the Crockauns / Keelogyboy Bogs NHA, the site synopsis for which states that woodland in the area supports Irish Whitebeam *(Sorbus hibernica)*. This woodland is considered to be an important constraint in ecological terms.

The woodland in the townland of Lugatober appears to be largely comprised of ash, and is periodically grazed by sheep.

A number of the streams in the northeastern part of the study area are bordered by wooded areas or scrub. Most notably, the two easternmost streams are bordered by a mix of native species, in particular to the north of the existing N16 (illustrated in Figure 4.4.2). Although these areas are generally grazed and have little in the way of understorey vegetation, they are likely to be of value for other species, such as feeding bats and breeding birds. In addition, there is significant growth of bryophytes in places.

Southwest section: Sligo Town to Castlegal

The southwestern part of the study area is mainly pasture interspersed with dwellings, but contains two main areas of woodland. One is associated with the Doonally / Rathbraghan stream, mainly west of the existing N16, with a small section to the east. This area is a linear woodland, extending for over 1 km along the stream, and appears to be variously dominated by beech, alder and ash. It has a relatively open structure in the vicinity of the existing N16 but scrub species appear to increase westwards. Further survey of this area would be advisable.

The other area of woodland in this section of the study area is situated slightly further north, associated with the Willowbrook tributary of the Rathbraghan stream, where it flows westwards from the Willowbrook reservoir and then southwest adjacent to the existing N16. Due to its proximity to the road, this area was viewed only cursorily and further survey would be desirable.

Other than this, there is little woodland in this section of the study area but it does support a well-established network of hedgerows, containing substantial numbers of trees in places, some quite mature (see section 4.4.4, below). These are particularly abundant in the Drum area.

Figure 4.4.3 – Woodland in the Lugnagall area

4.4.4 Hedgerows and Copses

The study area contains a well-established network of hedges, in particular in the agricultural land to the west. Some of these contain a significant number of mature trees. There are also a number of small copses within the area, which support a variety of native tree species; ash (*Fraxinus excelsior*) tends to dominate. These vary in ecological value, but some hold sufficiently mature trees to harbour bat roosts.

Figure 4.4.4 Farmland in the west / southwest of the Constraints Study Area showing well-developed network of hedgerows

4.5 Watercourses and Fisheries

The northeastern part of the study area contains a number of tributaries of the Drumcliff River, while the southwestern area contains the Magheragillemeeve (Springfield) stream; the Doonally / Rathbraghan river and its tributary, the Bellanurly stream; and, to the extreme south, the Copper River.

Outside the study area, but potentially within its zone of influence, are the Tully stream (to the northwest), and the main Drumcliff River (to the north and northwest).

The Inland Fisheries Ireland consultation response (below) states that a number of the streams in the study area contain resident brown trout and sea trout populations, and also salmonid spawning grounds, which are highly sensitive to siltation.

Their response identifies the main concerns, and outlines mitigation measures which would minimise impact of future works on watercourses in the area.

4.6 Consultation responses

4.6.1 Response from Inland Fisheries Ireland:

Following our phone conversation and email correspondence of 15th April, the N16 constraints study may impact on a number of tributaries of the Garvoge River system, Drumcliffe River and Doonally/Rathbraghan River. The Garvoge and Drumcliffe Rivers are important salmon and trout fisheries and are popular for angling. The Garvoge River forms part of the Lough Gill SAC. The Doonally/Rathbraghan River has a resident stock of brown trout and some sea trout. The water bodies located within the N16 constraints study as provided for in the Western River Basin Management Plan are:

Name of water body	Ecological Status	Action required
Magheragillerneeve	Moderate	Restore to good by 2021
Lough Gill	Good	Protect status
Drumcliffe	Poor	Restore to good by 2021
Bellanurly	Good	Protect
Tully	Poor	Restore to good by 2021

The N16 constraints study mainly covers salmonid spawning and nursery areas of the Drumcliffe, Garvoge and Doonally/Rathbraghan rivers. These spawning and nursery areas are highly sensitive to siltation. The IFI guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development work" should be followed, available at: http://www.fisheriesireland.ie/fisheries-management-1/90-requirements-for-the-protection-of-fisheries-habitat-during-construction-and-development-works-at-ri-1

Measures should be put in place to prevent the spread of invasive species as a result of road realignment being carried out. The IFI 'Bio-security Protocol for "Field Survey Work December 2010" is available at: http://www.fisheriesireland.ie/Biosecurity/biosecurity-protocol-for-field-survey-work.html
Other areas of concern are during road realignment are:
Discharge of polluting materials to rivers and watercourses during construction and operational phase. Surface water and silt control measures must be in place to ensure no pollution to watercourses occurs.

Instream works – removal of riparian vegetation and bed materials; All in-stream works must be carried out between May and September in accordance with IFI approved method statements.

Watercourse diversions; if these are a requirement they must be agreed with IFI beforehand.

Barriers to migratory fish movement – bridge and culvert design; Culverts should be installed so as not to provide any barrier to the movement of fish; the internal base of culverts must be at the same level as the existing river bed. Bottomless culverts should be used where possible. Culverts should be as short as possible, not exceeding lengths of 40m. Clear span bridges are recommended.

4.6.2 Response from National Park and Wildlife Service (NPWS)

I refer to your correspondence of the 10th of April 2015 in relation to the preparation of a Constraints Study Area Report for Sligo County Council. The following are the nature conservation observations of the National Parks & Wildlife Service of the Department of Arts, Heritage & the Gaeltacht.

It is noted that the proposed development is partly within Sligo/Leitrim Uplands SPA and and Lough Gill SAC, and immediately adjacent to Benbulben, Gleniff and Glenade Complex SAC, Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC, and Cummeen Strand SPA. Drumcliff Bay SPA lies within the wider vicinity of the Constraints Study Area.

Baseline information regarding the habitats and species may be available from the National Parks & Wildlife Service (www.npws.ie), National Biodiversity Data Centre (www.biodiversityireland.ie), Inland Fisheries Ireland (www.fisheriesireland.ie) and BirdWatch Ireland (www.birdwatchireland.ie). Information from the National Parks & Wildlife Service should be sourced via the Data Request Form at www.npws.ie .

Site Specific Conservation Objectives (SSCO) for Natura 2000 sites can be found at www.npws.ie. The SSCO must be used to determine and assess potential constraints.

Information has been obtained from the suggested websites (incorporated into Table 4.2 and Appendix 3), and in addition a Data Request Form was submitted to NPWS for the 10km grid squares represented by the study area (G63, G73 and G74), in response to which 1640 records were received (a total of 91 species). However, the three 10km squares cover a much larger area than the study area itself and support habitat types not represented within the study area. The list of records was therefore edited according to habitat suitability, and was searched for protected, red-listed and endangered species. The resulting list (17 species) was incorporated into Table 4.2.

5 Conclusions

Considering the above information there are a number of ecological issues that will need to be considered in the development of the project. These are described in sections below.

5.1 Ecological constraints – Potential impact pathways

The identification of ecological constraints and a potential zone of influence is affected by potential impacts and potential pathways to receptors. In the case of a new road, or road realignment, impacts (both during construction and operational phases) include direct loss, pollution, obstruction to species movement, and disturbance. Pathways include direct destruction, watercourses and proximity. These issues have been considered in determining the zone of influence and the potential ecological constraints within it.

The ecological zone of influence associated with the constraints study area is shown in Figure 12, and encompasses:

- All river systems into which the study area drains, downstream of the study area
- Glencar Lough, which receives drainage from the northern end of the study area and is situated within the Benbulben, Gleniff and Glenade SAC.
- The cliffs on Cope's Mountain, which are used by breeding peregrine and chough, situated adjacent to the study area and within the Sligo/Leitrim Uplands SPA and Crockauns/Keelogyboy NHA
- Cummeen Strand/Drumcliff Bay (Sligo Bay SAC) – linked to the study area by the Copper River.
- Drumcliff Bay SPA – this is linked to the study area by the Drumcliff River.
- Cummeen Strand SPA - this is linked to the study area by the Copper River.
- Lough Gill SAC – this is potentially connected to the study area by the Copper River and drainage network.

5.2 Ecological constraints – Designated Areas

A main aspect of ecological constraints is the designated areas within or immediately adjacent to the site. The location and nature conservation interest of each of these designations is summarised below.

- **Benbulben, Gleniff and Glenade Special Area of Conservation (SAC).** Upland habitat over limestone and shales, situated at the extreme eastern end of the study area. A small section of this SAC lies within the study area, to the north of the current N16. This SAC is of particular importance for alpine plants, some of which occur

nowhere else in Ireland, but it is also of importance for otter, peregrine and Geyer's whorl snail.

- **The Sligo / Leitrim Uplands Special Protection Area (SPA)**. This area of limestone cliffs, upland habitats and scree borders the south west of the study area. It is designated because of its importance for breeding peregrine and chough, but also supports a rich assemblage of arctic-alpine vascular plants and bryophytes.

- **The Crockauns / Keelogyboy Bogs National Heritage Area (NHA).** This falls partly within the north eastern part of the study area. Much of the NHA is blanket bog and other upland habitats over limestone, with areas of exposed cliffs and limestone scree, and also small areas of woodland. One of these lies within the study area and is described in the site synopsis.

- **Lough Gill Special Area of Conservation (SAC)**. This lies to the immediate south of the study area, and comprises the eutrophic lake Lough Gill and its associated woodland and wetland habitats, as well as otter, Atlantic salmon, lamprey species and white-clawed crayfish.

- **Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC.** Located immediately west of the study area, this incorporates estuarine and dune habitats and tufa springs, with associated species such as seal and lampreys.

- **Cummeen Strand Special Protection Area (SPA**). Immediately west of the study area and occupying part of the same area as Cummeen Strand / Drumcliff Bay (Sligo Bay) SAC, the site is designated because of its importance for wintering waterfowl.

- **Drumcliff Bay Special Protection Area (SPA)**. This site lies approximately 2.5km outside the study area, at the mouth of the Drumcliff River, which provides biological connectivity between them. Drumcliff Bay SPA lies within the zone of influence of any future works which may be carried out within the study area. It is designated on the basis of its importance for wintering waterfowl, supporting nationally-important populations of sanderling and bar-tailed godwit.

5.3 Ecological constraints – Habitats and Species

Potentially, all tributaries of river systems within the study area known to be used by salmon (the Drumcliff River, the Garvoge River and the Doonally / Rathbraghan stream complex) have the potential to be affected by works carried out within the study area, including those upstream of the study area. This is because any barriers (for example resulting from culverts or siltation) within the watercourses may negatively affect migration by salmon or sea trout to upstream spawning areas.

A number of species known or considered likely to occur within the study area are protected under international and / or national legislation. Others are considered to be rare, declining or threatened. These species have the potential to be impacted either directly or indirectly and either during the construction and / or operational phases of a new N16 route. These

are detailed in table 4.2. The requirement for detailed surveys and assessment relating to these species will depend on the location and extent of the route selection corridor.

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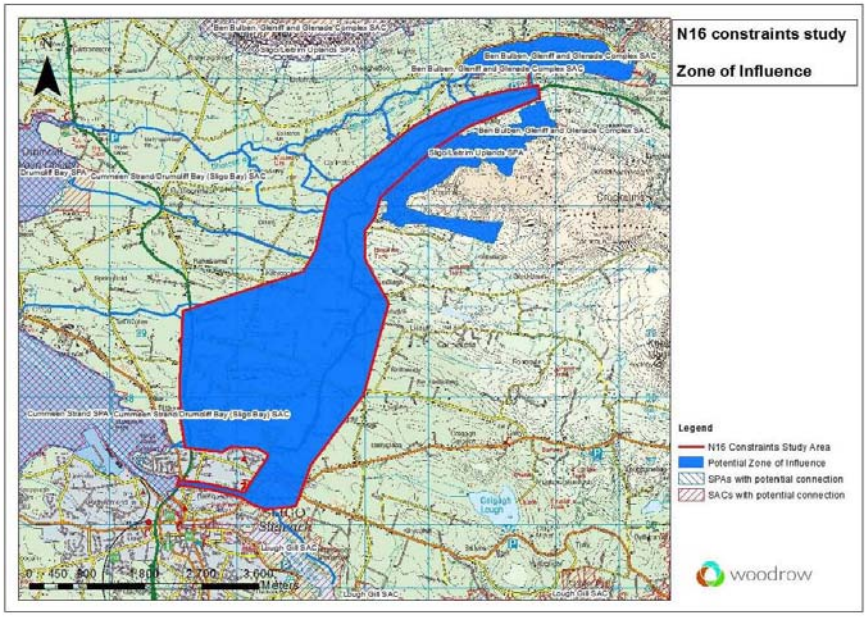
Figure 11 Zone of Influence of the Constraints Study Area taking account of issues detailed above



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7. Appendices

Appendix 1: Natura 2000 areas (SACs and SPAs) within and adjacent to the Constraints Study Area, with details of their designated interest

Site	Code	County	Location	Designated Interest [Natura 2000 code]
SACs				
Benbulben, Gleniff and Glenade Complex SAC	623	Leitrim, Sligo	Latitude 54.3731 Longitude -8.385	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260] European dry heath [4030] Alpine and Boreal heath [4060] *Juniperus communis* formations on heath or calcareous grassland [5130] Petrifying springs with tufa formation (Cratoneurion) [7220] Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii) [8120] Calcareous rocky slopes with chasmophytic vegetation [8210] Geyer's Whorl Snail (*Vertigo geyeri*) [1013] Otter (*Lutra lutra*) [1355]
Cummeen Strand/ Drumcliff Bay (Sligo Bay) SAC	627	Sligo	Latitude 54.3222 Longitude -8.54139	Estuary [1130] Mudflats and sandflats not covered by seawater at low tide [1140] Embryonic shifting dunes [2110] Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120] Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130] *Juniperus communis* formations on heath or calcareous grassland [5130] Petrifying springs with tufa formation (Cratoneurion) [7220] Narrow-mouthed whorl snail (*Vertigo angustior*) [1014]

				Sea lamprey (*Petromyzon marinus*) [1095] River lamprey (*Lampetra fluviatilis*) [1099] Common seal (*Phoca vitulina*) [1365]
Lough Gill SAC	1976	Leitrim, Sligo	Latitude: 54.2489 Longitude-8.37639	Natural eutrophic lake with Magnopotamion or Hydrocharition - type vegetation [3150] Old sessile oak wood with *Ilex* and *Blechnum* [91A0] Alluvial forest with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0] White-clawed crayfish (*Austropotamobius pallipes*) [1092] Sea lamprey (*Petromyzon marinus*) [1095] Brook lamprey (*Lampetra planeri*) [1096] River lamprey (*Lampetra fluviatilis*) [1099] Salmon (*Salmo salar*) [1106] Otter (*Lutra lutra*) [1355]
SPAs:				
Sligo/ Leitrim Uplands SPA	4187	Leitrim, Sligo	Latitude 54.355 Longitude -8.47472	Peregrine (*Falco peregrinus*) [A103] Chough (*Pyrrhocorax pyrrhocorax*) [A346]
Cummeen Strand SPA	4035	Sligo	Latitude 54.2908 Longitude -8.54333	Light-bellied Brent goose (*Branta bernicla hrota*) [A046] Oystercatcher (*Haematopus ostralegus*) [A130] Redshank (*Tringa totanus*) [A162] Wetland and waterbirds [A999]
Drumcliff Bay SPA	4013	Sligo	Latitude 54.3289 Longitude -8.57306	Sanderling (*Calidris alba*) [A144] Bar-tailed godwit (*Limosa lapponica*) [A157] Wetland and waterbirds [A999]

Appendix 2: Natural Heritage Areas and proposed Natural Heritage Areas within and adjacent to the Constraints Study Area, with details of their main features of interest

Site	Type	Code	County	Location	Features of Interest
NHAs					
Crockauns/ Keelogyboy Bogs	NHA	2435	Leitrim, Sligo	Latitude: 54.3094 Longitude: -8.3761	Flat-topped mountains supporting upland blanket bog, heath, upland grassland and associated habitats. Steep to vertical exposed cliffs and limestone scree. On the more gentle lower slopes: lowland blanket bog, wet heath, wet grassland, woodland and scrub. Chough (*Pyrrhocorax pyrrhocorax*) Hen harrier (*Circus cyaneus*) Peregrine (*Falco peregrinus*) Red grouse (*Lagopus lagopus*) Yellow saxifrage (*Saxifraga aizoides*) Irish whitebeam (*Sorbus hibernica*)
pPNHAs					
Benbulben, Gleniff and Glenade Complex	pNHA			Latitude: 54.3731 Longitude: -8.385	Water courses of plain to montane levels (see SAC) European dry heath Alpine and boreal heath *Juniperus communis* formations on heath or calcareous grassland Petrifying springs with tufa formation (Cratoneurion) Calcareous and calcshist screes of the montane to alpine levels Calcareous rocky slopes with chasmophytic vegetation Geyer's Whorl Snail (*Vertigo geyeri*)

					Otter (*Lutra lutra*)
Cummeen Strand/Drumcliff Bay (Sligo Bay)	pNHA			Latitude: 54.3222 Longitude: -8.54139	Estuary; mudflats and sandflats not covered by seawater at low tide Dunes: Embryonic shifting dunes; white dunes; grey dunes *Juniperus communis* formations on heath / calcareous grassland [Petrifying springs with tufa formation (Cratoneurion) Narrow-mouthed whorl snail (*Vertigo angustior*) Sea lamprey (*Petromyzon marinus*) River lamprey (*Lampetra fluviatilis*) Common seal (*Phoca vitulina*)
Lough Gill	pNHA			Latitude: 54.2489 Longitude: -8.37639	Natural eutrophic lake Woodland: • Old sessile oak wood with *Ilex* and *Blechnum*; • Alluvial forest with *Alnus glutinosa* and *Fraxinus excelsior* White-clawed crayfish (*Austropotamobius pallipes*) Sea lamprey (*Petromyzon marinus*) Brook lamprey (*Lampetra planeri*) River lamprey (*Lampetra fluviatilis*) Salmon (*Salmo salar*) Otter (*Lutra lutra*)
Colgagh Lough	pNHA	1658		Latitude: 54.275 Longitude: -8.4	Limestone/Marl lake with benthic vegetation of *Chara* spp. (3140). Various waterfowl species including whooper swan (*Cygnus cygnus*) [Annex 1]

Appendix 3. Details of protected species and red listed or endangered species recorded in the immediate locality, from the NBDC and NPWS databases (summary table appears in Table 4.2)

(Those species having potential to occur within the study area because of their habitat requirements are highlighted in green.)

Grid square	Common name	Scientific name	Protection / importance	Habitat	Date of last record	Approx. location	Resolution
G74F G74L	Fitzgerald's Notchwort (liverwort)	*Lejocolea fitzgeraldiae*	Irish Red List: Near Threatened	Calcareous flushes, fens and rock-faces	2003	Cope's Mountain; NE slope of Crockauns (damp soil over rocks of low limestone crag); S of Glencar Lough	2 km
G74F	Irish Beard-moss	*Didymodon maximus*	Irish Red List: Near Threatened	Limestone cliffs	2003	Cope's Mountain (W side of N-facing gully on rock ledge); Lugnagall	2 km
G74F	Short-beaked Thyme-moss	*Mnium thomsonii*	Irish Red List: Near Threatened	Damp lightly-shaded base-rich soil,mainly in hilly areas	2003	Cope's Mountain (N-facing limestone crag); Lugnagall,	2 km
G74F G74L	Red Leskea (moss)	*Orthothecium rufescens*	Irish Red List: Near Threatened	Wet base-rich rocks, flushed rock faces	2003	Cope's Mountain; Lugnagall; NW of Crockauns; Glencar Lough near Co Boundary	2 km
G74F	Zierian Hump-moss	*Plagiobryum zieri*	Irish Red List: Near Threatened	Mountains, rock outcrops and cliffs (not known below750m)	2003	Cope's Mountain: G735414	2 km
G74F	Clint Crisp-moss	*Tortella densa*	Irish Red List: Near Threatened	Base-rich cliffs; calcareous grassland	2003	Cope's Mountain: G736415	2 km
G74L	Felted Thyme-moss	*Rhizomnium pseudopunctatum*	Irish Red List: Near Threatened	Fens and base-rich marshes and flushes	2000	G751422: outside CSA. Part of moss carpet in calcareous flush with Eqp and sparse grasses	2 km
G74L		*Seligeria patula*	Irish Red List: Near Threatened	Vertical limestone faces	2000	G755438: outside CSA.	2 km
G74L	Greville's Forklet-moss	*Dicranella grevilleana*	Irish Red List: Near Threatened	In mountains, on damp base-rich soil on slopes, rock ledges and disused quarries	2000	G750420/750421: outside CSA. With other bryophytes on steep thin damp soil, part shaded over limestone rock below waterfall on S facing hillside	2 km
G74L	Hook-beak Tufa-moss	*Hymenostylium recurvirostrum*	Irish Red List: Near Threatened	Upland limestone flushes; damp base-rich rocks	2000	G750422 (outside CSA). S of Glencar Lough damp crevices of steep limestone. Knocknarea; Benbulben; Rosses point	2 km
G74F	YellowSaxifrage	*Saxifraga aizoides*	Irish Red List: Vulnerable	Damp rocky places in the north; mostly in the mountains; rather rare	1999	Recorded within the G74F tetrad	2 km

G74F	Copse Snail	*Arianta arbustorum*	•Irish Red List: Vulnerable	Mainly in woodland; also rich, fenny, unimproved pasture, scrub woods and rocks in limestone or chalk areas	1984	The only recent record is Lugnagall, Glencar: G7241	2 km
G63Y	A snail	*Hydrobia acuta*	•Irish Red List: Endangered	Coastal lagoons	1983	Standalaun Point near Sligo Quay G6837	2 km
G63Y	Moss Chrysalis Snail	*Pupilla (Pupilla) muscorum*	•Irish Red List: Endangered	Dry, warm calcareous habitats: minimally enriched calcareous pasture / coastal dune pasture	1983	Standalaun Point near Sligo Quay G6837; Sligo	2 km
G74L	Common Whorl Snail	*Vertigo (Vertigo) pygmaea*	•Irish Red List: Near Threatened	Damp pastures and wetland margins at low altitude, often with *V. substriata* & *V. antivertigo*. In the north and west mostly in coastal habitats e.g. dune grassland	2000	The only recent records are from Glencar Lough / S of Lough, G7542 (outside and E of CSA)	2 km
G74L	Striated Whorl Snail	*Vertigo (Vertigo) substriata*	•Irish Red List: Near Threatened	Wet unimproved pasture with underlying calcareous bedrock; also in wet scrub, particularly in the west.	2000	Glencar Lough / S of Lough, G7542, (outside and E of CSA)	2 km
G74L	Marsh Whorl Snail	*Vertigo (Vertigo) antivertigo*	•Irish Red List: Vulnerable	Fen, marsh, lakeshores and riverbanks	2000	Glencar / S of Lough / Glencar Falls, G7542, Outside and E of CSA. Lough Gill. Rest are old records	2 km
G74L	Geyer's Whorl Snail	*Vertigo (Vertigo) geyeri*	•EU Habitats Directive: Annex II •Protected Species: Wildlife Acts •Irish Red List: Vulnerable	Base-rich flush and bog	2005	Glencar lough and calcareous flushes S of Glencar lake. G7542 (just outside and east of CSA)	2 km
G74L	Point Snail	*Acicula fusca*	•Irish Red List: Vulnerable	Old woods or scrub in limestone areas	2000	The only recent records are from Glencar Lough / S of Lough, G7542, (outside and E of CSA) and Lough Gill.	2 km
G74L	English Chrysalis Snail	*Leiostyla (Leiostyla) anglica*	•Irish Red List: Vulnerable	Wet, shaded habitats; neutral to base-rich soils. More open habitats towards west coast: acid coastal heath, rough pasture	2000	The only recent records are from Glencar Lough / S of Lough, G7542, (outside and E of CSA) and Lough Gill.	2 km
G74L	Slender Amber Snail	*Oxyloma (Oxyloma) sarsii*	•Irish Red List: Data deficient	Mud or low vegetation on lake and river margins	2000	The only recent records are from Glencar/S of Lough/Glencar Falls, G7542 (outside and east of CSA) and Lough Gill.	2 km
G74L	A diving beetle	*Nebrioporus (Nebrioporus) depressus*	•Irish Red List: Data deficient	Freshwater habitats	2002	Glencar Lough, outside (NE) of CSA	2 km

G74F	bumblebee	*Bombus (Bombus) cryptarum*	•Irish Red List: Data deficient	A variety of habitats where flowers are found: gardens, farmland, woodland edges, hedgerows and heathland	2005	Lugnagall, Glencar: G7241	2 km
G74F	bumblebee	*Bombus (Bombus) magnus*	•Irish Red List: Data deficient	As above	2005	Lugnagall, Glencar: G7241	2 km
G74F	Field Cuckoo Bee	*Bombus (Psithyrus) campestris*	•Irish Red List: Vulnerable	As above	2005	Lugnagall, Glencar: G7241	2 km
G74F	Moss Carder-bee	*Bombus (Thoracombus) muscorum*	•Irish Red List: Near Threatened	As above	2005	Lugnagall, Glencar: G7241	2 km
G63Y	Large Red Tailed Bumble Bee	*Bombus (Melanobombus) lapidarius*	•Threatened Species: Near Threatened	As above	1997	Knocknarea and Sligo Harbour (outside CSA)	2 km
G74L	A solitary bee	*Andrena (Oreomelissa) colitana*	•Irish Red List: Vulnerable	A solitary bee that constructs its nests in well-drained soils. In Ireland, recorded from dry gravelly river banks.	1934	Glencar Lough (outside and just north of CSA)	2 km
G74L	European Eel	*Anguilla anguilla*	•Threatened Species: OSPAR Convention •Irish Red List: Critically Endangered	Aquatic habitats	2007	Glencar Lough (but will use adjoining watercourses for migration)	2 km
G74L	Atlantic Salmon	*Salmo salar*	•EU Habitats Directive: Annex II •EU Habitats Directive: Annex V •Threatened Species: OSPAR Convention •Irish Red List: Vulnerable	Aquatic habitats	2007	Glencar Lough. Spawning and nursery areas include the Drumcliffe, Garvoge and Doonally/ Rathbraghan rivers (see Fisheries report below).	2 km
G63Y G74G G73E	Common Frog	*Rana temporaria*	•EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	Pond margins; bogs; damp grassland	2003	A widespread and common species	2 km
G63Y	Great Northern Diver	*Gavia immer*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	Winters along the Irish coastline	2010	A coastal species, not occurring within CSA boundary	2 km
G63Y	Herring Gull	*Larus argentatus*	•Protected Species: Wildlife Acts •Threatened Species: Birds of Conservation Concern: Red List	Breeds along the Irish coast but may feed inland	2011	A widespread and common species locally	2 km
G63Y	Black-headed Gull	*Larus ridibundus*	•Protected Species: Wildlife Acts •Threatened Species:	Breeds along the coast and also inland, on bogs, marshes and lakes	2011	Breeding confirmed in the 10km squares G63 and G73	2 km

			Birds of Conservation Concern : Red List				
G74A	Whooper Swan	*Cygnus cygnus*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	Winters on lowland open farmland around inland wetlands, feeding on grasslands and stubble.	2011	Drumcliff River/Collinsford: G7141	2 km
G63Y	Common Redshank	*Tringa totanus*	•Protected Species: Wildlife Acts •Threatened Species: Birds of Conservation Concern: Red List	Nests on the ground in grassy tussock, in wet, marshy areas and occasionally heather. Winters around the coast, also at inland lakes and large rivers.	2011	Wintering within 10km square G73 and also at Colgagh Lough, south of CSA. Possibly breeding in 10km square G63, unlikely to be within CSA due to habitat constraints	2 km
G63Y	Northern Lapwing	*Vanellus vanellus*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex II, Section II •Threatened Species: Birds of Conservation Concern: Red List	Breed in open farmland; winter in a variety of habitats, including wetlands, pasture and bog	2006	Breeding either suspected or confirmed in each of the 10km squares within which the CSA lies	2 km
G63Y G74L G73D	Eurasian Curlew	*Numenius arquata*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex II, Section II •Threatened Species: Birds of Conservation Concern: Red List	Nests on the ground in rough pastures, meadows and heather. Winters in wetland areas and damp fields.	2011	Recorded both wintering and breeding in a number of locations in the vicinity of the CSA	2 km
G63Y	Dunlin	*Calidris alpina*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I, •Threatened Species: Birds of Conservation Concern: Amber List	Breeds in sparse, low vegetation, especially machair. Winters ijn coastal areas	2006	Cartron Marsh, Ballisadare Bay	2 km
G63Y	Bar-tailed Godwit	*Limosa lapponica*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I, •Threatened Species: Birds of Conservation Concern: Amber List	Winters in coastal areas, especially estuaries	2006	Cartron Marsh /Drumcliff Bay / Ballisadare Bay	2 km
G63Y G74A G74G G73J G74L G74F	Meadow Pipit	*Anthus pratensis*	•Threatened Species: Birds of Conservation Concern:Red List	Breeds in bogs, uplands and areas of scrub and pasture. Tends to move to lowland areas in winter.	2011	Common throughout Ireland	2 km

G63Y G74 G74L	Grey Wagtail	*Motacilla cinerea*	•Threatened Species: Birds of Conservation Concern: Red List	Breeds mainly along streams and rivers, often under bridges.	2006	Common throughout Ireland	2 km
G74G	Red-billed Chough	*Pyrrhocorax pyrrhocorax*	•Protected Species: Wildlife Acts •EU Birds Directive: Annex I	Nests in caves, rock crevices or old buildings, generally in coastal areas.Winters along coast.	1991	Breeding and wintering in G74. Breeding in 2km square G74G and G74B (outside CSA)	2 km
G74L G73D G73J G74A	Pipistrelle	*Pipistrellus pipistrellus sensu lato*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Feeds along continuous lines of wooded habitat in both rural and urban areas. Roosts in houses and trees	2010	Sightings from G7136 and G7239. Also from Glencar lake, G7443 (just outside CSA)	2 km
G74L G73D G73J G74A	Soprano Pipistrelle	*Pipistrellus pygmaeus*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Feeds along continuous lines of wooded habitat in both rural and urban areas. Roosts in houses and trees	2010	Roost in building at G7040 (Kiltycooley, just outside CSA), and also at Bellanode, G7036. Audio records from G7239 and sighting from G7136.	2 km
G74A	Brown Long-eared Bat	*Plecotus auritus*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Generally feeds in woodland; roosts in buildings and tree holes	2008	Roost in building at Killycooley (G7040), just outside CSA. Sighting at G7136	2 km
G73J	Lesser Noctule	*Nyctalus leisleri*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Feeds over open spaces such as parks and fields. Roosts mainly in buildings but also in trees	2010	Audio records from G7239	2 km
G74G	Daubenton's Bat	*Myotis daubentonii*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Feeds overs lakes and slow-flowing rivers. Roost under stone bridges, in ruins, canal tunnels, trees and damp caves.	1998	Roost at G7342 (bridge near Glencar) – likely	2 km
G74A	Whiskered Bat	*Myotis mystacinus*	•EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Forages along forest tracks or near water. Very few confirmed roosts in Ireland – these may be in old buildings, crevices under stone bridges and in trees.	2008	Roost in building at G7040	2 km
G63Y	Common Seal	*Phoca vitulina*	•EU Habitats Directive: Annex II •EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	Coastal habitats	1982	Drumcliff Bay, Ballisadare Bay, Sligo Town	2 km
G63Y G74L G63Z G73E G73J G74A G74G	Eurasian Badger	*Meles meles*	•Protected Species: Wildlife Acts	Pasture, hedgerow, scrub and woodland	2008	A widespread and common species	2 km

G73D	Pine Marten	*Martes martes*	•EU Habitats Directive: Annex V •Protected Species: Wildlife Acts	Require forest or scrub cover but in the west may inhabit relatively open habitats	1991	Kiltycahill, nr Dromahair rd (outside CSA)	2 km
G63Y G74G G74L	European Otter	*Lutra lutra*	•EU Habitats Directive: Annex II •EU Habitats Directive: Annex IV •Protected Species: Wildlife Acts	Range of aquatic habitats: major rivers, upland lakes, coastal lagoons and sandy beaches	2013	Recorded at Gortnagrelly Bridge, Glencar Lough and the 10km square G74 Also Sligo Harbour (G63), Garavogue estuary (Quay Street) and Garavogue river, Sligo town	2 km
G74L G73D G74A	Eurasian Red Squirrel	*Sciurus vulgaris*	•Protected Species: Wildlife Acts	Woodland	2012	Collinsford; Lislahelly; Glencar	2 km
G63Y	Eurasian Pygmy Shrew	*Sorex minutus*	•Protected Species: Wildlife Acts	A wide variety of habitats rich in ground cover - hedgerows, grasslands, woodlands and peatlands	1982	A widespread and common species	2 km
G63Y G63Z G73D	West European Hedgehog	*Erinaceus europaeus*	•Protected Species: Wildlife Acts	Hedgerows and pasture	2013	A widespread and common species	2 km

Appendix 4. Invasive species recorded in the immediate locality (Source - NBDC and NPWS databases).

Grid square	Type of species	Scientific name	Common name	Most recent record	Source	Status	Location
G63Y G73D G74F G74A G74L	flowering plant	*Acer pseudoplatanus*	Sycamore	12/08/2009	EPA River Biologists data	Invasive Species: Medium Impact Invasive Species	
G63Y	flowering plant	*Buddleja davidii*	Butterfly-bush	31/12/1999	BSBI tetrad data for Ireland	Invasive Species: Medium Impact Invasive Species	Sligo Town
G63Y G74L	flowering plant	*Fallopia japonica*	Japanese Knotweed	06/10/2009	National Invasive Species Database	Invasive Species: High Impact Invasive Species	Glencar, at E end of site. Teesan. Sligo Town
G63Y	flowering plant	*Heracleum mantegazzianum*	Giant Hogweed	25/09/2006	National Invasive Species Database	Invasive Species: High Impact Invasive Species	Willsborough sream: bridge on Sligo bundoran road
G73D	flowering plant	*Clematis vitalba*	Traveller's-joy	31/12/1999	BSBI tetrad data for Ireland	Invasive Species: Medium Impact Invasive Species	Ballinode/Rathbrangan
G74F	flowering plant	*Rhododendron ponticum*		21/07/2010	Species data extracted from the National Vegetation Database	Invasive Species: High Impact Invasive Species	The Dooins Lugh Gill Castlegal Hazelwood
G74A	flatworm (Turbellaria)	*Arthurdendyus triangulatus*		19/11/2011	Irish New Zealand Flatworm Database	Invasive Species: High Impact Invasive Species	Collinsford, garden
G63Y	mollusc	*Cornu aspersum*	Common Garden Snail	27/07/1983	All Ireland Non-Marine Molluscan Database	Invasive Species: Medium Impact Invasive Species	Glencar
G74L	mollusc	*Dreissena (Dreissena) polymorpha*	Zebra Mussel	04/04/2011	National Invasive Species Database	Invasive Species: High Impact Invasive Species	Glencar Lough. Drumcliff River. Lough Gill (Toberconnell Bay) Garavogue River, Sligo Town
G73E G73J	terrestrial mammal	*Mustela furo*	Feral Ferret	30/04/1999	National Feral Ferret (Mustela putoris furo) Database	Invasive Species: High Impact Invasive Species	Doonally. Dunkinsella. Both records though to be excaped animals, both captured and rehomed
G63Y	terrestrial mammal	*Rattus norvegicus*	Brown Rat	22/08/2013	Atlas of Mammals in Ireland 2010-2015	Invasive Species: High Impact Invasive Species	Garavogue Sligo Harbour, Finisklin
G63Z	terrestrial mammal	*Oryctolagus cuniculus*	European Rabbit	15/02/2014	Atlas of Mammals in Ireland 2010-2015	Invasive Species: Medium Impact Invasive Species	

14 Soils & Geology

14.1 Introduction

This section of the report describes the soils and geology along the route corridors and considers how they contribute to the selection of an emerging preferred route corridor. This assessment should be read in conjunction with drawings no. N16-RS-077 to N16-RS-078 (Feasible Route Options – Soils & Geology Assessment) and N16-RS-105 to N16-RS-106 (Refined 'Feasible' Route Options - Soils & Geology Assessment).

14.2 Project Outline

The route corridor sections and options are described in Sections 5 and 8 of the Main Report (Volume 1) and can be seen on drawings no. N16-RS-002 (Study Area Overview: Sectional Splitting) and N16-RS-003 (Feasible Route Options – General Overview).

There are 13 initial Feasible Route Options in total, the southern section commences at 4 different potential tie in points with the existing N15, or N16 at the northern perimeter of Sligo urban development and comprises a total of nine different route options 1 through 9. It should be noted that route options 3, 10 and 11 follow the same footprint in the southern section. The route corridor reduces in width significantly in the central and northern sections, resulting in fewer alternative options as follows: Central Section – four alternative route options 1A, 3, 4 and 9 (It should be noted that route options 7,8 and 9 follow the same footprint and route options 2, 3, 5, 6, 10 and 11 follow the same footprint in the central section); and Northern Section - five alternative route options 1A, 3, 5, 10 and 11 (It should be noted that route options 5 and 6 follow the same footprint in the northern section, route options 2A, 3, 4, 7, 8 and 9 follow the same footprint in the northern section). Route options that follow the same footprint have differing earthworks volumes in a number of cases.

14.3 Methodology & Data Sources

In preparation of the Route Options Assessment Report, the soils and geological impacts of each of the route corridor options in each section were assessed and reported in general accordance with the NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, Chapter 3.4.

The majority of the data was collected and assessed in the form of a desk study of available published information from the sources listed at the end of this chapter, together with additional sources of information included as references. Borehore geophysical survey data was not considered necessary for the assessment of the alternative route options.

A site reconnaissance was made by Roughan and O'Donovan Consulting Engineers staff on Wednesday & Thursday 17th & 18th February 2016 to identify any particular constraints and geotechnical or geologic risks evident in the study area.

14.4 Solid Geology, Subsoils and Soils

The Geological Survey of Ireland (GSI) has detailed maps showing the various ground conditions that exist around the country. From these maps and reports it can be determined what existing ground conditions exist in the study area. Areas of solid geology, subsoil's and soils which are located in the

region can be seen in drawings N16-RS-077 (Bedrock formations) and N16-RS-078 (Soils and Geology), which also shows each of the route options considered.

The following sections describe the ground conditions anticipated along each route corridor option and a brief assessment of the associated geotechnical issues.

14.4.1 Solid Geology

A summary of the geological sequence and main rock types likely to be encountered along the route from north to south are shown in Table 14-1. These are shown on drawing N16-RS-077. These are based on the available information on the 1:100,000 scale Geological Survey of Ireland map of the area (Sheet 7 Bedrock Geology Map Series for Sligo – Leitrim).

Table 14-1: Geological Formations occurring in the Study Area

PERIOD	FORMATION	ROCK TYPES
Carboniferous (Dinantian)	Glencar Limestone Formation	Dark fine limestone and calcareous shale
Carboniferous (Dinantian)	Ballyshannon Limestone	Pale grey calcite limestone
Carboniferous (Dinantian)	Mullaghmore Sandstone	Sandstone, siltstone and shale
	Benbulben Shale Formation	Calcareous shale with minor calcarenite

The site is shown to be underlain by Glencar Limestone Formation, Ballyshannon Limestone Formation, Benbulben Shale Formation and Mullaghmore Sandstone from the Carboniferous Age. Some of these rocks are non-argillaceous and should meet the NRA specifications for use as aggregates in road projects.

14.4.1.1 Northern Section

Glencar Limestone was recorded by the GSI throughout the northern section. A number of areas of rock outcrop are noted in the vicinity of Lugnagall and Copes Mountain. These areas are shown on drawing N16-RS-078 and are likely to be of Glencar Limestone Formation.

14.4.1.2 Central Section

In the central section, Glencar Limestone, Ballyshannon Limestone, Benbulben Shale Formation and Mullaghmore Sandstone have been recorded by the GSI. All route options are underlain by Glencar Limestone in the north of the central section, then pass over an area of Mullaghmore Sandstone Formation and are underlain by Ballyshannon Limestone Formation in the south of the Central Section. Benbulben Shale Formation is noted in the west of this section. Route option 4 is the only route that crosses this rock formation. One area of rock outcrop has been noted in the vicinity of Kiltycooly to the south of the L3406-0 very close to the boundary with the southern section. This rock is noted to be karstified and is likely to be of the Ballyshannon Limestone Formation. Further description of karst features is contained in Section 14.7.

14.4.1.3 Southern Section

In the southern section, Glencar Limestone and Ballyshannon Limestone were recorded on the GSI mapping. In the northern portion of the southern section all routes are underlain by Ballyshannon Limestone Formation and then pass into Glencar Limestone to the south, approaching Sligo. A

number of areas of rock outcrop exist between Kiltycooly and Carncash. This rock outcrop is likely to be of Ballyshannon Limestone Formation. This rock is karstified in a number of locations.

14.4.2 Soils & Subsoils

Information on the subsoil/Quaternary geology of the Study Area has been obtained from the GSI and EPA websites. These are shown on drawing N16-RS-078**.**

14.4.2.1 Glacial Deposits

Glacial deposits range from sandy gravelly clay to sands and gravels based on GSI data and information from a recent ground investigation at Sligo General Hospital. These deposits typically do not pose a problem for road construction and for civil engineering purposes, they can be divided into glacial till (fine grained) and glacial till (coarse grained). The majority of the study area is underlain by glacial deposits based on the Teagasc soils mapping data.

14.4.2.1.1 *Glacial Till (Fine Grained)*

Fine grained glacial tills dominate much of the Study Area.

The depth of the fine grained till occurring within the Study Area is not known and is likely to vary considerably between 0 and 10m below ground level.

The geotechnical properties of Irish glacial tills are well documented (Hanrahan, 1977). These soils are generally well graded, variable with gravel lenses, with an absence of clay minerals. The clay fraction typically consists of rock flour, with fines fraction (clay and silt) amounting from about 15% up to about 50%. The glacial tills are generally over-consolidated and therefore possess low compressibility. These soils are usually firm to stiff, however due to their low plasticity, they are very susceptible to softening and deterioration in wet weather, especially if heavily trafficked. When the clayey tills are kept dry, they present relatively little difficulty to road construction.

14.4.2.1.2 *Glacial Till (Coarse Grained)*

Glacio-fluvial deposits of gravels may be present within the Study Area.

Gravel materials do not present problems for road construction, provided the road alignment is kept above the water table. Generally, gravels provide good formation for pavement construction and are generally suitable for reuse. Water bearing sand and silt layers, where encountered, can be problematic.

14.4.2.2 Soft Ground

More recent deposits include soft alluvium, marine deposits, lake sediments and possibly peat. Construction in soft ground may be difficult due to the presence of groundwater and the limited bearing capacity of these soils to accommodate surcharge loading.

Engineering design of road embankments through soft ground, although not desirable, is generally feasible where soil thicknesses are modest. To accommodate road embankments and suitable pavement, the excavation and replacement of soft soils, ground improvement or piled load transfer platforms are required. Also, the TII specification places limits on settlements experienced by the constructed roadway in its design life. There are implications on design, programme and cost to meet these requirements, if construction passes through large or deep areas of soft ground. The rate

of construction can be affected and environmental impacts are increased. The identification and sufficient investigation of soft ground when a preferred route has been selected will be required

The following sections describe the soft soils expected to be present in the Study Area, based on desk study and previous project experience.

14.4.2.2.1 *Marine Estuarine Silts & Clays*

Marine estuarine sediments have been deposited at one location within the route corridor, just west of the existing N15 in the Southern Section only. These deposits are typically high plasticity silts and clays and may have an amount of organic content. They typically consist of normally or slightly over consolidated silt and clays or marine sands.

14.4.2.2.2 *Lake Sediments*

Lake sediments are associated with former basins and channels close to the coastline and exist in isolated areas in the Southern Section only. These deposits are typically high plasticity silts and clays and may have an amount of organic content. They typically consist of normally or slightly over consolidated silt and clays or fluvial sands and gravels.

14.4.2.2.3 *Alluvium*

Alluvial deposits are primarily associated with the Drumcliff River, its tributaries and other small streams. Alluvial deposits located within the study area are indicated to be *'alluvium – gravelly'* according to the Teagasc soil mapping database. Alluvial deposits can vary from high plasticity silts and clays with an amount of organic content to sandy, gravels in upland areas. They typically consist of normally or slightly over consolidated silt and clays or fluvial sands and gravels.

14.4.2.2.4 *Peat Deposits*

Peat soils are naturally transitional, forming from waterlogged vegetation and consequently influencing the habitat as its geochemistry and moisture contents evolve. They are highly organic due to the accumulation and decay of vegetation over time through humification. The mass characteristics and presence of fibres, sands, silts or clays can strongly influence their engineering properties but they are generally low in strength. They are typically highly plastic, settling considerably if subject to surcharge loading.

Fen peat is present as marsh-like conditions, normally high in nutrient content, and comes about from surface water and percolating groundwater.

Cutover peat is what remains following extraction of peat fuel for human use. This would normally have been limited by thickness and water levels, although drainage measures may have been provided to optimise their removal. Thickness of peat in these areas is generally less than 1.5m. Blanket bog peat is present in upland areas mantling bedrock or glacial soils. Blanket peat is present at the northern end of North Section with minor impacts to Route 10.

The following Table 14-2 gives a brief summary of the type and estimated lengths of soft ground that were identified from Teagasc sub soil and GSI Quaternary mapping. The areas are identified by both the townland names. It should be noted that the depth of potential soft material is not known at this stage.

Table 14-2: Summary of Soft Ground Conditions

Section	Route Corridor	Length & Soil Type	Townland
Northern	1A, 2A, 3, 4, 5, 6, 7, 8, 9 & 11	No soft ground noted	
	10	145m of blanket peat	Gortnagrelly
Central	1A, 2A, 3, 4, 5, 6, 10 & 11	70 – 80m of alluvium (potentially soft)	Drum East / Drumkilsellagh
	7,8 & 9	No soft ground noted	
Southern	1A	30m of alluvium (potentially soft)	Teesan
	1B	140m – Estuarine Sediments (likely soft), 130 of alluvium (potentially soft)	Estuarine Deposits - Shannon Eighter, Alluvial Deposits – Teesan, Shannon Eighter
	2A	300m of alluvium (potentially soft)	Rathbraghan, Shannon Oughter
	2B	140m – Estuarine Sediments (likely soft), 400m of alluvium (potentially soft)	Estuarine Deposits -Shannon Eighter, Alluvial Deposits – Rathbraghan, Shannon Oughter
	3, 4, 10 and 11	290m of alluvium (potentially soft)	Doonally / Carnash, Shannon Oughter, Rathbraghan
	5	180m of alluvium (potentially soft)	Rathbraghan, Doonally
	6	140m of alluvium (potentially soft)	Rathbraghan, Doonally
	7	110m of alluvium (potentially soft)	Willowbrook, Rathbraghan, Doonally
	8	295m of alluvium (potentially soft)	Faughts, Rathbraghan, Doonally, Willowbrook, Drumkilsellagh
	9	120m of alluvium (potentially soft)	Willowbrook, Doonally, Rathbraghan

The following paragraphs outline in more descriptive detail the soft ground conditions assessed by this assessment.

14.4.2.2.5 *Northern Section*

An area of blanket peat is noted at the far northern end of Route Option 10. Route option 10 crosses this area of blanket peat over a length of approximately 145m. The depth of this peat is not

likely to be significant as the peat deposits are located on sloping ground located at the foot of Copes Mountain.

Alluvial deposits associated with the Drumcliff River are located outside the study area, approximately 400m to the north of the proposed route options. These alluvial deposits are unlikely to impact on any of the route options in the northern section.

14.4.2.2.6 *Central Section*

Alluvial Deposits

Two areas of alluvial deposits were recorded in the central section adjacent to an existing stream in the townlands of Drum East and Drumkilsellagh. Route options 1A, 2A, 3, 4, 5, 6, 10 and 11 cross one of these areas of alluvium over lengths of between 70m and 80m. This material is recorded as alluvium – gravelly on the Teagasc soils database and may not present any problems for road construction if material is found to be granular.

14.4.2.2.7 *Southern Section*

Estuarine Deposits

An area of estuarine sediments was recorded on the GSI subsoils mapping to the west of the existing N15 between Sligo Town and Shannon Eighter. This material is located adjacent to Sligo Harbour where a number of rivers including the Garvogue River and Willsborough Stream enter Sligo Harbour. Route options 1B and 2B cross a length of approximately 140m of this material. The two routes follow the same path where this material is crossed.

Alluvial Deposits

A number of areas of alluvium were recorded in the southern section adjacent to a number of streams including the Willsborough Stream and its tributaries. The following areas of alluvium were noted from the subsoils mapping database within the footprint of proposed route options:

- Route Option 8 crosses five separate areas of alluvium which equal a total length of 295m (50m + 40m + 135m + 40m + 30m).
- Route Option 9 crosses three separate areas of alluvium which equal a total length of 120m (50m + 40m + 30m)
- Route Option 7 crosses three separate areas of alluvium which equal a total length of 110m (40m + 40m + 30m)
- Route Option 5 crosses two separate areas of alluvium which equal a total length of 180m (50m + 130m)
- Route Option 6 crosses two separate areas of alluvium which equal a total length of 140m (130m + 10m)
- Route Option 3, 4, 10 and 11 cross four separate areas of alluvium which equal a total length of 290m (100 + 60m + 40m + 90m)
- Route Option 2A cross three separate areas of alluvium which equal a total length of 300m (90m + 40m + 170m).

- Route Option 2B crosses four separate areas of alluvium which equal a total length of 400m (90m +40m +170m+100m).
- Route Option 1A crosses one area of alluvium which equals a total length of 30m.
- Route Option 1B crosses two separate areas of alluvium which equal a total length of 130m (100m + 30m).

All this material which is recorded as '*alluvium – gravelly'* on the Teagasc soils database and may not present any problems for road construction if material is founded to be granular. Alternatively cohesive alluvial material is likely to be soft, highly compressible and would present problems for road construction.

Made Ground

A number of areas of made ground have been identified from the GSI mapping within the study area. Made ground is likely to exhibit variable strength and compressibility characteristics and could potentially consist of soft material. The majority of these made ground areas are located within the southern half of the south section and are associated with residential, retail, industrial developments and existing road connections. The following areas of made were identified from the subsoils mapping:

- Route Options 3 and 4 cross two areas of made ground which equal a total length of 420m (400m + 20m). These areas are associated with an existing residential housing development.
- Route Options 2B and 1B cross approximately 940m of made ground associated with existing developments and the existing road network.

It is considered that the areas of made ground indicated above are unlikely to be soft and would be unlikely to present soft ground problems for road construction due to extensive urban development that has already taken place in these areas.

14.5Earthworks Volumes

Each route option will require cuts in areas of higher elevation and embankment construction in areas of low lying topography. The following paragraphs detail the earthworks volumes associated with the various route options. A summary of bulk earthworks quantities for each route is given in Table 14-3.

Excavations for deep cuttings (greater than 10 meters) through steep, sloping ground are at risk of encountering both short term and long term stability problems. The Route selection should avoid alignments with excessive depths or quantities in cuttings on the basis of both safety and economic assessments. From this point of view, all options have cuttings below 10m in height and suitable engineering mitigation methods can be deployed to allay this concern when necessary.

To minimise the geotechnical requirements it would also be best to avoid the construction of high embankments (over 5m especially) on the low-lying ground that contain significant depths of soft material. The ground in these areas is more likely to be marshy and wet so differential settlements and instability are concerns which may require engineering solutions at increased cost to the project.

14.5.1 Northern Section

14.5.1.1 Route Option 1A/1B

Route Option 1 mainline has three cut sections and three fill sections. This route option has a maximum embankment height of 9.1m and a maximum cut depth of 5m. The route is in cutting greater than 2m for 255m of its length while the route is on embankment greater than 2m for 1,286m of its length. This route option has cut and fill volumes of 33,000m^3 and 130,000m^3 respectively. This leaves a deficit of approximately 97,000m^3.

In the case of Option 1A/1B, improvements to the N15 are all at-grade, meaning that there are no significant cut/fill volumes.

14.5.1.2 Route Option 2A/2B

Route Option 2 mainline has five cut sections and four fill sections. This route has a maximum embankment height of 7.8m and a maximum cut depth of 9.9m. The route is in cutting greater than 2m for 530m of its length while the route is on embankment greater than 2m for 395m of its length. This route option has cut and fill volumes of 75,000 m^3 and 57,000m^3 respectively. This leaves a surplus of approximately 19,000m^3.

In the case of Option 2A/2B, improvements to the N15 are all at-grade, meaning that there are no significant cut/fill volumes.

14.5.1.3 Route Option 3

Route Option 3 mainline has four fill sections and four cut sections. This route has a maximum embankment height of 9.5m and a maximum cut depth of 4.4m. This route option is in cutting greater than 2m for 185m of its length while the route is on embankment greater than 2m for 692m of its length. This route option has cut and fill volumes of 30,000 m^3 and 111,000m^3 respectively. This leaves a deficit of approximately 81,000m^3.

14.5.1.4 Route Option 4

Route Option 4 mainline has four cut sections and four fill sections. This route has a maximum embankment height of 10.7m and a maximum cut depth of 5.7m. This route option is in cutting greater than 2m for 196m of its length while this route is on embankment greater than 2m for 670m of its length. This route option has cut and fill volumes of 38,000m^3 and 126,000m^3 respectively. This leaves a deficit of approximately 88,000m^3.

14.5.1.5 Route Option 5

Route Option 5 mainline has four cut sections and four fill sections. This route option has a maximum embankment height of 6.5m and a maximum cut depth of 9.5m. This route is in cutting greater than 2m for 403m of its length while the route is on embankment greater than 2m for 781m of its length. This route option has cut and fill volumes of 69,000m^3 and 71,000m^3 respectively. This leaves a deficit of approximately 2,000 m^3.

14.5.1.6 Route Option 6

Route option 6 mainline has four cut sections and four fill sections. This route option has a maximum embankment height of 6.5m and a maximum cut depth of 9.5m. This route is in cutting greater than 2m for 402m of its length while the route is on embankment greater than 2m for 781m of its length.

This route option has cut and fill volumes of 62,000m^3 and 68,000m^3 respectively. This leaves a deficit of approximately 6,000m^3.

14.5.1.7 Route Option 7

Route option 7 mainline has five cut sections and five fill sections. This route option has a maximum embankment height of 7.9m and a maximum cut depth of 8.6m. This route is in cutting greater than 2m for 551m of its length while the route is on embankment for 348m of its length. This route option has cut and fill volumes of 72,000m^3 and 57,000m^3 respectively. This leaves a surplus of approximately 15,000m^3.

14.5.1.8 Route Option 8

Route option 8 mainline has five cut sections and five fill sections. This route option has a maximum embankment height of 8.1m and a maximum cut depth of 9.9m. The route is in cutting greater than 2m for 471m of its length while the route is on embankment greater than 2m for 426m of its length. This route option has cut and fill volumes of 72,000m^3 and 63,000m^3 respectively. This leaves a surplus of approximately 8,000m^3.

14.5.1.9 Route Option 9

Route option 9 mainline has four cut sections and four fill sections. This route option has a maximum embankment height of 8.0m and a maximum cut depth of 8.5m. This route is in cutting greater than 2m depth for 540m of its length while this route is on embankment greater than 2m in height for 442m of its length. This route option has cut and fill volumes of 71,000m^3 and 66,000m^3 respectively. This leaves a surplus of approximately 5,000m^3.

14.5.1.10 Route Option 10

Route option 10 mainline has three cut sections and two fill sections. This route option has a maximum embankment height of 9.1m and a maximum cut depth of 7.6m. This route is in cutting greater than 2m depth for 1,298m of its length while this route is on embankment greater than 2m in height for 347m of its length. This route option has cut and fill volumes of 204,000m^3 and 42,000m^3 respectively. This leaves a surplus of approximately 162,000m^3.

14.5.1.11 Route Option 11

Route Option 11 mainline has three cut sections and three fill sections. This route option has a maximum embankment height of 8.3m and a maximum cut depth of 8.2m. This route is in cutting greater than 2m depth for 643m of its length while this route is on embankment of greater than 2m in height for 1,406m. This route option has cut and fill volumes of 86,000m^3 and 178,000m^3 respectively. This leaves a deficit of 92,000m^3.

14.5.2 **Central Section**

14.5.2.1 Route Option 1

Route Option 1 mainline has 1 cut section and 2 fill sections. This route option has a maximum embankment height of 19.1m and a maximum cut depth of 12.1m. This route is in cutting greater than 2m depth for 697m of its length while this route is on embankment greater than 2m in height for 967m of its length. This route option has cut and fill volumes of 167,000m^3 and 240,000m^3 respectively. This leaves a deficit of 73,000m^3.

14.5.2.2 Route Option 2

Route Option 2 mainline has 2 cut sections and 3 fill sections. This route option has a maximum embankment height of 22.7m and a maximum cut depth of 12.4m. This route is in cutting greater than 2m depth for 475m of its length while this route is on embankment greater than 2m in height for 920m of its length. This route option has cut and fill volumes of 107,000m^3 and 279,000m^3 respectively. This leaves a deficit of 172,000m^3.

14.5.2.3 Route Option 3

Route Option 3 mainline has 2 cut sections and 3 fill sections. This route option has a maximum embankment height of 22.9m and a maximum cut depth of 12.2m. This route is in cutting greater than 2m depth for 500m of its length while this route is on embankment greater than 2m in height for 923m of its length. This route option has cut and fill volumes of 100,000m^3 and 288,000m^3 respectively. This leaves a deficit of 188,000m^3 respectively.

14.5.2.4 Route Option 4

Route Option 4 mainline has 1 cut section and 2 fill sections. This route option has a maximum embankment height of 20.1m and a maximum cut depth of 15.4m. This route option is in cutting greater than 2m depth for 571m of its length while this route is on embankment greater than 2m for 1,025m of its length. This route option has cut and fill volumes of 221,000m^3 and 411,000m^3 respectively. This leaves a deficit of 190,000m^3.

14.5.2.5 Route Option 5

Route Option 5 mainline has 2 cut sections and 3 fill sections. This route option has a maximum embankment height of 23m and a maximum cut depth of 9.8m. This route is in cutting greater than 2m depth for 337m of its length while this route is on embankment of greater than 2m in height for 666m of its length. This route option has cut and fill volumes of 66,000m^3 and 244,000m^3 respectively. This leaves a deficit of 178,000m^3.

14.5.2.6 Route Option 6

Route Option 6 mainline has 3 cut sections and 3 fill sections. This route option has a maximum embankment height of 23m and a maximum cut depth of 9.8m. This route is in cutting greater than 2m depth for 337m of its length while this route is on embankment of greater than 2m in height for 666m of its length. This route option has cut and fill volumes of 66,000m^3 and 231,000m^3 respectively. This leaves a deficit of 165,000m^3.

14.5.2.7 Route Option 7 & 9

Route Options 7 and 9 mainlines have 3 cut sections and 4 fill sections. These route options have a maximum embankment height of 15.7m and a maximum cut depth of 15.7m. These routes are in cutting greater than 2m depth for 508m while these routes are on embankment greater than 2m for 437m. These route options have cut and fill volumes of 162,000m^3 and 116,000m^3 respectively. This leaves a surplus of 46,000m^3.

14.5.2.8 Route Option 8

Route Option 8 mainline has 3 cut sections and 4 fill sections. This route option has a maximum embankment height of 14.9m and a maximum cut depth of 16m. This route is in cutting of greater

than 2m depth for 578m of its length while this route is on embankment greater than 2m for 345m of its length. This route option has cut and fill volumes of 182,000m^3 and 86,000m^3 respectively. This leaves a surplus of 96,000m^3.

14.5.2.9 Route Option 10 & 11

Route Options 10 and 11 mainlines have 2 cut sections and 3 fill sections. These route options have a maximum embankment height of 21.9m and a maximum cut depth of 13.3m. These routes are in cutting greater than 2m depth for 425m while these routes are on embankment greater than 2m for 950m. These route options have cut and fill volumes of 111,000m^3 and 334,000m^3 respectively. This leaves a deficit of 223,000m^3.

14.5.3 Southern Section

14.5.3.1 Route Option 1

Route Option 1 mainline has 4 cut sections and 4 fill sections. This route option has a maximum embankment height of 8.4m and a maximum cut depth of 12.2m. This route is in cutting greater than 2m depth for 516m of its length while this route is on embankment greater than 2m in height for 634m. This route option has cut and fill volumes of 108,000m^3 and 91,000m^3 respectively. This leaves a surplus of 17,000m^3.

14.5.3.2 Route Option 2

Route Option 2 mainline has 6 cut sections and 7 fill sections. This route option has a maximum embankment height of 5.8m and a maximum cut depth of 10.7m. This route is in cutting greater than 2m depth for 770m of its length while this route is on embankment greater than 2m for 1,023m of its length. This route option has cut and fill volumes of 136,000m^3 and 111,000m^3. This leaves a surplus of 25,000m^3.

14.5.3.3 Route Option 3

Route Option 3 mainline has 4 cut sections and 5 fill sections. This route option has a maximum embankment height of 7.7m and a maximum cut depth of 12.0m. This route is in cutting greater than 2m depth for 859m of its length while this route is on embankment greater than 2m height for 1,266m of its length. This route option has cut and fill volumes of 189,000m^3 and 131,000m^3 respectively. This leaves a surplus of 58,000m^3.

14.5.3.4 Route Option 4

Route Option 4 mainline has 4 cut sections and 4 fill sections. This route option has a maximum embankment height of 7.7m and a maximum cut depth of 12.0m. This route is in cutting greater than 2m depth for 1,426m while this route is on embankment greater than 2m in height for 1,039m. This route option has cut and fill volumes of 259,000m^3 and 104,000m^3 respectively. This leaves a surplus of 155,000m^3.

14.5.3.5 Route Option 5

Route Option 5 mainline has 4 cut sections and 4 fill sections. This route option has a maximum embankment height of 9.3m and a maximum cut depth of 5.5m. This route is in cutting greater than 2m for 188m while this route is on embankment greater than 2m in height for 1,414m. This route option has cut and fill volumes of 33,000m^3 and 210,000m^3. This leaves a deficit of 177,000m^3.

14.5.3.6 Route Option 6

Route Option 6 mainline has 5 cut sections and 5 fill sections. This route option has a maximum embankment height of 7.3m and a maximum cut depth of 8.0m. This route is in cutting greater than 2m depth for 378m while this route is on embankment greater than 2m in height for 1,337m. This route option has cut and fill volumes of 64,000m^3 and 135,000m^3. This leaves a deficit of 71,000m^3.

14.5.3.7 Route Option 7

Route Option 7 mainline has 5 cut sections and 6 fill sections. This route option has a maximum embankment height of 9.2m and a maximum cut depth of 15.5m.This route option is in cutting greater than 2m depth for 908m while this route is on embankment greater than 2m for 1,577m. This route option has cut and fill volumes of 294,000m^3 and 192,000m^3 respectively. This leaves a surplus of 102,000m^3.

14.5.3.8 Route Option 8

Route Option 8 mainline has 5 cut sections and 6 fill sections. This route option has a maximum embankment height of 9.6m and a maximum cut depth of 12.8m. This route is in cutting greater than 2m depth for 828m while this route is on embankment greater than 2m in height for 1,307m of its length. This route option has cut and fill volumes of 186,000m^3 and 144,000m^3 respectively. This leaves a surplus of 42,000m^3.

14.5.3.9 Route Option 9

Route Option 9 mainline has 4 cut sections and 6 fill sections. This route option has a maximum embankment height of 9.0m and a maximum cut depth of 15.5m. This route is in cutting greater than 2m depth for 854m of its length while this route is on embankment greater than 2m in height for 1,556m in length. This route option has cut and fill volumes of 289,000m^3 and 201,000m^3 respectively. This leaves a surplus of 88,000m^3.

14.5.3.10 Route Option 10

Route Option 10 mainline has 4 cut sections and 5 fill sections. This route option has a maximum embankment height of 7.6m and a maximum cut depth of 12.1m. This route is in cutting greater than 2m depth for 870m of its length while this route is on embankment greater than 2m in height for 1,272m. This route option has cut and fill volumes of 195,000m^3 and 131,000m^3. This leaves a surplus of 64,000m^3.

14.5.3.11 Route Option 11

Route Option 11 mainline has 4 cut sections and 5 fill sections. This route option has a maximum embankment height of 7.6m and a maximum cut depth of 12.1m. This route is in cutting greater than 2m depth for 870m of its length while this route is on embankment greater than 2m in height for 1,272m. This route option has cut and fill volumes of 200,000m^3 and 186,000m^3. This leaves a surplus of 14,000m^3.

Table 14-3 Earthworks Quantities

Route Option	Southern Section			Central Section			Northern Section			Total		
	Cut	Fill	Cut / Fill Balance	Cut	Fill	Cut / Fill Balance	Cut	Fill	Cut / Fill Balance	Cut	Fill	Cut / Fill Balance
	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)
1	108,155	91,002	**17,153**	167,006	239,827	**(72,821)**	32,728	130,195	**(97,467)**	307,889	461,024	**(153,135)**
2	135,673	111.363	**24,310**	107,095	279,475	**(172,380)**	75,302	56,564	**18,739**	318,070	447,401	**(129,331)**
3	188,758	130,730	**58,028**	100,295	288,169	**(187,873)**	30,261	111,037	**(80,776)**	319,314	529,936	**(210,621)**
4	258,560	103,933	**154,627**	221,018	410,762	**(189,743)**	38,425	126,030	**(87,605)**	518,003	640,724	**(122,722)**
5	32,610	210,058	**(177,448)**	65,694	244,484	**(178,790)**	69,307	71,466	**(2,159)**	167,611	526,008	**(358,397)**
6	63,787	135,220	**(71,433)**	65,794	230,819	**(165,025)**	61,851	68,442	**(6,592)**	191,432	434,481	**(243,049)**
7	294,351	191,777	**102,574**	162,050	115,643	**46,407**	72,461	57,221	**15,240**	528,862	364,640	**164,221**
8	185,551	144,388	**41,164**	181,702	85,744	**95,958**	71,645	63,411	**8,234**	438,898	293,542	**145,355**
9	289,048	200,879	**88,169**	160,969	115,994	**44,976**	70,960	65,779	**5,181**	520,977	382,652	**138,326**
10	194,684	130,915	**63,769**	110,900	334,407	**(223,507)**	204,482	42,393	**162,089**	510,066	507,715	**2,351**
11	199,578	185,578	**14,000**	110,953	334,379	**(223,425)**	86,094	177,673	**(91,579)**	396,625	697,630	**(301,005)**

NB: The above analysis excludes extensions to 1A and 2A, i.e. 1B and 2B – Designs will be at grade

Note: Volumetric Analysis for options 3, 4, 10 and 11 include the link in the southern section to the AbbVie Roundabout, excluded from the analysis is the local access link onto the existing N15

14.6Made Ground / Contaminated Land / Landfills

Made ground occurs frequently as a result of various human activities and patterns. Site developments associated with housing, sportsfields, retail and industrial constructions can cause varied changes to ground topography, drainage and may often result in instability or long term settlements where located on soft soils or at tip areas following their removal. Made ground is likely to exhibit variable strength and compressibility characteristics. Made ground may prove problematic for road construction if contaminated materials are present.

A number of areas of made ground have been identified from the GSI mapping within the study area. The majority of these are located within the southern half of the south section and are associated with residential, retail and industrial construction.

A site with a certificate of registration for the importation of fill has been identified within the Study Area. This is Sean Gilroy's Quarry, located at Lugnagall and was an active quarry in the past. In 2008, the EPA granted permission to Sligo County Council for the importation of 4,100 tonnes of inert fill (200 tonnes of EWC code 17 01 07 – mixture of non hazardous concrete, bricks, tiles and ceramics, 400 tonnes of EWC code 17 03 02 – bituminous mixtures not containing coal tar and 3,500 tonnes of EWC code 17 05 04 soil and stones) to this site. This certificate remains valid. All of the route options in the northern section are likely to pass close to this site. This site may present a potential risk of contamination.

Two historic authorised fill sites have been identified within the study area. One of these areas is Francis Scanlon's Quarry (Glen Resources) which is no longer active. The other area is Patrick Goggins' site located on the L3406-0 local road at the western boundary of the study area.

The sites of Sean Gilroy's Quarry and Francis Scanlon's Quarry were visited during the site walkover. These areas show possible areas of contaminated ground from disused construction machinery plus waste material noted at the ground surface. All of the route options in the northern section pass in close proximity to both these areas. Photographs of the historic quarry sites below:

Locations of all known landfill sites and quarries are shown on drawing N16-RS-078.

Plate 14-1 Francis Scanlon's Quarry 1

Plate 14-2 Francis Scanlon's Quarry 2

Plate 14-3 Francis Scanlon's Quarry 3

Plate 14-4 Sean Gilroy's Quarry 1

Plate 14-5 Sean Gilroy's Quarry 2

14.7Karst Features

Karst features manifest themselves by the progressive dissolution of pure and nearly pure carbonate minerals from limestones. The weathered rock can display several characteristics such as swallow holes, springs or caves and areas susceptible to surface erosion. Acidic rainwater speeds up the process just as clearly defined bedding also makes rocks more susceptible. Groundwater movements can be complicated in such an aquifer, with connectivity and transport times between locations being difficult to predict.

A preliminary assessment of potential areas of karstification has been conducted based on surface features such as swallow holes, springs, caves and surface erosion from the GSI database and site reconnaissance.

A number of areas of karstification have been identified in the study area. There are five areas identified from the GSI mapping that indicated karstified limestone bedrock at surface level between Kiltycooly and Carnash. These are shown on drawing N16-RS-078. A number of these areas were visited during the site walkover. Karst surface features such as sinkholes and evidence of surface erosion were identified at these locations. No karst features have been identified within the footprint of any of the route options. Route Option 1A + 1B passes in close proximity to a number of these areas and the minimum distance from this route option to an identified area of karstification is approximately 30m. The possibility of undisclosed Karst features along any of the Route Options cannot be discounted but Route Option 1A + 1B is likely to present greater potential risk of encountering areas of karstification.

In addition to these karst areas, two further wet depressional areas have been identified, in the central section of the study area and a further one of these areas outside the study area. Route option 4 crosses one of these features. Without further exploration, it is not possible to confirm whether these wet areas present a significant geotechnical risk.

14.8Historical Land Use

In the northern section, the central section and the north of the southern section the route options pass through areas of mainly agricultural land. There are a number of residential properties dotted across the landscape. The existing N16 passes through these areas with a number of local roads branching off the existing N16.

In the northern section, the proposed route options are located in the Drumcliff River Valley with King's Mountain to the north and Cope's Mountain to the south. Both of these mountains have relatively steep slopes with rock outcrop present on the slopes to the south leading to Cope's Mountain.

In the south of the southern section, to the north of Sligo Town and environs, there is much residential and commercial use of the lands, which have been developed for the construction of the Sligo Institute of Technology, St. Columba's Hospital and the Abbvie Ireland Pharmaceutical Plant. These are all located to the north of the River Garavogue and influence the tie-in points of the route options in the Southern Section.

14.9Unstable Land / Rock Slope Instability

Areas of historical landslide instability are mapped and recorded on the GSI Landslide database. North of the route corridor along the southern slopes of King's Mountain several landslides are recorded but none of these appear to have the potential to have any impact on the route corridor as the cliff faces are located at least 1.5 km distant and separated from potential route options by the Drumcliff River valley. Of greater potential concern are 3 historical landslides located on the 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. Historical landslides are shown on drawing N16-RS-078.

Inspection of Teagasc sub soil and GSI Quaternary mapping indicates that none of the route options are threatened directly or indirectly by rock falls or scree. The historical rock fall location of greatest concern is located near the townland of Lugnagall in the Northern Section but all of the route options are 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 south west of the alternative route options. Rock slope instability is not included in the characteristics assessed for alternative route options.

14.10 Economic Geology

There are no active quarries or pits situated in the Study Area. The closest active quarry to the study area is Aughamore Quarry, located approximately 6km to the south of Sligo Town in Carraroe. If there is likely to be a deficit of material for construction of the scheme it is likely that nearby quarries will be utilised.

Two known quarry sites that were active in the past have been identified within the study area. These are Francis Scanlon's Quarry (Glen Resources) and Sean Gilroy's Quarry. Both of these quarry

owners commenced the registration process under Section 261, of the Planning and Development Act, 2000. Neither of these quarries are authorised for the extraction of materials at present. Sean Gilroy's Quarry has the potential to accept some inert fill material. Two historic authorised fill sites have been identified within the study area. One of these areas is Francis Scanlon's Quarry (Glen Resources). The other areas are Patrick Goggins' site located on the L3406-0 local road plus a historic quarry at Lugnagall close to the existing N16.

Drawing N16-RS-078 shows the locations of active and historic quarry sites.

14.11 Geological Heritage Sites

A number of county geological heritage sites are included in the County Development Plan in the general vicinity of the project. These include the following:

- Ben Bulben
- Truskmore;
- King's Mountain Rift;
- Swiss Valley;
- Glencarbury Mine;
- Gleniff Valley;
- Diarmuid and Grainne's cave

None of these features are located in the route corridor study area and from a Soils and geology perspective, none are directly or indirectly affected by any of the alternative route options. Hence Geologic Heritage is not included in the characteristics assessed for alternative route options.

14.12 Comparison of Route Options

The comparison and ranking of the route options was divided into three sections; the northern section, the central section and the southern section as indicated on drawing N16-RS-002. The route options in each section were compared on geotechnical criteria for the length of the Route that passed through or impacted:

(a) cut and fill balance and total earthworks volumes;
(b) made ground, contaminated land and quarries;
(c) soft ground deposits; and
(d) karst.

Other factors relating to economic geology, rock slope instability and geological heritage are not likely to have differential impact for any of the alternative route corridors and therefore were not ranked. The route option with the worst ranking was given a value of 5, while the route corridor with the best ranking was given a value of 1. The rankings are as follows:

- Very high preference – 1
- High preference – 2
- Medium preference – 3
- Low preference – 4
- Very low preference – 5

14.12.1 Northern Section

Cut and Fill Balance was determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 2 and 7 were ranked as

most favourable as they have a surplus of approximately 25 – 40% of the fill requirement. Route options 1, 3, 4 and 11 were marked as the least favourable as they have unfavourableearthworks deficits.

The rating for made ground / landfill / quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. All route options in the northern section pass close to Sean Gilroys Quarry which holds a licence to accept inert fill. The sites of Sean Gilroy's Quarry and Francis Scanlon's Quarry are unlikely to impact on the proposed routes within this area. All route options have been given the same rating in the northern section.

The rating for soft ground is based on the length of routes that pass through this type of material. In the northern section, route option 10 passes through approximately 145m of blanket peat. None of the other routes in the northern section passed through soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification as described in Section 14.7. None of the routes in the northern section pass through any areas of suspected karstification, so therefore all routes have been rated the same.

14.12.2 Central Section

Cut and Fill Balance was determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 7 and 9 were ranked as the most favourable as they had a surplus of approximately 25 – 40 % of the required fill volume. Route options 1, 2, 3, 4, 5, 6, 10 and 11 were ranked as least favourable as they have notable earthworks deficits.

The rating for made ground / landfill / quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. None of the routes in the central section pass in close proximity to any areas of made ground, landfill or quarry sites which present a risk of contamination. All route options have been given the same rating in this instance.

The rating for soft ground was based on the length of route options that pass through this type of material. In this section, route option 1A, 3 and 4 pass through between 70 and 80m of potential soft ground while route options 7, 8 and 9 do not pass through any soft ground. Route option 9 has been ranked as most favourable in terms of soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification as described in Section 14.7. Two wet depressional areas have been identified, in the central section of the study area and a further one of these areas outside the study area. Route option 4 crosses one of these features. Route option 4 has been ranked as least favourable in this case.

14.12.3 Southern Section

Cut and Fill Balance was determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 3, 7, 9 and 10 were ranked most favourably as they generally had a surplus of 25 to 40 % of the required fill volume. Route option 5 was ranked as least favourable it has the highest deficit.

The rating for made ground / landfill / quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. Route option 4 passes to the east of Patrick Goggins' historic fill site as indicated on drawing N16-RS-078. This closed landfill is located at the western boundary of the study area.

The rating for soft ground is based on the length of routes that pass through this type of material. All route options cross some length of soft ground in this section. Route options 1B, 2A +2B, 3, 4 and 8 cross between 270m and 440m of soft ground and have been ranked as least favourable in terms of soft ground. Route options 5, 6, 7 and 9 cross between 110m and 180m approximately and have been ranked next favourable in terms of soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification as described in Section 14.7. Route Option 1A + 1B passes in close proximity to a number of potential karst areas with the minimum distance from this route option to an identified area of karstification is approximately 30m. Route Option 1A + 1B is likely to present the greatest potential risk of encountering areas of karstification and is ranked as least favourable in terms of karst in this case.

Table 14-4 gives a summary of the overall rankings for each route option where the route option with the worst ranking is given a value of 5, while the route corridor with the best ranking is given a value of 1

Table 14-4: Feasible Route Options Ranking (North)

NORTHERN SECTION	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks
Route Corridor Option	1A	2A / 7	3	4	5 / 6	8 /9	10	11
EW Volume / Cut & Fill Balance	5	1	5	5	4	2	3	5
Made Ground / Landfill / Quarries	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site	4 – Route near to historical fill site
Peat and Soft Ground	2	2	2	2	2	2	3 – Route crosses 145m of peat.	2
Karst	3	3	3	3	3	3	3	3
Total	14	10	14	14	13	11	13	14
Ranking	Joint 5th	1st	Joint 5th	Joint 5th	Joint 3rd	2nd	Joint 3rd	Joint 5th
Preference	(4) Low	(2) High	(4) Low	(4) Low	(3) Medium	(2) High	(3) Medium	(4) Low

*Route Option 2A, 4, 7, 8 and 9 follow the same footprint but have different cut / fill balances.

Table 14-5: Feasible Route Options Ranking (Central)

CENTRAL SECTION	Marks	Marks	Marks	Marks	Marks
Route Corridor Option	1A	2 /3 / 5 /6 / 10 / 11	4	7/9	8*
EW Volume / Cut & Fill Balance	5	5	5	1	2
Made Ground / Landfill / Quarries	3	3	3	3	3
Peat and Soft Ground	3	3	3	2	2

Karst	3	3	4 – route option crosses a wet depressional area	3	3
Total	14	14	15	9	10
Ranking	Joint 3rd	Joint 3rd	5th	1st	2nd
Preference	(4) Low	(4) Low	(5) V. Low	(1) V. High	(2) High

*Route Option 8 follows the same footprint as Route Options 7 and 9, however it has a different cut / fill balance.

Table 14-6: Feasible Route Options Ranking (South)

SOUTHERN SECTION	Marks										
Route Corridor Option	1A	1B	2A +2B	3 /10	4	5	6	7	8	9	11
EW Volume / Cut & Fill Balance	2	2	2	1	2	5	4	1	2	1	2
Made Ground / Landfill / Quarries	3	3	3	3	3	3	3	3	3	3	3
Peat and Soft Ground	3	5	5	5	5	4	4	4	5	4	5
Karst	5 – route option crosses an area of karstified rock outcrop	5 – route option crosses an area of karstified rock outcrop	3	3	3	3	3	3	3	3	3
Total	13	15	13	12	13	15	14	11	13	11	13
Ranking	Joint 4th	Joint 9th	Joint 4th	3rd	Joint 4th	Joint 9th	8th	Joint 1st	Joint 4th	Joint 1st	Joint 4th
Preference	(3) Medium	(5) V. Low	(3) Medium	(3) Medium	(3) Medium	(5) V. Low	(4) Low	(2) High	(3) Medium	(2) High	(3) Medium

*Route Option 11 follows the same footprint as Route Options 3 and 10, however it has a different cut / fill balance.

Table 14-7: Feasible Route Options Ranking (Total)

	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks	Marks
Route Corridor Option	1A	1B	2A + 2B	3	4	5	6	7	8	9	10	11
Northern	4	4	2	4	4	3	3	2	2	2	3	4
Central	4	4	4	4	5	4	4	1	2	1	4	4
Southern	3	5	3	3	3	5	4	2	3	2	3	3
Total	11	13	9	11	12	12	11	5	7	5	10	11
Ranking	Joint 5th	7th	3rd	Joint 5th	Joint 6th	Joint 6th	Joint 5th	Joint 1st	2nd	Joint 1st	4th	Joint 5th
Preference	4 (Low)	5 (V. Low)	2 (High)	4 (Low)	4 (Low)	4 (Low)	3 (Medium)	1 (V. High)	2 (High)	1 (V. High)	3 (Medium)	3 (Medium)

Table 14-8: Feasible Route Options Ranking (Total)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	5	3	3	3	3	5	4	2	3	2	3	3
Middle	4	4	4	4	4	5	4	4	1	2	1	4	4
North	4	4	2	2	4	4	3	3	2	2	2	3	4
Overall	4	5	2	2	4	4	4	3	1	2	1	3	3

14.13 Refined Route Options

Following completion of stage 1 of the route selection process and the issue of the document 'N16 Refinement of Route Options', an additional amalgamated route option 12 has been identified. It is an amalgamation of a number of different routes. Route option 12 follows the same footprints as existing route option 7 in the very south and then ties in with existing route option 8 for the southern and central section. The route then follows the footprint of existing option 11 in the southern part of the northern section and then ties in with and follows the same footprint of route option 9 for the remainder of the northern section. Option 12 also has an alternative alignment at Gortnagrelly which is referred to as Option 12 – V2.

Localised changes have also been made to a number of routes of follows:

Southern Section

- **Route Options 1A/B** change to **Options 1A /B – V2.** The change is the provision of an underbridge arrangement over the L7421-0;
- **Route Options 2A/B** change to **Options 2A /B – V2**. The change is the provision of an underbridge arrangement over the L7422-0;
- **Option 13** – The East/West link which was previously proposed as part of Option 03 is retained and will be considered as a **complimentary** element to Options 05 and 12.

Central Section

- **Route Option 08** changes to **Option** 0**8 – v2**: The change is the provision of an underbridge arrangement over the L3404-0. In addition, there are **3 separate** junction arrangements.

Northern Section

- **Route Option 08** changes to **Option** 0**8 – v2**: The change is a continuation of the above change in the Central Section.

A number of route options have been discounted following the stage 1 refinement of route options. Option 1A/B and 2A/B have been discounted in the central and northern sections, options 3, 4, 6, 7, 9, 10 and 11 have been discounted entirely, option 5 has been discounted in the northern section and option 8 has been discounted in the southern section. Drawings no. N16-RS-004 (Refined 'Feasible Route Options' – General Overview) and N16-RS-005 (Refined Route Options – General Overview) show the refined route options. These refined route options are assessed in this section.

Provision of under bridges as indicated in the localised changes indicated above will not affect the original rankings of route options 1A / B, 2A/B and route option 8 in terms of soft ground. The foundations for these bridges which form part of option 1A/B and option 8 are likely to be founded in glacial tills and the bridge within option 2A/B is likely to be founded on alluvial granular material (Option 2A/B).

Route option 12, which is new, crosses approximately 245m of alluvium – gravelly material in the southern section and approximately 70m of alluvium - gravelly material in the central section. Material which is recorded as '*alluvium – gravelly'* on the Teagasc soils database and may not present any problems for road construction if material is found to be granular. Alternatively cohesive alluvial material is likely to be soft, highly compressible and would present problems for road construction. Route option 12 does not cross any areas of likely soft ground in the northern section.

There are no karst features within close proximity to route option 12. Route Option 12 and Route Option 12 V2 pass immediately adjacent to Lugnagall Historic Quarry while route option 12 V2 also crosses in close proximity to Francis Scanlon's Quarry.

Earthworks Quantities for the redefined options are indicated in Table 14-8.

Rankings for the refined options for earthworks balance, made ground / landfill / quarries, soft ground and karst likelihood are indicated for options in the northern section, the central section and the southern section in Table 14-10, Table 14-11 and Table 14-12. The total preferences are provided in Table 14-13.

Table 14-9: Earthworks Quantities for Redefined Options

	Southern Section					Middle Section					Northern Section				
	Chainage (m)		Volumetric Analysis		Cut Fill balance	Chainage (m)		Volumetric Analysis		Cut Fill balance	Chainage (m)		Volumetric Analysis		Cut Fill balance
Option	*from*	*to*	*Cut (m^3)*	*Fill (m^3)*	*(m^3)*	*from*	*to*	*Cut (m^3)*	*Fill (m^3)*	*(m^3)*	*from*	*to*	*Cut (m^3)*	*Fill (m^3)*	*(m^3)*
1 - v2	0	2,600	81,685	243,364	**-161,678**										
2 - v2	0	3,690	85,135	216,036	**-130,901**										
5	0	3,210	32,610	210,058	**-177,448**	3,210	5,010	55,129	249,095	**-193,966**					
8 - v2						3,730	5,570	194,676	156,564	**38,113**	5,570	end	27,898	187,786	**-159,888**
12 & 12-V2	0	3,730	232,398	218,431	**13,968**	3,730	5,580	90,873	179,777	**-88,904**	5,580	end	37,152	129,080	**-91,928**

Table 14-10: Refined Route Options Preferences (North)

NORTHERN SECTION	Marks	Marks	Marks
Route Corridor Option	8	12	12 – V2
EW Volume / Cut & Fill Balance	5	4	4
Made Ground / Landfill / Quarries	4 – Route near to historical fill site	5 – route runs immediately adjacent to historical fill site	5 – route runs immediately adjacent to historical fill site
Peat and Soft Ground	2	2	2
Karst	3	3	3
Total	14	14	14
Ranking	Joint 1st	Joint 1st	Joint 1st
Preference	(3) Medium Preference	(3) Medium Preference	(3) Medium Preference

Table 14-11: Refined Route Options Preferences (Central)[12]

CENTRAL SECTION	Marks	Marks	Marks
Route Corridor Option	5	8 *	12*
EW Volume / Cut & Fill Balance	5	1	4
Made Ground / Landfill / Quarries	3	3	3
Peat and Soft Ground	3	3	3
Karst	3	3	3
Total	14	10	13
Ranking	3rd	1st	2nd
Preference	(3) Medium	(1) V. High	(2) High

Table 14-12: Refined Route Options Preferences (South)[13]

SOUTHERN SECTION	Marks	Marks	Marks
Route Corridor Option	1A	1B	2A + 2B
EW Volume / Cut & Fill Balance	4	4	4
Made Ground / Landfill / Quarries	3	3	3

[12] Options 8 and 12 follow the same path in the central section but have different earthworks volumes

[13] *Route Option 13 is combined with the assessment of Options 5 and 12 and is considered to form part of these options in the southern section.

SOUTHERN SECTION	Marks	Marks	Marks
Peat and Soft Ground	3	5	5
Karst	5 – route option crosses an area of karstified rock outcrop	5 – route option crosses an area of karstified rock outcrop	3
Total	15	17	15
Ranking	Joint 2nd	4th	Joint 2nd
Preference	(4) Low	(5) V. Low	(4) Low

Table 14-13: Refined Route Options Preferences (Total)

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	4	5	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	1	n/a	n/a	n/a	2	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
Overall	3	3	3	3	n/a	n/a	3	n/a	n/a	2	n/a	n/a	n/a	3	3

15 Hydrology and Hydrogeology

15.1 Introduction

This section details the assessment of the N16 route options with respect to hydrology and hydrogeology constraints. The study area is split into 3 sections, Southern, Central and Northern and a total of 13 route options are assessed. This assessment should be read in conjunction with drawings no. N16-RS-079 to N16-RS-080 (Feasible Route Options – Hydrology Assessment) and N16-RS-107 to N16-RS-108 (Refined 'Feasible' Route Options - Hydrology Assessment).

15.2 Methodology

The assessment is undertaken in line with TII (NRA, 2008) guidelines on procedures for assessment and treatment of geology, hydrology and hydrogeology for national road schemes. The assessment involved the assessment of each route option using data presented at the constraints study to identify potential impacts on water dependent receptors, which include water dependent habitats both surface water and groundwater fed habitats, surface water resources, flooding and flood risk, water quality, groundwater resources including groundwater bodies and aquifers and water abstractions. This assessment highlights those water dependent receptors considered to be at risk from the route options and provides qualitative assessments of potential impact on such receptors.

15.3 Overview of hydrology

15.3.1 General Description of N16 Study Area

Within the Study Area there are four 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 Kellogyboy 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 N16, moderate to gentle sloping lands are present which become more gentle in gradient towards the coast. The ground levels within the study area and along the proposed route options increase northwards, with the Southern section near Sligo Town being typically at 10 to 20m OD and increasing to 70 to 80m OD in the central section in the vicinity of the existing N16 road at Drumkilsellagh td. and then following the 70 to 100mOD contours along the western and northern side of Cope's Mountain to the Leitrim Border.

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 and 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, 1650mm for the Willsborough Stream, 1260mm for the Cregg Stream and 1340mm for the Drumcliff-Glebe stream. Evapotranspiration rates are approximately 500mm per annum.

15.3.2 Drainage Features

The largest river basin is the Drumcliff River catchment to the north of the Study area having a total catchment area of approximately 61.3km^2 and discharges into Drumcliff Bay. To the south of the Drumcliff Basin, a small Stream, the Drumcliff-Glebe Stream, drains a catchment area of some 7km^2 and also discharges into Drumcliff Bay. The Cregg Stream (catchment area of 5.4km^2) and the Willsborough Stream (catchment Area 19.2km^2) located further to the south of the study area

discharge into the Garvogue Estuary. The Willsborough Stream is the Outflow from the Kilsellagh Reservoir and Dam. South of the Study Area the Garvogue River which is the outflow from Lough Gill flows westward into the Garvogue Estuary and Sligo Harbour. The total catchment area of the Garvogue River is 369km^2. Lough Gill which is 12.8km^2 in area and typically at an elevation of 7m OD is a major source to the Sligo Public Water supply. This lake is located up-gradient of the N16 Study Area at Sligo Town and outside of the hydrological zone of influence of the proposed route options.

Glencar Lough at the north end of the scheme lies in the Glencar Valley, between the Dartry Mountains to the north and the mountain range of the Crockauns and Cope's Mountain to the south. Glencar Lough is primarily fed by Glencar Waterfall, on the lake's northern shore, and by the Diffreen River, entering at the lake's eastern end. The lake drains west into the Drumcliff River, which in turn flows into Sligo Bay. This is a steep sided valley and has a well defined flood zone and permanent lake area (1.15km^2). This lake performs a major attenuation function for the Drumcliff River significantly attenuating the surface runoff from the Hillslopes to the north and South. The Glencar Lough is at a typical elevation of 26m OD and it along with the Drumcliff River are located sufficiently downgradient of the Route Options as not to represent a direct flood risk to the various routes. The Northern Section of the Route options which for topographical reasons is confined to a narrow band width of 300 to 400m close to the existing N16 road alignment traverse numerous small hillslope tributaries of the Drumcliff River and Glencar Lough (5 main tributaries and numerous smaller drainage channels). It should be noted that the status of Glencar Lough is extremely high (International) being within the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The Drumcliff River that forms the outflow from Glencar Lough is not within the SAC and would have a local higher ecological status being considered a fishery stream and discharging into the Drumcliff Bay SAC.

The ecological status (Q-Rating) of these streams is reported to be 'Poor' for the main Drumcliff River channel both downstream and upstream of Glencar Lough (possible agricultural drainage impacts) but has good status in respect to Physio-chemical water quality testing. Glencar Lough is classified to be of good water quality status having oligotrophic/mesotrophic status. The head waters of the Willsborough Stream are classified as being of high ecological status including the main upstream Kilsellagh inflow stream. The main channel of the stream from the Kilsellagh reservoir downstream to the sea is also recorded as being of 'Good' Status. There is no classification for the Drumcliff-Glebe Stream being a small drainage channel and of little ecological value. The Cregg stream which receives a treated sewage discharge from the Cregg Village area is classified (by extrapolation) to be of 'moderate' ecological status.

Road crossings of watercourses represent a potential impact on the flow regime and morphology of the watercourse as a result of these features requiring bridging or culverting. Given the reasonably small scale of all of the watercourses encountered by the various route options it is expected that large bridge structures will not be required by this project and that generally culverting will suffice from a flood conveyance perspective. The watercourse crossing section is generally also the location for potential road drainage discharge outfalls which can through increased flows cause local flow regime change and represents a new point source of pollution to the watercourse from the road drainage runoff resulting in local sediment deposition and water chemistry impacts including heavy metals, hydrocarbons and salt in both particulate and dissolved solute forms.

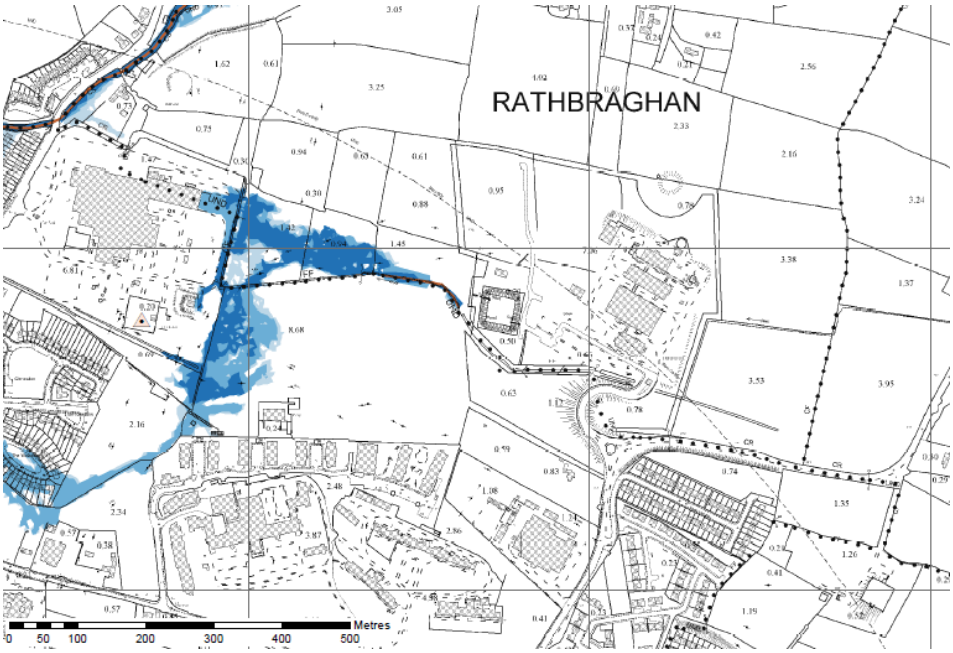
15.3.3 Flood Risk

Flooding along the various river systems within the study area have been assessed based on the hydrological characteristics of the catchment and by reviewing the national Preliminary Flood Risk Assessment mapping and the available draft CFRAM[1] mapping for the lower southern section of the

study area near Sligo Town. The various route corridors have been assessed in terms of potential encroachment within floodplain extents and generally it has been found that the proposed route options make relatively small encroachments into flood Risk Zones. Also assessed using the pFRA mapping is fluvial, pluvial, coastal and groundwater flood risk. The proposed route corridors are not impacted by coastal flood risk being on lands sufficiently elevated above the Coastal Flood Risk Zone (elevations < 5m O.D. Malin). Groundwater flooding in terms of winter turlough formation was not identified as a constraint within the route corridors with no significant groundwater flood risk or turlough formation occurring. The main source of flood risk is fluvial (river and stream flooding) and pluvial (rainfall generated overland flooding of local depressions and low-lying lands). The occurrence of pluvial flooding is very much dependent on the existing surface drainage network, the soil permeability characteristics and the topography. The southern section has a moderate number of mapped pluvial and fluvial flood risk areas, particularly at the south end of the scheme close to Sligo Town and along the Willsborough Stream. An extensive area of pluvial flood risk is identified in the pFRA mapping to the east of the N16 and to the north of the local road between Bellanurly/Bellawillinbeg and Lisgorey townlands. To the west of the N16 in the townlands of Lisnalurg, Carncash and Rathbraghan there are a number of small scattered pluvial flood risk areas associated with the flatter land scape and poor permeability soils. The recent final draft CFRAM mapping available for Sligo Town and the Rathbraghan area shows in more detail the flood risk zones associated with the lower Willsborough Stream and with the local Rathbraghan tributary stream that joins the Willsborough just upstream of the Garvoge Estuary.

In the central and north sections of the route selection study area there are very few pluvial and no significant fluvial flood risk areas identified by the pFRA mapping. The more detailed CFRAM mapping is not available for these more rural areas. This is misleading as the high overland runoff from Cope's Mountain crossing the existing N16 towards the Drumcliff River and the Glencar Lough represents a significant flood risk to the existing road and to the proposed route options.

Figure 15-1: CFRAM Mapping - Rathbraghan



15.4Overview of hydrogeology

15.4.1 Groundwater bodies and hydrogeological Features

There are 2 groundwater bodies, the Rosses Point West GWB and the Drumcliff-Strandhill GWB, located within the study area. The Rosses Point West GWB stretches east-west from Rosses point to Crockauns to the south of Glencar Lough and occupies principally the central section of the study area. This GWB is primarily underlain by Dinantian Pure bedded Limestones which are characterised as a Regionally Important karstified aquifer dominated by conduit flow. The Drumcliff-Strandhill GWB bounds the Rosses Point West GWB to the north and also to the south and occupies the northern and southern sections of the study area. This GWB occupies an area from Benbulben to Drumcliff to Sligo and Strandhill and is underlain by Dinantian Upper Impure Limestones and Dinantian shales and limestones with its groundwater aquifer characterised as locally important aquifer that is generally moderately productive only in local areas.

The main recharge mechanism to these GWB's is diffuse recharge via rainfall percolating through permeable soil and rock outcrops. The steep slopes in mountainous areas to the east of the existing N16 promote surface run-off dominated flows. In the Drumcliff-Strandhill GWB recharge is limited by Peat and the low permeability limestone bedrock and majority of recharge discharges rapidly to nearby streams and small springs. In the Rosses Point West GWB diffuse groundwater recharge occurs through the permeable soils and weathered bedrock. There is no evidence of point recharge occurring (sink holes), however there may be unrecorded karst features via which point recharge is occurring. Within the landscape of this regionally important karst aquifer there is little evidence of karst surface features and no recorded features on the GSI karst database. The main groundwater flow will be in the epikarstic layer, a couple of metres thick and in a zone of interconnected solutionally enlarged fissures and conduits that extend approximately 30 m into the bedrock and general flow direction is Westward towards the coast. A small section of Dinantian sandstones extends from Cope's Mountain towards the routes. Within the sandstones, groundwater flow is likely to be in the upper part of the aquifer similar to the limestones.

Estimated bedrock groundwater recharge rates vary depending on a number of hydrogeological factors. The main hydrogeological controls on groundwater recharge include soil and subsoil permeability, subsoil thickness, saturated soils, and the ability of the underlying aquifer to accept percolating waters. Estimated groundwater recharge is lowest in areas overlain by thick, low permeability clay. Where lower productivity aquifers underlie the land surface, recharge can be rejected, even where subsoils are thin. This reflects the limited ability of these aquifers to accept and transmit recharging waters (with maximum capacities capped at 200mm per annum). In the southern section (Rathbraghan, Shannon Oughter, Lisnalurg and Bellanurly townlands) the recharge rates are generally low reflecting the poor permeability soils and subsoils and relatively shallow water table with recharge coefficient varying from 7.5 to 25% (generally at 15%) of the annual effective rainfall (which is typically 900mm per annum). Moving northwards the ground elevation increases and also the annual rainfall amount. Reasonably high recharge coefficients are encountered in the central section at Castlegal reflecting a till overlain by well drained soils of a thin cover (high to extreme vulnerability), with recharge coefficients, typically high, at 60%. The northern section of the proposed routes has a groundwater recharge coefficient of 22.5% which is moderate to low reflecting till overlain by poorly drained gley top-soil. In the northern section upgradient of the proposed routes there are sections of exposed rock outcrop and subcrop and bedrock near the ground surface giving rise to potentially very high groundwater recharge coefficient of 85% and an effective rainfall of 1150mm (975mm/annum recharge rate). This recharge rate is not achieved as

the bedrock does not have the capacity to absorb such rates with a recharge capacity restricted to c. 200mm per annum.

There are no sand and gravel quaternary aquifers identified within the study area and the bedrock aquifers present are categorised as Locally Important which are moderately productive only in local zones and represent the majority of the study area except for a section of Regionally Important karstified conduit flow Limestone aquifer from Doonally to Drumkilsellagh to Castlegal. The aquifer vulnerability to contamination is dependent on the overburden depth and is generally categorised as moderate vulnerability (5 to 10m depths) in the southern section and increasing to high vulnerability in the central section and extreme (< 3m) in the northern section.

The main features of the groundwater flow within Glencar Bedrock Formation and within the Benbulben Shale formations both classified as Locally important Bedrock Aquifer which are moderately productive only in Local Zones, is a relatively shallow flow system within the upper weathered bedrock layer and generally the groundwater table correlates with the surface topography. The groundwater flow in the southern half of the study area is westward towards the coast, whereas in the northern half it is northwest and north with the hill slope towards the Drumcliff and Glencar Valley. The aquifer has generally a low permeability, except for local zones where there is weathering and fracturing and potentially along fault lines. The major groundwater pathway is in the upper weathered zone of the rock, which may be deeper along faults and fractures. The degree of weathering depends on overburden permeability and depth of cover and purity of the limestones.

15.4.2 Karst features

A review of the GSI National Karst Database system shows no identified karst features within the N16 Route Selection 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 central section, 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 Lugotober 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 Td and some depression features are present there also.

15.4.3 Water abstractions / groundwater supplies

There are two main sources of water supplying the Sligo Town and Environs area, namely Kilsellagh Reservoir and Lough Gill which are surface water abstractions and source protection would apply to their immediate upstream catchment. There is a water treatment plant at Kilsellagh (4500m^3 per day, recently upgraded) and two plants treating water from Lough Gill, recently upgraded Foxes Den (11,000m^3 per day) and the Cairns Hill (5,450m^3/day). The Kilsellagh Water Supply scheme serves the majority of households and agricultural connections within the N16 Route Selection Study Area

and is located in reasonably close proximity to the various proposed route options, to the east and upgradient. The Kilsellagh Reservoir is supplied by mountain runoff from the southern slopes of Copes Mountain and the Eastern Slopes of Keelogyboy Mountain. The Lough Gill Public supply source is remote to the proposed route options and is located in a separate catchment and not hydrologically linked to the proposed Study area.

There are no major group water sources within the study area or any designated source protection areas located within or in proximity to the study area. The National Federation of Group Water Schemes (2015) 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 the study area and located remote from the various route options. The Castletown, Benbulben and Drum East Sources are to the North of the Drumcliff River and supplied from the slopes of 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 more elevated northern section of the Route from Lugatober to Gortnagrelly is supplied by individual and grouped private wells and boreholes and not serviced by the Kilsellagh Public Supply. South of Lugatober mains supply is available from Kilsellagh Public water supply.

15.4.4 Relevant Designated Sites

The various designated sites in proximity to the Study area are:

- Lough Gill SAC and pNHA (001976);
- Crochauns/Keelogyboy Bogs NHA (002435);
- Sligo Leitrim Uplands SPA (004187);
- Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623);
- Cummeen Strand / Drumcliff Bay SAC and pNHA (000627) in the coastal and estuarine waters and shoreline area to the west of the Route options;
- Cummeen Strand SPA (004035);
- Drumcliff Bay SPA (004013);

The potential impact to these designated sites is limited to potential indirect impacts via watercourse discharges and groundwater flow to the Cummeen Strand and Drumcliff Bay SAC and to the Glencar Lough (part of the Ben Bulben, Gleniff and Glenade Complex SAC) and potential impact on the Bog habitat of the Crockauns/Keelogyboy Bogs NHA and the Sligo Leitrim Uplands SPA from drainage impacts.

All of the route options avoid direct encroachment but the route options are in moderately close proximity to the Crockauns/Keelogyboy Bogs NHA at Lugnagall. However given the gradient and set back distance and location of proposed road cut-sections no hydrological impact Crockauns/Keelogyboy Bogs NHA is predicted.

15.4.5 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 route options. The various route options pass close to these wetland sites with the potential for hydrological impact in terms of flow regime and water balance changes. A summary of these key groundwater dependant wetland habitat sites of relevance to the route selection options is presented in Table 15-1 below.

Table 15-1: Summary Description Groundwater Dependent Wetland Sites

Site no.	Site name	Annex I habitats	Ecological evaluation
10	Lugnagall Flush – south of road	Small remnants of alkaline fen and petrifying springs	**National** Ecological Importance as supports two Annex I habitats and overlaps with Crockauns/ Keelogboy Bogs NHA
11	Gortnagrelly – southern wet woodland	Small area of wet woodland with affinity petrifying spring vegetation	Small area of springs with no/ little tufa formation. **County** Ecological Importance
11	Gortnagrelly – central woodland area	Three areas of calcareous springs and significant tufa formation	**National** Ecological Importance as supports good examples of Annex I priority habitat within a mosaic of species-rich semi-natural woodland, river and marsh vegetation.
12	South of Collinsford	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.
13	East of Drum	Rich fen and flush vegetation with some affinity to alkaline fen	**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.
14	West of Castlegal	Three petrifying springs 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.
16	At the Leitrim border	No wetland Annex I habitats recorded	North-facing wooded ravine with species-rich woodland vegetation and potential to support rare/ protected bryophyte species, particularly in area of waterfalls. Part of the Ben Bulben, Gleniff and Glenade Complex SAC and therefore of **International** Ecological Importance.

In respect of the Lugnagall Flush wetland area immediately to the east of the existing N16 road all of the proposed route options pass close to this feature but are located downgradient (west to northwest) of this fen feature and buffered by the existing N16 road. The topography falls northwest, with recharge to this feature from the steep hillslopes upstream sustaining this wetland habitat via interflow and groundwater flow from the upper weathered limestone and calcareous shale bedrock and subsoil interface. Recharge is reasonably high with outcropping and shallow shale and sandstone till (<3m). The steepness of the hill slopes gives rise to high overland runoff to this feature also. The proposed route options located downstream are unlikely to impact this feature.

The Gortnagrelly wet Woodland with Tufa Mounds and petrifying springs which are classified as annex 1 habit of National Significance and have a potential to be severely impacted by all of the route options with a number of the route options directly crossing the petrifying springs, some crossing immediately upstream and downstream of the springs. To avoid profound impacts to such

features specific design measures may need to be incorporated within the road design to avoid directly encroaching the springs (bridging the discharge zone) and also ensuring that options crossing its upstream catchment do not intercept and divert groundwater recharge from its upstream catchment.

The small wetland feature south of Collinsford which comprises Rich Fen and flush vegetation is a small rising to a minor stream that eventually discharges into the Drumcliff River approximately 1km to the northwest. This site is considered to be of County Ecological importance with the flush vegetation having some affinity to Annex I priority Petrifying springs habitat (7230). The proposed route options pass very close to this feature with the majority of the route options crossing upstream and option 4 which intercepts this feature. The potential for significant impact to this feature exists from all options both where the feature is intercepted and also where the up-gradient groundwater recharge is interfered with as a result of road construction.

The rich Fen and Flush Feature east of Drum represents a small area of potential calcareous spring / alkaline fen vegetation with moderate to high potential to support Annex I priority Petrifying Spring and Annex I Alkaline Fen habitats. Similar to the Collinsford feature, route option 4 potentially intercepts the feature, whereas, the other route options are located approximately 200m upgradient and within the recharge zone of the feature.

The wetland feature west of Castegal which is approximately 450m upgradient (east) and within the same drainage basin as the East of Drum fen and flush feature described in previous paragraph. This is an alkaline fen feature with three petrifying springs identified within the flush area which are considered to be small examples of Annex I priority Petrifying Springs habitat and is ranked as of County Ecological Importance. All of the Route options are located downgradient (west) of the springs and fen habitat and considered unlikely to impact directly or indirectly this feature as the recharge catchment is to the east and upstream of the existing N16 road.

The Leitrim Border ecological site is a wooded ravine and exposed limestone bedrock. No calcareous springs were recorded during the site survey. This ravine coveys a hill slope stream at a steep gradient with waterfalls features down to Glencar Lough. Given the presence of limestone outcrop and supcrop and the relatively shallow till there is a potential for calcareous springs within this feature. The various route options either intercept it or cross upstream of it. This feature is rated as Internationally important as it is part of the designated Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). .

Blanket Bog Habitat is located on upper slopes of Cope's Mountain to the east and southeast of the central and northern sections of the route options. This Blanket Bog is relatively shallow overlying shale and sandstone bedrock. These peatland habitats are located sufficiently up-gradient and remote from the proposed route options as not to be at risk of impact from the road development and the various route options.

15.5Preliminary Options Assessment – Part 1

15.5.1 Introduction

There are 13 route options for consideration and the assessment is split into a southern section, a short central section and a northern Section. Because of topographical and ecological constraints the route options corridor narrows to a study band width of 300 to 400m at the northern end. The greatest spatial spread of route options is in the southern section with routes to the east of the N16 and extending 3km west to the N15. The hydrological assessment takes into account the potential

impact on the groundwater bodies, impact on hydrological features (karst, springs, drinking supplies), impact on water dependent habitats, watercourse crossings and flooding and flood risk.

15.5.2 Southern Section

In the southern section there are 9 distinct route options to be assessed with options 10 and 11 being the same alignment as Option 3 both in the South and Central Sections. Options 7 and 9 are also very similar.

15.5.2.1 Route Option 01A and 01A/01B

Route Option 01B which extends out along the existing N15 Road from Rathquarter in Sligo Town to the commencement of Option 01A at Teesan. This option represents an online upgrade to the N15 road and therefore represents increase traffic numbers on the road and potentially increased risk during the operation phase from road drainage pollutants discharging to over the edge drainage and existing outfalls. This option is located closest to the Garvogue Estuary and the shortest travel path for road pollutants from either a serious spillage or routine road runoff to enter the SAC. A section of the existing N15 Road to the north of Cartron Bridge is shown to be within the 100 to 1000year flood risk zone (Flood Zone B) from overbank flooding of the Willsborough Stream. The remainder of the N15 section of the route is not identified to be at risk of flooding.

Route Option 01A commences at the N15 near Teesan and travels initially east north-east to Doonally before turning in a northerly direction through the central section at Castlegal following generally the N16 route around Cope's Mountain in a north easterly direction until it terminates at the Leitrim border. In the southern section this route traverses through a regionally important karstic conduit flow bedrock aquifer for the majority of its length. Limestone outcropping and potential karst features are evident to the north of Carncash where the route cuts through a small hill with bedrock outcropping visible. Along this route in the Teesan townland area the route traverses close to a number of local well and spring supplies, which are located to the north and given the karstic nature of the aquifer there is potential for contamination of such supplies during construction and operation. The road in this area is likely to be at grade or slightly in fill and therefore impact implications on well yield to such sources is minor. Road cutting through a local limestone hill will be required but such a cutting is unlikely to intercept groundwater table.

This route in the south section avoids any of the larger watercourses and intercepts only two small local drains of no fishery importance or local ecological value. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway. Flood risk to this route is associated with pluvial flooding with a number of small potential pluvial flood risk sources encountered. The scarcity of surface drainage lends to potential drainage difficulties for road project and particularly as it may involve discharging to groundwater which is a regionally important karst conduit flow aquifer. The groundwater vulnerability based on the overburden depth varies between moderate, high and extreme with (38% as moderate, 31% as high and 31% as extreme vulnerabilities). The high and extreme vulnerability areas are associated with the higher ground and hills.

There are no key aquatic dependent ecological receptors encountered along this route.

15.5.2.2 Route Option 02A and 02A/02B

Route Option 2B represents an online upgrade of the N15 road to Shannon Eighter. This represents increased traffic numbers on the road and potentially increased pollution risk during the operation phase from road drainage discharging to over the edge drainage and to existing surface outfalls.

This option is located close to the Garvogue Estuary and the shortest travel path for road pollutants from either a serious spillage or routine road runoff to enter the downstream channel reach of the Lough Gill SAC and the Cummeen Strand and Drumcliff Bay SAC. A section of the existing N15 Road to the north of Cartron Bridge is shown to be within the 100 to 1000year (Flood Zone B) flood risk zone whose source of flooding is fluvial from the Willsborough Stream.

A large portion of the southern section of this route 02A/02B traverses through the darker impure (fine grained clayey) limestone bedrock formation that is characterised as a Local Important Bedrock Aquifer that is moderately productive only in local zones. The final 700m of the route at Doonally traverses through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to W separating the impure Glencar limestone formation from the pure Ballyshannon Limestone formation. There is no cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow being intercepted.

In this southern section the route option avoids any karst features and is not close to any private abstraction wells, springs of hydrogeological features. The alignment will involve a number of road cut sections (at Rathbraghan, Shannon Oughter and Doonally) which are unlikely to encounter bedrock based on the overburden and groundwater vulnerability information. The soil and subsoils along this route option are generally classified as poor draining and therefore a raised / perched groundwater is anticipated which may be intercepted by the various cuttings. The dewatering impact of this will be insignificant. The groundwater vulnerability based on the overburden depth varies between moderate, high and extreme (60.1% as moderate, 32.3% as high and 7.6% as extreme vulnerabilities).

There are no aquatic dependent key ecological receptors (KERs) encountered along this route within the southern section.

This route in the south section crosses the Willsborough Stream and flood plain at two locations in the Shannon Oughter area and potentially encroaches 200m of floodplain width based on CFRAM Mapping. It also traverses close to two areas of pluvial flood risk located between Shannon Oughter and Doonally.

The proposed route option 2A will have a total of 6 watercourse crossings (2 No. of the Willsborough, one crossing of its tributary stream at Shannon Eighter and three crossings of relatively minor drains). The Willsborough Stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway.

The Option 2B N15 section has existing crossing of the Garvogue River, the Rathbraghan Stream and the Willsborough Stream.

15.5.2.3 Route Option 03 (also represents Options 10 and 11)

Route Option 3 commences at Rathbraghan with proposed link road east-west to the existing N16 and to the existing N15 roads. This route travels initially northwards and then north east through Shannon Oughter and Doonally before turning northwards along and adjacent to the existing N16 road towards Castlegal. The southern section of this route and the link road to the N15 and N16 is predominantly in the dark impure (fine grained, clayey) bedrock formation that is characterised as a Local Important Bedrock Aquifer that is generally productive only in local zones. The final 700m of the route at Doonally traverses through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to WSW separating the impure Glencar limestone formation from the pure

Ballyshannon Limestone formation. There is no cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow being intercepted.

In this southern section the route option avoids any karst features and is not proximate to any private abstraction wells and springs. The alignment will involve a number of road cut sections (at Rathbraghan, Shannon Oughter and Doonally) which are unlikely to encounter bedrock based on the depth of overburden inferred from the groundwater vulnerability information. The soil and subsoils along this route option are generally classified as poor draining and therefore a raised / perched groundwater table is anticipated which may be intercepted by the various cuttings. The dewatering impact of such cutting will be insignificant given the low permeability nature of the overburden. The groundwater vulnerability based on the overburden depth varies between low, moderate, high and extreme with (7% Low, 60% moderate, 27% as high and 6% as Extreme). There are no aquatic dependent ecological receptors encountered along this route within this southern section.

This route option significantly encroaches Flood Risk zones of high and moderate flood risk at Rathbraghan and near the N15 along the L-9005-0 and two locations at Rathbraghan associated with flooding from the local Rathbraghan Stream that rises some 700m to the ESE of the proposed route. The CFRAM mapping indicates an encroachment length of some 370m in total. The route option also crosses the flood plain of the Willsborough Stream to the south of Shannon Oughter. It also traverses close to two areas of pluvial flood risk located between Shannon Oughter and Doonally. It is important to note that the northerly route at Rathbraghan traverses through a proposed flood attenuation storage area identified by the CFRAM project as a possible flood mitigation measure to combat local and downstream flooding.

The proposed route option 3 will have a total of 6 watercourse crossings (2 no. of the Rathbraghan Stream and Floodplain, 1 No. of the Willsborough Stream and flood plain and 3 culvert crossings of relatively minor drains). The Willsborough Stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway to a European site.

15.5.2.4 Route Option 04

Route Option 04 is similar to Route Option 03 up to Doonally in the southern section. North of Doonally it takes a more westward alignment away from the existing N16.

Route Option 4 commences at Rathbraghan with proposed link road east-west to the existing N16 and to the existing N15 roads. This route travels initially northwards and then north east through Shannon Oughter and Doonally before turning northwards along and adjacent to the existing N16 road towards Castlegal. The southern section of this route and the link road to the N15 and N16 is predominantly in the dark impure (fine grained, clayey) bedrock formation that is characterised as a Local Important Bedrock Aquifer that is generally productive only in local zones. The final 700m of the route at Doonally traverses through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to W separating the impure Glencar limestone formation from the pure Ballyshannon Limestone formation. There is no significant cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow along the Faultline in the bedrock being intercepted.

In this southern section the route option avoids any identified karst features and is not proximate to any private abstraction wells, springs or hydrogeological features. The alignment will involve a number of road cut sections (at Rathbraghan, Shannon Oughter and Doonally) which are unlikely to encounter bedrock based on the depth of overburden inferred from the groundwater vulnerability

information. The soil and subsoils along this route option are generally classified as poor draining and therefore a raised / perched groundwater table is anticipated which may be intercepted by the various cuttings. The dewatering impact of such road cutting will be insignificant given the low permeability nature of the overburden. The groundwater vulnerability based on the overburden depth varies between low, moderate, high and extreme vulnerabilities (8% Low, 62% moderate, 24% high and 6% as extreme). There are no aquatic dependent ecological sensitive receptors encountered or impacted along this southern Section of the route.

This route option significantly encroaches Flood Risk zones of high and moderate flood risk at Rathbraghan and near the N15 along the L-9005-0 and two locations at Rathbraghan associated with flooding from the local Rathbraghan Stream that rises some 700m to the ESE of the proposed route. The CFRAM mapping indicates an encroachment length of some 370m in total. The route option also crosses the flood plain of the Willsborough Stream to the south of Shannon Oughter. It also traverses close to two areas of pluvial flood risk located between Shannon Oughter and Doonally. It is important to note that the route at Rathbraghan traverses through a proposed flood attenuation area identified by the CFRAM project as a potential flood mitigation measure.

The proposed route option 4 will have a total of 5 watercourse crossings (2 no. crossings of the Rathbraghan Stream and Floodplain, 1 No. crossing of the Willsborough Stream and flood plain to the north of Rathbraghan and 2 culvert crossings of relatively minor drains). The Willsborough Stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway as does the groundwater bodies.

15.5.2.5 Route Option 05 and 06

These route options are similar in nature with the exception of a minor deviation to the south at Rathbraghan and Barroe. From the aforementioned location they both head northwards to the west of the existing N16 and intersecting the N16 Road to the east of Shannon Oughter and maintaining an alignment west of the N16 to Drumkilsellagh where they cross to the East and continue east of the N16 to Castlegal. They represent a total mainline length in the southern section of c. 3.2km (Option 05) to c. 3.4km (Option 06).

The route option is predominantly located in the dark impure (fine grained, clayey) Limestone bedrock of the Glencar Limestone Formation that is characterised as a Local Important Bedrock Aquifer that is generally productive only in local zones (Li). The final 640m of the route at Doonally traverses through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to WSW separating the impure Glencar limestone formation from the pure Ballyshannon Limestone formation crosses the alignment north of Doonally. There is no significant cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow along the Faultline in the bedrock being intercepted.

The route options are remote from any identified karst features and do not come in close proximity to any private abstraction wells, springs or other hydrogeological features. They traverse the Rathbraghan Stream just downstream of the streams spring source to the north of Farranacardy. The alignments are generally at grade or in embankment in this section with very minor cut sections required and therefore unlikely to impact on the local groundwater table. The soil and subsoils along these route options are generally classified as poor draining and therefore a raised / perched groundwater table is anticipated. The groundwater vulnerability based on the overburden depth

varies between moderate, high and extreme vulnerabilities (48% moderate, 44% as high and 8% as Extreme).

There are no aquatic dependent key ecological receptors encountered or impacted along this southern Section of the routes.

This route options have generally a low flood risk avoiding pluvial Flood Risk Zones and fluvial flood risk in its southerly section to Shannon Oughter. The routes encroache the Willsborough floodplain at its mainline crossing and its associated link road north of Faucets Bridge on the L3407. The alignments are almost parallel to the river channel and has the potential to encroach the east bank flood plain over a 100 to 200m.

The proposed route options 05/06 will have a total of 10 watercourse crossings (2 no. crossings of the Rathbraghan Stream, 2 No. crossing of the Willsborough Stream and flood plain to the north of Rathbraghan and 6 culvert crossings of relatively minor drains). The Willsborough Stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway as does the groundwater bodies.

The Option 6 route is very similar to Route Option 5 commencing from the N16 at Farranacardy and heading northwards to the west of the existing N16 and intersecting the N16 Road to the east of Shannon Oughter and maintaining an alignment west of the N16 to Drumkilsellagh where it crosses to the East and continues east of the N16 to Castlegal. The section of the route that is slightly different than Option 5 is the initial part where it heads east along the existing N16 and then north to Faucets Bridge in Shannon Oughter. This route avoids the Rathbraghan stream and therefore has two less watercourse crossings than Option 05, otherwise it is hydrologically similar in all respects to Option 05 in the southern section.

15.5.2.6 Route Option 07 and Option 09

Route Option 07 commences from the N16 to the north of Farranacardy and initially heads ENE to Barroe after which it turns northwards and to the east of the existing N16 and remains east until it crosses to the west side of the N16 near Doonally and remains to the west of the existing N16 to near Castlegal.

Route Option 09 is similar to Option 07 except at its very southern end where it takes a slightly more northerly route similar to Option 8.

The route options are predominantly located in the dark impure (fine grained, clayey) Limestone bedrock of the Glencar Limestone Formation that is characterised as a Local Important Bedrock Aquifer that is generally productive only in local zones (Li). The final 535m of the routes at Doonally, traverse through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to WSW separating the impure Glencar limestone formation from the pure Ballyshannon Limestone formation crosses the alignment is intercepted near Doonally. There is no cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow being intercepted.

This route directly intercepts the spring source to the Rathbraghan Stream located just north of N16 to the north of Farranacardy. The alignments will involve a deep road cut section at Faughts and two shallower cuttings further north towards Willowbrook. The shallower cuttings are unlikely to encounter bedrock based on the depth of overburden inferred from the groundwater vulnerability information and the deep cutting at Faughts may intercept bedrock towards the base of the excavation. The soil and subsoils along these route options are generally classified as poor draining

and therefore a raised / perched groundwater table is anticipated which may be intercepted by the various cuttings. The dewatering impact of such road cuttings are unlikely to be insignificant given the low permeability nature of the overburden and bedrock. The groundwater vulnerability based on the overburden depth varies between low, moderate, high and extreme with (36.5% moderate, 38.7% as high and 24.8% as Extreme).

There are no aquatic dependent key ecological receptors encountered or impacted along this southern Section of the route.

In this southern section the route option is remote from any identified karst features and is generally not very proximate to any private abstraction wells or springs or other sensitive hydrogeological features. A deep cutting is proposed through a local hill at Faughts and a well is shown on the OSI mapping located 90m to the east of the cutting. Based on the topography it is expected that groundwater flow is from north to south and therefore it is expected that the deep cutting is unlikely to significantly impact this well source, but impact cannot be ruled out without further detailed assessment. This area is also serviced by the Public Kilsellagh water supply scheme.

This route option has generally a low fluvial flood risk crossing the Willsborough stream at a steep narrow section just downstream of Willowbrook Bridge on the N16. A significant pluvial flood zone is identified to the north of the local road between Bellanurly and Faughts (L3407-22) and the route encroaches this area. This pluvial flood risk zone is drained westward in an open drain outfalling west of the N16 Road to Willsborough Stream.

The proposed route options 07/09 will have a total of 10 watercourse crossings (1 no. crossings of the Rathbraghan Stream at its spring source, 1 No. crossing of the Willsborough tributary Stream and a 1 crossing of the Willsborough Stream. The remaining seven watercourse crossings are of small land drain and minor streams. The Willsborough Stream and its tributary stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway as does the groundwater bodies.

The only difference from a hydrological perspective between Option 07 and 09 is that Option 09 avoids crossing the Rathbraghan Stream at its spring rising, crossing it 40m downstream of the spring which is preferable in terms of culverting and protection of the spring.

15.5.2.7 Route Option 08

Route Option 8 commences from the N16 to the North of Farranacardy and heads northeast towards Barroe and Faughts townlands. After Faughts it heads due north taking the most easterly route of the route options considered and crosses the Willsborough Stream east of the N16 Willowbrook Bridge. It crosses the N16 to the west at Doonally and remains west of the N16 until south of Castlegal.

The route option is predominantly located in the dark impure (fine grained, clayey) Limestone bedrock of the Glencar Limestone Formation that is characterised as a Local Important Bedrock Aquifer that is generally productive only in local zones (Li). The final 535m of the route at Doonally traverses through Regionally important karst conduit flow limestone bedrock aquifer. A Fault line ENE to WSW separating the impure Glencar limestone formation from the pure Ballyshannon Limestone formation crosses the alignment near Doonally which may represent a zone of preferential groundwater flow. There is no cut section proposed adjacent to this fault line which avoids the risk of preferential groundwater flow being intercepted.

This route option will involve a deep road cut section at Faughts and two shallower cuttings further north towards Willowbrook. The shallower cuttings are unlikely to encounter bedrock based on the depth of overburden inferred from the groundwater vulnerability information and the deep cutting at Faughts may intercept bedrock towards the base of the excavation. The soil and subsoils along this route option are generally classified as poor draining and therefore a raised / perched groundwater table is anticipated which may be intercepted by the various cuttings. The dewatering impact of such road cutting will be insignificant given the low permeability nature of the overburden and bedrock. The groundwater vulnerability based on the overburden depth varies between moderate, high and extreme vulnerabilities (42.9% as moderate, 30.1% as high and 27% as extreme).

There are no aquatic dependent key ecological receptors encountered or impacted along this southern Section of the route.

In this southern section the route option is remote from any identified karst features and is generally not very proximate to any private abstraction wells or springs or other sensitive hydrogeological features. A deep cutting is proposed through a local hill at Faughts and a well is shown on the OSI mapping located 90m to the west of the cutting. Based on the topography it is expected that groundwater flow is from north to south and therefore it is expected that the deep cutting is unlikely to significantly impact this well source, but impact cannot be ruled out without further detailed assessment. This area is also serviced by the Public Kilsellagh water supply scheme. A spring is located 350m to the east of the cutting near Lisgorey and is unlikely to be impacted by the cutting as it is most likely to be fed from the higher ground to the north.

This route option has generally a low fluvial flood risk crossing the Willsborough stream at a steep narrow section just downstream of Willowbrook Bridge on the N16. A significant pluvial flood zone is identified to the north of the local road between Bellanurly and Faughts (L3407-22) and the route encroaches this area. This pluvial flood risk zone is drained westward in an open drain outfalling west of the N16 Road to Willowsborough Stream.

The proposed route Option 8 will have a total of 9 watercourse crossings (1 no. crossings of the Rathbraghan Stream downstream of its spring source, 1 No. crossing of the Willsborough tributary Stream and a 1 crossing of the Willsborough Stream. The remaining 6 watercourse crossings are of small land drain and minor streams. The Willsborough Stream and its tributary stream would be considered of Local higher value and of fishery interest and potentially Salmonid. The Q-rating status for this river is good. All watercourses small or large eventually discharge into sensitive coastal SAC waters and therefore represent a potential pollution pathway as does the groundwater bodies.

Table 15-2: Stage 1 Route Preferences for Southern Section

Hydrology and Hydrogeology	Route Options												
	01A	01A/01B	2	02A/02B	3	4	5	6	7	8	9	10	11
Water courses (Flow, water quality and morphology)	2	3	3	3	3	3	3	3	3	3	3	3	3
Flood /impact and Flood Risk	2	3	4	3	5	5	4	4	3	3	3	5	5
Groundwater Resources, water abstractions and hydrogeological features	5	5	3	5	3	3	33	3	4	4	4	3	3
Groundwater dependent Key Ecological Receptors	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.
Combined Score value	9	11	10	11	11	11	10	10	10	10	10	11	11
Overall Preference	Medium	Low	Medium	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Low	Low

Nb.: There are no Groundwater Dependent Key Ecological Receptors identified for the Southern section impacted by the proposed Route options and therefore score is not included

Scores 1 very high preference

2 high preference

3 medium preference

4 low preference

5 very low preference

15.5.3 Central Section

In the central Section there are only four distinct Route Options and these are Routes 01, 02, 04 and 07. Routes 03, 10 and 11 are very similar to Route 02 and Routes 0 and 06 have similar mainline to route 02 but have a separate link road crossing of the Drum East Stream Valley and Routes 08 and 09 are similar to Route 07 in this section. In the interest of avoiding repetition these four routes will be assessed and the findings applied to the other routes as appropriate.

15.5.3.1 Route Option 01

The Central Section which is 1.88km in length has a groundwater vulnerability of extreme (overburden depth < 3m) throughout its length and encounters a Regionally important karst conduit flow bedrock aquifer (Rkc) for the first 880m and a Locally Important Bedrock aquifer that is generally productive only in local zones (Ll) for the remainder of the central section. The route crosses near the intercept point of two fault lines to the west of Castlegal. These faults lines run east to west and southeast to northeast and separate the pale grey calcarenite pure limestones of the Ballyshannon formation to the south and west, the Mullaghmore Sandstone formation to the east and the dark, fine grained impure limestones of the Glencar Limestone Formation to the North. Fault lines can often represent zones of high permeability and zones of preferential groundwater flow paths. The alignment is in a large cutting through the regionally important karst aquifer and likely to encounter bedrock and the reasonably elevated groundwater table. The deep cutting is located south of Castlegal, at grade crossing the fault lines and in embankment to north and consequently this option is unlikely to intercept potential preferential groundwater flow along the Faultline.

The route comes close to a number of local household and farmyard supply wells to the west of the N16 at Lugatober whose water quality and yield may potentially be impacted. The wells to the east and upgradient are unlikely to be affected.

This route option crosses three small hill slope streams, the Drumcliff-Glebe stream discharging westward to Drumcliff Bay, the Castlegal stream (small tributary of the Drumcliff River) flowing westward and then north-westward into the Drumcliff River and the Lugatober stream (small tributary of the Drumcliff River) flowing north-westward into Drumcliff River. These are relatively minor streams of little local fishery value and fluvial flood risk is not a factor for these watercourses with no significant floodplain encroached by the route option.

The route crosses upgradient (some 180 to 200m) of the East of Drum Wetland Feature (Ecological Site Number 13) of rich fen and flush of local higher ecological importance which is supplied by groundwater flow and seepage from hill slope lands upgradient (east). The route option is generally in high embankment crossing the valley floor at Lugtober and therefore unlike to intercept groundwater flow supplying this feature. A small section to the southeast of the feature near Castlegal House on a raised limestone ridge is in deep cutting but such cutting given the localised nature of the ridge is unlikely to intercept groundwater recharge supplying this wetland feature with the main recharge from the east migrating along the valley floor.

A second groundwater fed wetland feature referred to as West of Castlegal wetland (Ecological Site Number 14) and categorised as a small example of Annex I priority Petrifying spring habitat of County ecological importance with three small petrifying springs identified is located immediately downstream of the N16 and 160m upgradient of the route option. The fact that the receptor is up gradient and the valley floor is reasonably steep falling westward away from the Feature it is very unlikely that the proposed Route option will impact the hydrology or water quality of this feature.

15.5.3.2 Route Option 02 (similar to Routes 03, 10 and 11) (similar to 05 and 06 except for Link crossing at Castlegal)

The Central Section which is 1.82km in length has a groundwater vulnerability of extreme (overburden depth < 3m) throughout its length and encounters a Regionally important karst conduit flow bedrock aquifer (Rkc) for the first 760m, a Locally Important Bedrock aquifer that is generally productive (Lm) for 120m (associated with the sandstone formation) and a Locally Important Bedrock aquifer that is generally productive only in local zones (LI) for the remainder of the central section. The route crosses two fault lines to the west of Castlegal. These faults lines run east to west and southeast to northeast and separate the pale grey calcarenite pure limestones of the Ballyshannon formation to the south and west, the Mullaghmore Sandstone formation to the east and the dark, fine grained impure limestones of the Glencar Limestone Formation to the North. Fault lines can often represent zones of high permeability and groundwater preferential flow paths. The alignment is in a deep cutting through a portion of the regionally important karst aquifer and the Local Important Sandstone near Castlegal (c. 350m long) where it is likely to encounter bedrock and potentially elevated groundwater table. A proposed deep cutting to the east of the existing N16 intercepts the SE-NW Faultline between the Ballyshannon Limestone formation and the Mullaghmore Sandstone formation which could give rise to interception of groundwater flow towards the Castlegal Valley Area and the East of Drum Wetland Feature.

The route comes close to a number of local household and farmyard groundwater supply wells to the west of the N16 at Lugotober and at Castlegal (on the L-74151 and the L7413) whose water quality and yield may potentially be impacted. The wells to the east and upgradient are unlikely to be impacted.

This route option crosses three small hill slope streams, the Drumcliff-Glebe stream discharging westward to Drumcliff Bay, the Castlegal stream (small tributary of the Drumcliff River) flowing westward and then north-westward into the Drumcliff River and the Lugotober stream (small tributary of the Drumcliff River) flowing north-westward into Drumcliff River. These are relatively minor streams of little local fishery value and fluvial flood risk is not a significant factor for these watercourses with no significant floodplain areas encroached by the route option. The Castlegal stream is also crossed by a proposed link road associated with route option 2.

The route crosses upgradient (some 175m) of the East of Drum Wetland Feature of rich fen and flush of local higher ecological importance which is supplied by groundwater flow and seepage from lands upgradient (east). The route option including its proposed local link road is generally in high embankment crossing the valley floor at Lugotober and therefore unlike to intercept groundwater flow. However a section of the road alignment to the southeast of the feature near Castlegal House will involve a deep cutting into the hillslope and has the potential to intercept bedrock and groundwater recharge supplying this feature. The cutting is very close to the watershed divide and unlikely to represent a significant source of recharge to this wetland feature given the very limited contributing catchment that topographically drains towards the feature. The faultline running SE-NW is intercepted by the deep cutting and this fault line could potentially provide a preferential Flow path from the southeast towards this feature. Therefore a potential significant hydrological impact on this fen and Flush Feature cannot be ruled out.

A second groundwater fed wetland feature referred to as West of Castlegal wetland and categorised as a small example of Annex I priority Petrifying spring habitat of County ecological importance with three small petrifying springs identified is located immediately downstream of the N16 and 160m upgradient of the route option. The fact that the receptor is up gradient and the valley floor is reasonably steep it is very unlikely that the proposed Route option will impact on the hydrology of

this feature and the deep cutting associated with this route option is downgradient of the feature and therefore will not impact on recharge to the springs.

15.5.3.3 Route Option 4

The Central Section of this route option is 2.03km in length and is located the furthest west of the route options within the Central Section. It has a groundwater vulnerability of extreme (overburden depth < 3m) for the majority of its length except for a short 220m section where it is classified as High. It encounters a Regionally important karst conduit flow bedrock aquifer (Rkc) for the first 905m and a Locally Important Bedrock aquifer that is generally productive only in local zones (Ll) for the remainder of the central section (1.125km). The route crosses an east-west running fault line to the west of Castlegal. These faults separates the pale grey calcarenite pure limestones of the Ballyshannon formation to the south and west from the fine grained impure limestones of the Glencar Limestone Formation to the North. Fault lines can often represent zones of high permeability and groundwater preferential flow paths. The alignment is in a large (deep and long) cutting through a portion of the regionally important karst aquifer to the west of Castlegal (c. 470m in length) where it is likely to encounter bedrock and a potentially elevated groundwater table giving rise to slight local dewatering. The East-West Fault line the runs to the south of the east of Drum ecological feature is crossed by the proposed route in embankment and therefore preferential groundwater flow along the fault line will not be intercepted.

The route is located generally down gradient of the various identified local well supplies within this Central Section with only two potential well supplies in proximity down gradient of the route to the west of Lugatober. For the down gradient sources the water quality and well yield may potentially be impacted by the road construction. The wells to the east and upgradient are unlikely to be impacted.

This route option crosses three small streams, the Drumcliff-Glebe stream discharging westward to Drumcliff Bay, the Castlegal stream (small tributary of the Drumcliff River) flowing westward and then north-westward into the Drumcliff River and the Lugatober stream (small tributary of the Drumcliff River) flowing north-westward into Drumcliff River. These are relatively minor streams of little local fishery value and fluvial flood risk is not a significant factor for these watercourses with no significant floodplain areas encroached by the route option.

The route crosses immediately upgradient and slightly encroaches the East of Drum Wetland Feature of rich fen and flush having local higher ecological importance which is supplied by groundwater flow and seepage from lands upgradient (east). The route option is generally in high embankment crossing the valley floor at Lugatober and is in cutting to the south of this feature which may potentially intercept some recharge groundwater feeding this feature. The close proximity of the route to this feature and the large cutting to the south could significantly impact this wetland and represents a potential significant impact.

A second groundwater fed wetland feature referred to as West of Castlegal wetland and categorised as a small example of Annex I priority Petrifying spring habitat of County ecological importance with three small petrifying springs identified is located immediately downstream of the N16 and 160m upgradient of the route option. The fact that the receptor is well up gradient and the valley flood is reasonably steep it is very unlikely that the proposed Route option will impact on the hydrology and water quality of this feature of this feature.

15.5.3.4 Route Option 07 (similar to Route options 08 and 09)

This route option is very similar to route option 2 being slightly more westward than option 2. This Route option through the central section is 1.8km in length and forms a long curve from Drumkilsellagh to Lugatober commencing west of the N16 and crossing to the east in a deep cutting at Castlegal and then crosses in embankment the Castlegal stream valley to the west of the N16 and remains west of the N16 to Gortnagrelly. This option has a second link road crossing of the Castlegal stream valley immediately to the west of the proposed mainline crossing.

It has a groundwater vulnerability of extreme (overburden depth < 3m) for its entire length within this section. It encounters a Regionally important karst conduit flow bedrock aquifer (Rkc) for the first 885m and a Locally Important Bedrock aquifer that is generally productive (Lm) for a short distance of 120m and a Locally Important Bedrock aquifer that is generally productive only in local zones (Ll) for the remainder of the central section (920m).

The route crosses two fault lines to the west of Castlegal. These faults lines run east to west and southeast to northeast and separate the pale grey calcarenite pure limestones of the Ballyshannon formation to the south and west, the Mullaghmore Sandstone formation to the east and the dark, fine grained impure limestones of the Glencar Limestone Formation to the North. Fault lines can often represent zones of high permeability and groundwater preferential flow paths. The alignment is in a large (deep and long) cutting through a portion of the regionally important karst aquifer and the Local Important Sandstone near Castlegal (where it is likely to encounter bedrock and a potentially elevated groundwater table.

A proposed deep cutting at Castlegal will intercept the two fault lines E-W and the SE-NW faults which could give rise to interception of groundwater flow towards the Castlegal Valley Area and the East of Drum Wetland Feature.

The route comes close to a number of local household and farmyard groundwater supply wells to the west of the N16 at Lugotober and at Castlegal (on the L-74151 and the L7413) whose water quality and yield may potentially be impacted. The wells to the east and upgradient are unlikely to be impacted.

This route option crosses three small hill slope streams, the Drumcliff-Glebe stream discharging westward to Drumcliff Bay, the Castlegal stream (small tributary of the Drumcliff River) flowing westward and then north-westward into the Drumcliff River and the Lugatober stream (small tributary of the Drumcliff River) flowing north-westward into Drumcliff River. These are relatively minor streams of little local fishery value and fluvial flood risk is not a significant factor for these watercourses with no significant floodplain areas encroached by the route option. The Castlegal stream is also crossed by a proposed link road associated with route option 7 immediately adjacent to the west of the proposed mainline Crossing.

The route crosses upgradient (some 250m) of the East of Drum Wetland Feature of rich fen and flush of local higher ecological importance which is supplied by groundwater flow and seepage from lands upgradient (east). The route option including its proposed local link road is generally in high embankment crossing the valley floor at Lugotober and therefore unlike to intercept groundwater flow supplying this feature. However a section of the road alignment to the southeast of the feature near Castlegal House will involve a deep cutting into the hillslope and has the potential to intercept bedrock and groundwater recharge supplying this feature which may potentially impact this feature depending on the groundwater flow paths. This cutting also has the potential to intercept two Fault lines is very close to the watershed divide and unlikely to represent a significant source of recharge for this wetland feature given the very limited contributing catchment.

The deep cutting has the potential to intercept two fault lines heading west and northwest which could potentially provide a preferential groundwater flow path towards the east of Drum ecological feature and therefore a potential significant hydrological impact on this fen and flush Feature cannot be ruled out.

A second groundwater fed wetland feature referred to as West of Castlegal wetland and categorised as a small example of Annex I priority Petrifying spring habitat of County ecological importance with three small petrifying springs identified is located immediately downstream of the N16 and 75m up-gradient of the route option. The fact that the receptor is up gradient and the valley flood is reasonably steep it is very unlikely that the proposed Route option will impact on the hydrology of this feature and the deep cutting associated with this route option is downgradient of the feature and therefore will not impact on recharge.

Table 15-3: Stage 1 Route Preferences for Central Section

Hydrology and Hydrogeology	Route Options												
	1A	01A/01B	2A	02A/02B	3	4	5	6	7	8	9	10	11
Water courses (Flow, water quality and morphology)	3	3	3	3	3	3	3	3	3	3	3	3	3
Flood /impact and Flood Risk	3	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Resources, water abstractions and hydrogeological features	3	3	4	4	4	3	4	4	4	4	4	4	4
Groundwater dependent habitats	3	3	4	4	4	5	4	4	5	5	5	4	4
Combined Score Value	12	12	14	14	14	14	14	14	15	15	15	14	14
Overall Preference	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Scores 1 very high preference

2 high preference

3 medium preference

4 low preference

5 very low preference

15.5.4 Northern Section

In the Northerly Section there are five distinct route options in respect to hydrological impact for consideration These are Option 01, Option 02, Option 05, Option 10 and Option 11. Options 03, 04, 06, 07, 08 and 09 are similar to option 02. In the final section north of Gortnagrelly the route options converge to basically 3 options, an online route following the N16 with slight widening in places to the south and to the north, a new off line route to the south (option 10) and a new off-line route to the north.

15.5.4.1 Route Option 01A/01B

Option 01 generally follows the existing N16 alignment or just slightly to the north side of the N16 from Gortnagrelly east to the Leitrim Border. The alignment attempts to straighten the road between Lugnagall and Gortnagrelly and involves a deep cutting into the hillslope north of Lugnagall and just to the south of the existing N16 before crossing in deep embankment the Gortnagrelly Stream and valley area north of the N16 Road.

The northern Section of Route option 01 which follows the contours of Cope's Hill crosses a number of small hill-slope streams that fall with steep gradient northeast to the Drumcliff River and to Glencar Lough (which is of high sensitivity being a Natura Site). These streams generally have eroded the shallow sandstone and shale till overburden down to exposing the limestone bedrock and forming ravines and waterfalls on their steep decent towards the valley floor. A total of nine watercourse crossings are intersected by this route option and will require culverting (existing online culverts are likely to be replaced for flood conveyance purposes). These hill slope streams are unlikely to be of fishery interest within the affected reaches. Five of these watercourses discharge directly into Glencar Lough which is a European Site being designated as part of the Ben Bulben, Gleniff and Glenade Complex cSAC and pNHA (000623). The remaining four streams which include the Gortnagrelly Stream and the Lugnagall stream discharge to the Drumcliff River. The Drumcliff River would be considered of local higher ecological value and potential salmonid status. The Drumcliff River outfalls into the Drumcliff Bay cSAC.

The pFRA mapping does not show any of these small streams as having fluvial flood risk. However, given the steep upstream hill slopes, locally high rainfall conditions and low permeability gley soils over till it is considered that almost the full length of the N16 from Lugnagall to the Leitrim Border is at moderate to high flood risk and particularly at existing culvert locations on the N16.

The houses and farms in this northern section of the Route options are all serviced by private wells whose sources if located down gradient (north of the route option) could be impacted both to their well yield and water quality. Any source located on the alignment could potentially be lost, whereas upstream (to the south/southeast) impacts are unlikely. For this option one private source has been identified at potentially being significantly impacted. The groundwater aquifer along the entire northern section of this route is a Locally Important Bedrock aquifer that is generally productive only in local zones (Ll) and of extreme vulnerability (overburden < 3m) along its entire length. The groundwater table is relatively shallow close to the rock head along this section and the proposed cutting at Lugnagall is likely to excavate into limestone bedrock and intercept groundwater within the upper weathered layer.

Route option 1 is unlikely to impact the Lugnagall Flush being in embankment and located north of the N16 Road and therefore downstream and buffered by the existing N16 road and therefore not within the recharge zone of the feature nor capable of dewatering this feature.

Route option 1 crosses in deep embankment through the Gortnagrelly Woodland complex and slightly upstream of the identified seepage/spring area that includes the presence of petrifying springs and Tufa Mounds. To the north of the existing N16 another petrifying spring seepage area was identified. The proposed route option crosses the recharge zone to the southern seepage area and springs and therefore could act as a barrier and intercept recharge water to this feature. The road option is in deep cutting to the southwest of this feature which has the potential to intercept the groundwater table and potentially groundwater recharge supplying this wetland feature. This is considered to represent a potential significant impact on the hydrology and hydrochemistry of an Annex I priority habitat in the absence of mitigation. The mitigation if recharge is intercepted would be difficult to implement and could possibly involve the design of drainage mat with transverse barriers to prevent or limit interception and diversion of recharge flows from the feature. The mitigation may also require the lifting of the road cutting such that the groundwater table is not intercepted.

15.5.4.2 Route Option 2 (Similarly for Route Options 3, 4, 7, 8 and 9)

Route Option 2 is generally off line to the north from Lugatober to Gortnagrelly after which it traverse the existing N16 road to the Leitrim Border. The alignment attempts to straighten the road between Lugnagall and Gortnagrelly and involves a small cutting to the southwest of the Gortnagrelly Stream. The alignment crosses in embankment the Gortnagrelly Stream and valley area north of the N16 Road.

The northern Section of Route option 2 follows the contours of Cope's Hill crossing a number of small hill-slope streams that fall with steep gradient northeast to the Drumcliff River and directly to the Glencar Lough. These streams have generally eroded the shallow till overburden exposing the limestone bedrock and have formed ravines and waterfalls on their steep decent towards the valley floor. This route option will require 4 new stream crossings and upgrade of 6 stream crossings on the existing N16 road. Five of these existing watercourse crossings discharge directly into Gleancar Lough which is a European Site being designated as part of the Ben Bulben, Gleniff and Glenade Complex cSAC and pNHA (000623). The four new culvert crossings which include the Gortnagrelly Stream and the Lugnagall stream discharge to the Drumcliff River which would be considered to be of local higher ecological value and salmonid status. The Drumcliff River outfalls into the Drumcliff Bay cSAC. The intercepted watercourses themselves are hillslope streams and would not be considered to be of fisherly potential.

The pFRA mapping does not show any of these small streams as having fluvial flood risk. However, given the steep upstream hill slopes, locally high rainfall conditions and low permeability gley soils overlying shale and sandstone tills it is considered that almost the full length of the N16 from Lugnagall to the Leitrim border is potentially at moderate to high flood risk and particularly at the sites of existing culvert locations on the N16. The proposed online portion of Route option east of Gortnagrelly is considered most desirable in terms of least potential impact on the European site at Glencar Lough from uncontrolled construction runoff from controlling natural runoff from the steep hillslopes.

The houses and farms in this northern section of the Route options are all serviced by private wells whose sources if located down gradient (north of the route option) could be impacted both to their well yield and water quality. Any source located on the alignment would potentially be lost, whereas upstream south impacts are unlikely. For this option one private sources have been identified at potentially being significantly impacted and a number of downstream well sources are considered at risk of impact. The groundwater aquifer along the entire northern section of this route is a Locally Important Bedrock aquifer that is generally productive only in local zones (LI) and

of extreme vulnerability (overburden < 3m) along its entire length. This gives rise to a high risk of pollution to the Glencar Groundwater body in the absence of suitable road drainage mitigation. The groundwater table is relatively shallow close to the rock head along this section and the proposed cutting at Lugnagall is likely to only very slightly excavate into limestone bedrock and intercept groundwater in the upper weathered layer.

The existing N16 Road Represents a potential Water quality risk to Glencar Lough from routine road runoff waters. The proposed route which is on line will in the absence of suitable mitigation represent a significant risk to the Water quality of the Lake both during construction and operation in the absence of suitable mitigation to prevent pollution through control and treatment.

Route option 2 is unlikely to impact the Lugnagall Flush being in embankment and located north of the N16 Road and therefore downstream of and buffered by the existing N16 road. This route will not impact the recharge zone of this feature.

Route option 2 crosses in embankment through the Gortnagrelly Woodland complex towards the western end and potentially intercepts the downstream end of the petrifying springs and Tufa Mounds and seepage zone area. The proposed route option alignment is likely in the unmitigated case to have a significant to profound impact on this Annex I priority petrifying spring habitat. Mitigation is likely to involve full spanning of the valley floor to avoid direct encroachment and loss of habitat. The impact of this route option to the upstream petrifying spring to the southeast of the existing N16 will be imperceptible as it is downgradient and will not affect the recharge to the spring.

15.5.4.3 Route Option 05 and 06

The route option 5 and 6 are hydrologically very similar to Option 02 described above except at the crossing of the Gortnagrelly wetland habitat where they cross similar to option 10 directly over the Seepage zone of the Petrifying Springs which without appropriate mitigation (Bridge span of the seepage zone) would have a direct profound impact on an annex I Priority Habitat. These routes in this zone pass close to two supply wells with the potential for significant impact.

15.5.4.4 Route Option 10

The southern section at Lugnagall to Gortnagrelly is similar in terms of alignment to option 05 which has been described in the previous sub-section. From Gortnagrelly north this route goes off-line to south, up-gradient into the Hill-slopes of Copes mountain and therefore represents new culverts of the 6 intercepted watercourses in addition to the existing culverts under the N16 road. This option similar to Option 11 will require extensive earth works and significant excavation into the hill slopes of Cope's Mountain which given the depth of cutting is likely to intercept interflow and groundwater flow that may recharge the Glencar Lough as groundwater baseflow. The interception of this baseflow will result in it being discharged to surface watercourses.

The groundwater bedrock Aquifer is characterised by a Glencar fine-grained Limestone formation which is classed as a Locally Important Aquifer which is moderately productive only in Local Zones and the Aquifer vulnerability to pollution is Extreme Vulnerability have overburden cover of < 3m over its Length.

There are also five residential houses whose private well source and sources has a high probability of being significantly impacted given that the route will be in a deep cutting approximately 50 to 60m upstream of these dwellings.

In respect to Construction and the potential impact on the water quality of Glencar Lough this option is considered to be preferable than option 11 as the construction site is located further away from the lake and will be buffered by the existing N16 Road. Nevertheless given the high rainfall and steep terrain it will be difficult to control and prevent sediment laden site runoff entering the Lough for any of the Route options with the on-line the most preferable as it will involve the least volume of earthworks.

15.5.4.5 Route Option 11

The southern section at Lugnagall to Gortnagrelly is similar in terms of alignment to option 02 which has been described in a previous sub-section under option 2 (very slightly more westward at Lugnagall, similar to Option 3). From Gortnagrelly north this route goes off-line to the North, down-gradient of the existing N16 and on the hill slopes and closer to Glencar Lough (300 to 400m of the lake edge). This route to north of Gortnagrelly will require new culverts of 6 intercepted watercourses in addition to the existing culverts under the N16 road.

This route option will require extensive earthworks involving the transport if significant infill to construct embankments which represents a very high construction risk to the water quality of Glencar Lough. In respect to Construction and the potential impact on the water quality of Glencar Lough this option is considered to be the least preferable given the construction risks to an oligotrophic lake from construction runoff. The high rainfall and steep terrain make it difficult to control and prevent sediment laden site runoff entering the Lough.

There are two residential houses whose private well sources have a high probability of being impacted in terms of water quality by the proposed route. Impact to well yield is unlikely given that the road will be in embankment.

The groundwater bedrock Aquifer is characterised by a Glencar fine-grained Limestone formation which is classed as a Locally Important Aquifer which is moderately productive only in Local Zones and the Aquifer vulnerability to pollution is Extreme Vulnerability have overburden conver of < 3m over its Length.

Table 15-4: Stage 1 Route Preferences for Northern Section

Hydrology and Hydrogeology	Route Options												
	1A	01A/01B	2A	02A/02B	3	4	5	6	7	8	9	10	11
Water courses (Flow, water quality and morphology)	3	3	3	3	3	3	3	3	3	3	3	4	5
Flood /impact and Flood Risk	3	3	3	3	3	3	3	3	3	3	3	4	4
Groundwater Resources, water abstractions and hydrogeological features	5	5	4	4	4	4	5	5	4	4	4	5	4
Groundwater dependent habitats	4	4	5	5	5	5	5	5	5	5	5	5	5
Combined Score Value	15	15	15	15	15	15	16	16	15	15	15	18	18
Overall Preference	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Very Low	Very Low

Scores 1 very high preference

2 high preference

3 medium preference

4 low preference

5 very low preference

Table 15-5: Preliminary Options Assessment – Part 1: (Hydrology & Hydrogeology) Preferences

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	4	3	4	4	4	3	3	3	3	3	4	4
Central	3	3	4	4	4	4	4	4	4	4	4	4	4
North	4	4	4	4	4	4	4	4	4	4	4	5	5
Overall	3	4	4	4	4	4	4	4	4	4	4	4	4

15.6Preliminary Options Assessment – Part 2

15.6.1 Introduction

Refined route options were determined following a multi-disciplinary workshop on the outcomes of the Preliminary Options Assessment – Part 1. Refinement and localised modification to the routes were applied so as to achieve feasible options that avoid/minimise potential significant impacts on the environment.

At the Preliminary Options Assessment – Part 1, there were 13 route options considered. The refinement of the route options as part of Part 2 reduced the options to the following seven route options:

- Route 01A/B (version 2)
- Route 02A/B (version 2)
- Route 05
- Route 08 (version 2)
- Route 12
- Route 12 (version 2)

Option Route 01A/01B (v2) follows the existing N15, with improvements to the N15, from the N4/N15 junction northwards to Lisnalurg/Teesan, where it turns east/northeast across improved agricultural grassland to Doonally, after which it heads northwards to Drum East/ Castlegal. North of Drum East the route is broadly similar to Option 08-v2 which runs generally offline to the northeast of the existing N16 from Castlegal to Gortnagrelly after which it is broadly online along the existing N16 with slight widening and cutting into the hillslope immediately adjacent to the N16 at Gortnagrelly.

Option Route 02A/02B (v2) follows the existing N15, with improvements to the N15, from the N4/N15 junction northwards to Shannon Eighter, where it turns east and then northeast across improved agricultural grassland to Shannon Oughter and northeast to Doonally, after which it heads northwards to Drum East/ Castlegal. To the east of Drumkilsellagh the route ties into Route 05 and then ties in to Option 8-v2 in the townland of Collinsford.

Route Option 05 commences at existing N16 at Rathbraghan and traverses northwards to the east of the N16 road to Doonally and ties into Option 02A/02B at Drumkilsellagh and ties into Option 8 (v2) in the townland of Collinsford.

Route Option 8-v2 commences at existing N16 to north of Farranacardy and its southern section is identical to route option 12 and 12-v2 heading to the east of the existing N16 through the townlands of Barroe and Faughts after which it heads north, running to the east of the N16 to Willowbrook and crosses theN16 to turn to the west of the N16 at Doonally to Castlegal and at Lugnagall/Collinsford townland tying into route Options 05, 02A and 01A.

Route Option 12 commences at existing N16 road to the north of Farranacardy and its southern section is similar to route option 08- v2 heading to the east of the existing N16 through the townlands of Barroe and Faughts after which it heads north remaining east of the existing N16 to the south of Willowbrook Td. where it crosses to the west of the existing N16 at Doonally to Castlegal and at Lugnagall/Collinsford townland tying into Options 08v2, 05, 02A and 01A. There are alignment differences between Options 12 and 8(v2) between Castlegal to Gortnagrelly, with 12 taking an almost online route along the existing N16. In the vicinity of Gortnagrelly, option 12 is similar to Option 8 -v2, whereas, Option 12 -v2 takes a more easterly route closer to the N16 Road at the

Gortnagrelly ecological wetland site. To the northeast of Gortnagrelly, all of the alignments converge to broadly a similar alignment tying into the existing N16 road.

Route Option 12-v2 is the same as route Option 12 except with an alternative junction arrangement in the Collinsford / Lugnagall td and an alternate alignment at Gortnagrelly where it is pushed east closer to the Existing N16 Road.

15.6.2 Route option 01A/01B (version 2)

15.6.2.1 Hydrogeology

The southern section of this route passes through a regionally important karst aquifer of conduit flow which has vulnerabilities of moderate, high and extreme. A cutting is required which is likely to intercept bedrock and therefore this proposed route represents a risk to the water quality of a regionally important groundwater body. There are a number of wells to the north and west of the route whose yield are unlikely to be impacted but the water quality without appropriate mitigation could be impacted. In the central section a large cutting into the hill slopes near Castlegal is likely to excavate into the bedrock. This represents the deepest cutting slightly further to the east of the other route options and the cutting potentially intercepts 2 fault lines which may have a weathered zone that encourages preferential groundwater flow along the faultlines. Down gradient the Drum East ecological receptor which is groundwater fed may be impacted by such a cutting which potentially could divert groundwater flow. The route passes close to, but down gradient of the petrifying spring habitat at Castlegal and the potential impact to this groundwater fed system by the road construction is expected to be imperceptible. At Lugnagall the route option passes down gradient of the ecological receptor and is buffered by the existing N16 road and therefore unlikely to impact on this ecological receptor which is fed from up-gradient off the hill slopes of Cope's Mountain via bedrock recharge and direct overland flow.

At Gortnagrelly the route crosses over the seepage zone that includes springs of a Annex I petrifying spring and tufa mound ecological habitat. Without mitigation direct impact by the road alignment on this feature represents a significant impact. To avoid such impact, mitigation in the form of bridge spanning the road over this feature will be required. The required spanning is likely to be of the order of 40 to 60m in order to completely avoid the seepage zone.

Similar, to the other route options it passes up gradient of a number of domestic wells whose water quality could be impacted at Castlegal. At Lugatober the route passes down gradient of identified domestic supply sources and therefore is unlikely to impact these sources. At Gortnagrelly the route passes both down gradient and up gradient of a number of private domestic well supplies with no impact to those located up gradient and potential water quality impacts only to those down gradient as the road will be in embankment and unlikely to impact on well yield. A supply from the Gortnagrelly springs has been identified which would be impacted similar to the potential impact described above in regard to the Gortnagrelly ecological receptor.

From a hydrogeology impact perspective overall this route option in the southern section represents the least favoured of all the options primarily because of the deep cutting that potentially intercepts faultlines at Castlegal and the extent of road development within a regionally important karst aquifer system. Impact to ecological receptors and domestic supplies are generally similar between the various route options, however they direct encroachment of the Gortnagrelly ecological receptor is considered without mitigation to represent a significant impact on the groundwater fed habitat and with mitigation through bridge spanning it should be possible to avoid this impact.

15.6.2.2 Hydrology

The southern section of this route option avoids intercepting any significant streams with only small drainage channels as part of the Cregg stream system intercepted and therefore potential impact on surface hydrology will be slight. The absence of surface drainage features in the karst area to the north of Carncash may lead to difficulty in regard to disposing of road run-off with a potential requirement of discharging to groundwater. There are no significant flood risk zones encountered by this route option from Teesan east to Castlegal. The southern option 01B that takes the existing N15 road alignment to Teesan is shown to cross a number of streams including the Willsborough stream and the Rathbraghan Stream at existing structures which may potentially have to be extended or upgraded. Such watercourses represent the water quality risk during construction and operation and also represent a direct pathway for contaminants to enter Sligo Harbour and the Cummeen Strand SAC. In the central and northern sections similar to all of the route options a number of small hillslope streams are crossed which may require slight channel diversions and culverts, either new, replacement or extensions to the existing culverts, which will have implications on flooding and water quality. A number of these (three small streams) at the northeast end of the scheme feed directly into Glencar Lough which is part of the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623).

In terms of hydrology the impacts in the northern and central sections of the routes are similar between all of the route options and represent a potential moderate impact on flooding and the flow regime and potential significant impact without appropriate mitigation on the water quality to Glencar Lough and a moderate impact to the water quality of the Drumcliff River and the Drumcliff-Glebe Stream. Both of which eventually feed into the designated Cummeen Strand and Drumcliff Bay SAC. The main differences between the route options lie in the southern section south of Castlegal. In this respect option 01A is the most favoured of the options having a neutral to slight impact as it avoids any significant stream or flood risk area. However the southern section of option 1B along the existing N15 road represents potentially moderate impacts to local water quality and flood risk in the Willsborough and the Rathbraghan stream at the existing crossing points and potential slight to moderate impact on the water quality of the downstream Cummeen Strand SAC. In the central and northern sections there is little difference between all of the route options in respect to surface hydrology.

15.6.3 Route option 2A/B (version 2)

15.6.3.1 Hydrogeology

The southern section of this route option avoids the regionally important karst aquifer that is located to the north of Carncash and passes through a locally important bedrock aquifer which is generally productive only in local zones. The groundwater vulnerability to contamination ranges in the southern section from moderate to high. North of Doonally similar to all of the route options the regionally important karst aquifer is intercepted from Doonally to Castlegal where vulnerabilities range from high and extreme. North of Castlegal a locally important bedrock aquifer of extreme vulnerability is intercepted by all of the route options. In the southern section a number of small cuttings will be required which are unlikely to reach bedrock and therefore are unlikely to result in any significant dewatering of the local groundwater table which may be perched due to poor permeability of the overburden till.

In the central section a cutting into the hill slopes near Castlegal will be required which is likely to excavate into the bedrock. The alignment is slightly more west of option 01 and 08-v2 and therefore

does not require as extensive a cutting. Nevertheless, it intercepts a mapped faultline that runs southeast to northwest. A second east-west fault line is encountered just to the north of the cutting where the alignment is transitioning to embankment. These faultlines have potential to represent weathered zones in the bedrock that can give rise to preferential groundwater flow paths along the fault line and potentially may contribute to the downstream groundwater fed Drum East ecological feature. The impact of this route on a potential groundwater flow that supplies the Drum-East ecological feature cannot be ruled out, but relative to route options 01 and 08-v2 is likely to have a lesser potential for intercepting groundwater flow.

The route passes close to, but down-gradient of the petrifying spring habitat at Castlegal and the potential impact to this groundwater fed system by the road construction is expected to be imperceptible as the habitat lies just to the east of the existing N16 roads which will also buffer it. At Lugnagall the route option passes down gradient of the ecological receptor and is also buffered by the existing N16 road and therefore unlikely to impact on this ecological receptor which is fed from up-gradient off the hill slopes of Cope's Mountain via bedrock recharge and direct overland flow.

At Gortnagrelly the route crosses over the seepage zone that includes springs of a Annex I petrifying spring and tufa mound ecological habitat. Without mitigation direct impact by the road alignment on this feature represents a significant impact. To avoid such impact, mitigation in the form of bridge spanning the road over this feature will be required. The required spanning is likely to be of the order of 40 to 60m in order to completely avoid the seepage zone.

Similar, to the other route options it passes up gradient of a number of domestic wells whose water quality could be impacted at Castlegal. At Lugatober the route passes down gradient of identified domestic supply sources and therefore is unlikely to impact these sources. At Gortnagrelly the route passes both down gradient and up gradient of a number of well supplies with no impact to those located up gradient and potential water quality impacts only to those down gradient as the road will be in embankment and therefore unlikely to impact on yield. A supply from the Gortnagrelly springs has been identified which would be impacted similar to the potential impact described above in regard to the Gortnagrelly petrifying spring habitat.

From a hydrogeology impact perspective this Route Option has a higher preference than Route Option 01 in the southern section as it avoids for a large portion of it southern leg the regionally important karst groundwater body and has a more reduced road cutting into the bedrock at Castlegal.

Impact to the other ecological receptors and domestic supplies are generally similar between the various route options. However similar to Option 01 the direct encroachment of the Gortnagrelly ecological receptor is considered without mitigation to represent a significant impact on the groundwater fed habitat. Spanning this section with a Road bridge should mitigate this direct impact on the habitat.

15.6.3.2 Hydrology

The southern section of this route intercepts Willsborough stream and floodplain area at 2 locations to the north of Rathbraghan. CFRAM flood mapping shows the encroachment to be moderate in extent. It also intercepts the Lisnalurg stream at Shannon Eighter and a number of minor drains near Doonally. The southern option 01B that follows the N15 road to the N4/N15 junction is shown to cross a number of streams including the Willsborough stream and the Rathbraghan Stream at existing structures which may potentially have to be extended or upgraded / replaced. Such watercourse crossings represent a water quality risk both during construction and operation and

also represent a direct pathway for contaminants to enter the nearby Sligo Harbour and Cummeen Strand and Drumcliff Bay SAC.

In the central and northern sections of the route, similar to all other route options, a number of hillslope streams are to be crossed and which may require slight diversions and culverting. These streams may require new culverts or replacement or extensions to existing culverts under the N16 which have implications on flooding and water quality. A number of these (three small streams) at the northeast end of the scheme feed directly into Glencar Lough which is part of the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The others discharge to the Drumcliff River and the Drumcliff-Glebe Stream both of which outfall in to Drumcliff Bay and the SAC/SPA waters.

In terms of hydrology the impacts in the northern and central sections of the routes are similar between all of the route options and represent a potential moderate impact on flooding and the flow regime and potential significant impact without appropriate mitigation on the water quality to Glencar Lough and a moderate impact to the water quality in the Drumcliff River and Drumcliff-Glebe Stream and a potential slight impact on water quality in the Cummeen Strand-Drumcliff Bay SAC.

The main differences between the route options lie in the southern section south of Castlegal. In this respect option 02A has a potential for moderate impact to water quality in the receiving watercourses of the Willsborough stream and the Lisnalurg Stream through storm drainage discharges and construction. The proposed route presents a moderate impact on flood risk to lands adjacent to the Willsborough stream at the crossing points north of Rathbraghan. Road drainage discharge outfalling to these streams has the potential to increase flood flows which without mitigation (attenuation) has the potential to cause slight to moderate impact on the flow regime and flood risk downstream. Mitigation both for water quality and flooding will involve treatment and attenuation of run-off waters and the appropriate bridge/culvert design to ensure minimal encroachment into the effective, conveying floodplain areas. The southern section of option 2B along the existing N15 road to the N4/N15 Junction represents a potential moderate impact on water quality and flood risk in the Willsborough and the Rathbraghan stream at the existing crossing points adjacent to the N15 and a potential slight to moderate water quality impact on the downstream Cummeen Strand and Drumcliff Bay SAC. This route option is considered to be less favoured in the southern section over options 01, 0 and 12 and slightly better than option 05. In the central and northern sections there is little difference between all of the route options in respect to surface hydrology.

15.6.4 Route option 05 (version 2)

15.6.4.1 Hydrogeology

The southern section of this route option avoids the regionally important karst aquifer and passes predominantly through a locally important bedrock aquifer which is generally productive only in local zones. The groundwater vulnerability to contamination ranges in the southern section of this route to be predominantly moderate and increasing to high near Doonally. North of Doonally similar to all of the route options the regionally important karst aquifer is intercepted from Doonally to Castlegal where vulnerabilities range from high to extreme. North of Castlegal a locally important bedrock aquifer of extreme vulnerability is intercepted by all of the route options. In the southern section a number of small cuttings may be required which are unlikely to reach bedrock and therefore are unlikely to result in any significant dewatering of the local groundwater table. In this south section, to the south of Doonally a number of shallow wells are in proximity to the road but

are unlikely to be significantly impacted as the road is at grade or in embankment and the overburden permeability is low.

In the central section a cutting into the hill slopes near Castlegal will be required which is likely to intercept the limestone and sandstone bedrock. The alignment is slightly more west of option 01 and 08-v2 and therefore does not require as extensive a cutting. Nevertheless, it intercepts a mapped faultline that runs southeast to northwest. A second east-west fault line is encountered just to the north of the cutting where the alignment is transitioning to embankment. These faultlines have potential to represent weathered zones in the bedrock that can give rise to preferential groundwater flow paths along the fault line and potentially may contribute to the downstream groundwater fed Drum East ecological feature. The impact of this route on a potential groundwater flow that supplies the Drum-East ecological feature cannot be ruled out, but relative to route options 1 and 8 is likely to have a lesser potential for intercepting groundwater flow. The route passes close to, but down gradient of the petrifying spring habitat at Castlegal which is located just east of the existing N16 road and the potential impact to this groundwater fed system by the road construction is expected to be imperceptible. At Lugnagall the route option also passes down gradient of the ecological receptor and is buffered by the existing N16 road and therefore unlikely to impact on this ecological feature which is fed from recharge to bedrock and direct surface runoff from up gradient off the hill slopes of Cope's Mountain.

At Gortnagrelly the route crosses over the seepage zone that includes springs of a Annex I petrifying spring and tufa mound ecological habitat. Without mitigation direct impact by the road alignment on this feature represents a significant impact. To avoid such impact, mitigation in the form of bridge spanning the road over this feature will be required. The required spanning is likely to be of the order of 40 to 60m in order to completely avoid the seepage zone.

Similar, to the other route options it passes up gradient of a number of domestic wells whose water quality could be impacted at Castlegal. At Lugatober the route passes down gradient of identified domestic supply sources and therefore is unlikely to impact these sources. At Gortnagrelly the route passes both down gradient and up gradient of a number of well supplies with no impact to those located up gradient and potential water quality impacts only to those down gradient as the road will be in embankment and therefore unlikely to impact on yield. A supply from the Gortnagrelly springs has been identified which would be impacted similar to the potential impact described above in regard to the Gortnagrelly petrifying spring habitat.

From a hydrogeology impact perspective this Route Option 05 similar to 02A/02B has a higher preference than Route Option 01 as it avoids for a large portion in its southern leg the regionally important karst groundwater body and has a reduced road cutting into the bedrock at Castlegal with only one mapped Faultline being intercepted.

Impact to the other ecological receptors and domestic supplies are generally similar between the various route options. However similar to Option 01 the direct encroachment of the Gortnagrelly ecological receptor is considered without mitigation to represent a significant impact on the groundwater fed habitat. Spanning this section with a Road bridge should mitigate this direct impact on the habitat. The potential impact on the Drum East ecological receptor of county importance is rated as a potential moderate impact.

15.6.4.2 Hydrology

The southern section of this route intercepts Willsborough stream to the east of Shannon Oughter. The alignment potentially will result in the road running almost parallel and in close proximity to the stream channel and within the Floodplain for c. 200m. This will result in pushing the effective flood

plain area west of the road alignment and represents a potential moderate impact on local flooding and flood risk. A link road associated with this option will also require a new bridge crossing of the Willsborough channel and floodplain to the South of Doonally. Some channel diversion and regrading may be required to mitigate the impact on the Willsborough stream and floodplain area. Route Option 05 crosses the Rathbraghan Stream just downstream of its spring source and a number of small stream / drainage channels in its northerly route to the west of the Existing N16 road to north of Drumkilsellagh.

In the central and northern sections of the route, similar to all other route options, a number of hillslope streams are to be crossed and which may require slight diversions and culverting. These streams may require new culverts or replacement or extensions to existing culverts under the N16 which have implications on flooding and water quality. A number of these (three small streams) at the northeast end of the scheme feed directly into Glencar Lough which is part of the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The others discharge to the Drumcliff River and the Drumcliff-Glebe Stream both of which outfall in to Drumcliff Bay and the SAC/SPA waters.

In terms of hydrology the impacts in the northern and central sections of the routes are similar between all the route options and represent a potential moderate impact on flooding and the flow regime and potential significant impact without appropriate mitigation on the water quality to Glencar Lough and a moderate impact to the water quality in the Drumcliff River and Drumcliff-Glebe Stream and a potential slight impact on water quality in Drumcliff Bay SAC.

Mitigation both for water quality and flooding will involve treatment of run-off waters and the appropriate bridge/culvert design to ensure minimal encroachments into the effective, conveying floodplain area.

The main differences between this route option and route option 2 lies in its southern section where there is a potential greater impact on the Willsborough Stream due to the this route running parallel to the stream channel along the floodplain and the associated local ink road crossing of the stream and floodplain to the south of Doonally. In the central and northern sections there is little difference between all of the route options in respect to surface hydrology.

15.6.5 Route option 8 (version 2)

15.6.5.1 Hydrogeology

In the Southern Section Route Option 08-v2 is the same alignment as Route Options 12 and 12(v2). It is relatively similar to Route Option's 02 and 05 in that it avoids the regionally important karst aquifer and passes predominantly through a locally important bedrock aquifer which is generally productive only in local zones. Its alignment to the east of the existing N16 road results in the alignment being located on higher ground where shallower soils exist, resulting in a longer length of the road within bedrock aquifer of high and extreme vulnerability to contamination. The alignment also results in a local deep cuttings near Faughts but this cutting is unlikely to reach bedrock but may potentially intercept a perched water table within the overburden. North of Doonally similar to all of the route options the regionally important karst aquifer is intercepted from Doonally to Castlegal where vulnerabilities range from high to extreme. North of Castlegal a locally important bedrock aquifer of extreme vulnerability is intercepted by all of the route options.

In the central section this route similar to the other routes results in a potential bedrock cutting into the hill slopes near Castlegal. This represents almost as deep and extensive a cutting as Option 01A/01B. The road cut section intercepts 2 mapped fault lines at Castlegal which may have a weathered zone that potentially encourages preferential groundwater flow along the faultline. The

downstream groundwater fed Drum East ecological receptor could potentially be impacted by this cutting which could divert groundwater flow away from the feature. The route passes close to, but down gradient of the petrifying spring habitat at Castlegal which is located just east of the existing N16 road and the potential impact to this groundwater fed system by the road construction is expected to be imperceptible particularly as the road will be in embankment adjacent to this feature.

From Lugatober to north of Gortnagrelly, Option 08-v2 is similar to options 01A/01B, 02A/02B and 05 taking an offline alignment slightly to the west /northwest of the N16 Road. At Lugnagall the route option also passes down gradient of the ecological receptor and is buffered by the existing N16 road and therefore unlikely to impact on this ecological feature which is fed from recharge to bedrock and direct surface runoff from up gradient off the hill slopes of Cope's Mountain.

At Gortnagrelly the route crosses over the seepage zone that includes petrifying springs and tufa mounds of Annex I Habitat. Without mitigation direct impact by the road alignment on this feature represents a significant impact. To avoid such impacts mitigation in the form of bridge spanning the road over this feature will be required. The required spanning could be of the order of 40 to 50m in order to avoid the seepage zone.

Similar, to the other route options it passes up gradient of a number of domestic wells whose water quality could be impacted at Castlegal. At Lugatober the route passes down gradient of identified domestic supply sources and therefore is unlikely to impact these sources. At Gortnagrelly the route passes both down gradient and up gradient of a number of small local well supplies, with no impact anticipated to those located up gradient and potential water quality impacts only to those down-gradient as the road will be in embankment and should not impact well yield. A private supply from the Gortnagrelly springs has been identified which could be impacted by the road similar to the potential impact described above in regard to the Gortnagrelly Annex I habitat.

From a hydrogeology impact perspective this Route Option 08-v2 due to the deeper cutting at Faughts and Castlegal has a lower preference than Options 2A/B, 5 and 12 and a higher preference than Route Option 01 as it avoids for a large portion in its southern leg the regionally important karst groundwater body.

Impact to the other ecological receptors and domestic supplies are generally similar between the various route options. However similar to Option 1A/B, 2A/B, and option 05 the direct encroachment of the Gortnagrelly ecological receptor is considered without mitigation to represent a significant impact on the groundwater fed habitat and the potential impact on the Drum East ecological receptor of county importance is rated as a potential moderate impact.

15.6.5.2 Hydrology

The route crosses directly over the spring source to the Rathbraghan Stream to the north of Farranacardy townland near the existing N16 which will require culverting to avoid blockage and local flooding.

The southern section of this route intercepts Willsborough stream to the east of N16 road at Willowbrook where the floodplain is not extensive and the river is essentially confined to its river channel. To the north of Faughts in the vicinity of the existing country road an extensive area of pluvial flood risk has been identified which the proposed route traverses. This area is drained westward to the Willsborough stream via a series of small open drains with limited capacity and therefore potential for impact both by encroachment and storm drainage discharges.

In the central and northern sections of the route, similar to all other route options, a number of hillslope streams are to be crossed and which may require slight diversions and culverting. These streams may require new culverts or replacement or extensions to existing culverts under the N16 which have implications on flooding and water quality. A number of these (three small streams) at the northeast end of the scheme feed directly into Glencar Lough which is part of the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The others discharge to the Drumcliff River and the Drumcliff-Glebe Stream both of which outfall in to Drumcliff Bay and the SAC/SPA waters.

In terms of hydrology the impacts in the northern and central sections of the routes are similar between all the route options and represent a potential moderate impact on flooding and the flow regime and potential significant impact without appropriate mitigation on the water quality to Glencar Lough and a moderate impact to the water quality in the Drumcliff River and Drumcliff-Glebe Stream and a potential slight impact on water quality in Drumcliff Bay SAC.

Mitigation both for water quality and flooding will involve treatment of run-off waters and the appropriate bridge/culvert design to ensure minimal encroachments into the effective, conveying floodplain area.

The main differences between this route option and options 02 and 05 lie in its southern section where it has limited impact on the Willsborough stream and floodplain but increased flooding and flood risk due to its direct impact on the Rathbraghan Stream spring source and the pluvial flood risk area to the north of Faughts. However overall this option is rated higher than Option02A/02B and Option 05 and lower than option 01 in respect to flooding and water quality impact in the southern section. In the central and northern sections there is little difference between all of the route options in respect to surface hydrology.

15.6.6 Route option 12

15.6.6.1 Hydrogeology

In the Southern Section Route Option 12 is the same alignment as Route Options 8-v2 and Option 12(v2). It is relatively similar to Route Option's 02 and 05 in that it avoids the regionally important karst aquifer and passes predominantly through a locally important bedrock aquifer which is generally productive only in local zones. Its alignment to the east of the existing N16 road results in a longer section of the alignment located on higher ground where shallower soils exist, resulting in increased exposure to a bedrock aquifer with high and extreme vulnerability to contamination. The alignment also results in a local deep cuttings near Faughts which is unlikely to reach bedrock but may potentially intercept a perched water table within the overburden layer. North of Doonally similar to all of the route options the regionally important karst aquifer is intercepted from Doonally to Castlegal where vulnerabilities range from high to extreme. North of Castlegal a locally important bedrock aquifer of extreme vulnerability is intercepted by all of the route options.

In the central section this route similar to the other routes results in a potential bedrock cutting into the hill slopes near Castlegal. This option represents the furthest west of the options and results in a smaller length and depth and of bedrock cutting. This cutting still intercepts one of the faultlines at Castlegal which may have a weathered zone that potentially encourages preferential groundwater flow along the faultline. The downstream, groundwater fed Drum East ecological receptor could potentially be impacted by this cutting as the cutting could divert groundwater flow away from the feature. However in comparison to the other options (01A/01B, 02, 05 and 08-v2) this option represents the lowest risk to the feature. The route passes close to, but down-gradient of the petrifying spring annex I habitat that is located just upstream to the east of the existing N16 road at

Castlegal and consequently the potential impact to this groundwater fed system by the road construction is expected to be imperceptible.

From Lugatober to north of Lugnagall this Option 12 follows the N16 alignment which brings it very close to the Lugnagall ecological receptor with a potential for impact through dewatering during construction when the existing buffering N16 road is excavated to accommodate the proposed route. This potential impact is rated as potentially significant and will require careful construction mitigation and vertical alignment design.

At Gortnagrelly the route crosses over the seepage zone that includes petrifying springs and tufa mounds of Annex I Habitat. Without mitigation direct impact by the road alignment on this feature represents a significant impact. To avoid such impacts mitigation in the form of bridge spanning the road over this feature will be required. The required spanning could be of the order of 40 to 50m in order to avoid the seepage zone.

Similar, to the other route options it passes up gradient of a number of domestic wells whose water quality could be impacted at Castlegal. At Lugatober the route passes down gradient of identified domestic supply sources and therefore is unlikely to impact these sources. At Gortnagrelly the route passes both down gradient and up gradient of a number of small local well supplies, with no impact anticipated to those located up gradient and potential water quality impacts only to those down-gradient as the road will be in embankment and should not impact well yield. A private supply from the Gortnagrelly springs has been identified which could be impacted by the road similar to the potential impact described above in regard to the Gortnagrelly Annex I habitat.

From a hydrogeology impact perspective this Route Option 12 due to its potential impacts to the Drum East, Lugnagall and Gortnagrelly ecological receptors is the least favoured option in respect to hydrogeology in the central and northern sections of the road. In the southern section it has a slight preference over option 08-v2 due to its the less extensive bedrock cutting that would be required at Castlegal.

15.6.6.2 Hydrology

The route crosses directly over the spring source to the Rathbraghan Stream to the north of Farranacardy townland near the existing N16 which will require culverting to avoid blockage and upstream and local flooding.

The southern section of this route intercepts Willsborough stream to the east of N16 road at Willowbrook where the floodplain is not extensive and the river is essentially confined to its river channel. To the north of Faughts in the vicinity of the existing country road an extensive area of pluvial flood risk has been identified which the proposed route traverses. This area is drained westward to the Willsborough stream via a series of small open drains with limited capacity and therefore potential for impact both by encroachment and storm drainage discharges.

In the central and northern sections of the route, similar to all other route options, a number of hillslope streams are to be crossed and which may require slight diversions and culverting. These streams may require new culverts or replacement or extensions to existing culverts under the N16 which have implications on flooding and water quality. A number of these (three small streams) at the northeast end of the scheme feed directly into Glencar Lough which is part of the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The others discharge to the Drumcliff River and the Drumcliff-Glebe Stream both of which outfall in to Drumcliff Bay and the SAC/SPA waters.

In terms of hydrology the impacts in the northern and central sections of the routes are similar between all the route options and represent a potential moderate impact on flooding and the flow

regime and potential significant impact without appropriate mitigation on the water quality to Glencar Lough and a moderate impact to the water quality in the Drumcliff River and Drumcliff-Glebe Stream and a potential slight impact on water quality in Drumcliff Bay SAC.

Mitigation both for water quality and flooding will involve treatment of run-off waters and the appropriate bridge/culvert design to ensure minimal encroachments into the effective, conveying floodplain area.

The main differences between this route option (similarly for Option 8-v2 and 12-v2v2) and options 2 and 5 lie in its southern section where it has limited impact on the Willsborough stream and floodplain but increased flooding and flood risk due to its direct impact on the Rathbraghan Stream spring source and the pluvial flood risk area to the north of Faughts. However overall this option is rated higher than Option02A/02B and Option 05 and lower than option 01 and similar to option 08 and 12v2 in respect to flooding and water quality impact in the southern section. In the central and northern sections there is little difference between all of the route options in respect to surface hydrology.

The overall preference for this route option taking into account impact on hydrogeology, hydrology and groundwater dependent ecological receptors is that option 12 is second lowest preference with Option 12v2 given the lowest preference for the central section. The northern section is generally similar for all of the options and for the southern section this option is slightly favoured over 8, then 2 , 5 and 1A/B

15.6.7 Route Option 12 (version 2)

Route 12 v2 is essentially the same as route Option 12 except with an alternative junction arrangement in the Collinsford / Lugnagall townland and an alternate alignment at Gortnagrelly where it is pushed east closer to the Existing N16 Road. Therefore it is the same route for the southern section and the end section northeast of Gortnagrelly towards the Leitrim border. In terms of surface hydrology there is no real difference between these route options for any of the sections and in terms of hydrogeology and potential impact on groundwater fed ecological sites the route Option 12 (v2) has a potential to have a greater impact on the Gortnagrelly seepage area and petrifying spring Annex I habitat as it crosses directly over its recharge seepage area upstream of the petrifying springs with potential impact to seepage flows and water quality if such an area is not fully spanned.

The overall preference for this route option taking into account impact on hydrogeology, hydrology and groundwater dependent ecological receptors is that option 12v2 is the lowest preference with Option 12 the second lowest preference for the central section. The northern section is generally the same for all of the options and for the southern section this option (12 and 12v2) is slightly favoured over options 08-v2, then 02, 05 and 1A/B.

Table 15-6: Refined Route Options (Hydrology)

Section	Refined Route Option - Hydrology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	2	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
Overall	2	4	3	4	n/a	n/a	4	n/a	n/a	3	n/a	n/a	n/a	3	3

Table 15-7: Refined Route Options (Hydrogeology)

Section	Refined Route Option - Hydrogeology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	4	4	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
Overall	4	4	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	4

Table 15-8: Refined Route Options (Hydrology & Hydrogeology)

Section	Refined Route Option - Hydrology & Hydrogeology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	3	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
Overall	3	4	3	4	n/a	n/a	4	n/a	n/a	3	n/a	n/a	n/a	4	4

15.7Conclusions

The N16 Road scheme is split into a southern section from Sligo to Drumkilsellagh, a central section from Drumkilsellagh to north of Lugatober and a northern section that includes Lugnagall, Gortnagrelly to the county border with Leitrim. The Preliminary Options Assessment – Part 1considered 13 route options which were reduced to 7 route options for the Part 2 assessment. The sub-topics in respect to hydrology were water quality and morphological implications to watercourses, lakes, estuaries and coastal waters and flood impact / risk. The sub-topics in respect to hydrogeology were impact to hydrogeological features including karst features, groundwater bodies and local groundwater supplies and also groundwater fed ecological receptors. These were combined to give an overall preference score for hydrology/hydrogeology.

In respect to the Hydrology/Hydrogeology there is little difference in the potential impact scale between the various route options considered for any of the three sections, with no profound impacts predicted and where significant impacts were identified mitigation measures were also identified that could reduce/ eliminate such impacts to moderate, slight and imperceptible. Significant hydrological/hydrogeological impacts in respect to potential water quality impact of construction runoff on the Glencar Lough, potential significant hydrogeological impacts to the Gortnagrelly petrifying spring Annex I habitat, the Lugnagall Annex I habitat and moderate impact to the Drum East ecological receptor of Local Higher significance were identified. All other impacts in respect to water quality in receiving rivers and streams, impact to hydrogeological features and local well supplies and flood risk were rated as slight and moderate permanent impacts.

In that respect the overall rating for the various road options had a limited range varying from medium to low preference with none identified clearly as either High, Very High orVery Low preferences.

The Preliminary Options Assessment – Part 2 identified the preference for route 01A as Medium, route 01B as Low, route 02A as Medium and 02B as Low, route option 5 as Low, route option 8 as Medium and route options 12, 12-v2 as low.

Overall, in respect to the hydrology/hydrogeology route selection there are no show stoppers identified with all options considered to be feasible.