ENVIRONMENTAL IMPACT ASSESSMENT REPORT

TEN-T Priority Route Improvement Project, Donegal

Chapter 10: Land, Soils & Hydrogeology

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EIAR

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List of Abbreviations

The following is a list of abbreviations used within this chapter of the Environmental Impact Assessment Report (EIAR).

List of Abbreviations

List of Abbreviations	
BGL	Below Ground Level
CBR	California Bearing Ratio
CGS	County Geological Site
CIRIA	Construction Industry Research and Information Association
CPO	Compulsory Purchase Order
DCC	Donegal County Council
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EOP	Environmental Operating Plan
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
GSI	Geological Survey of Ireland
GWB	Groundwater Bodies
GWDTE	Groundwater Dependent Terrestrial Ecosystems
IEL	Industrial Emissions License
IGI	Institute of Geologists of Ireland
IGV	Interim Guideline Value
IPC	Integrated Pollution Control
IPCC	Intergovernmental Panel on Climate Change
LFS	Lough Foyle Succession
MASW	Multi-channel Analysis of Surface Waves
MED	Material Extraction and Deposition (areas)
mOD	metres above Ordnance Datum
NRA	National Road's Authority
OPW	Office of Public Works
pNHA	proposed Natural Heritage Area
PRC	Primary Road Connector
PWS	Public Water Supply
SAC	Special Area of Conservation
TII	Transport Infrastructure Ireland
WFD	Water Framework Directive
WSS	Water Supply and Sanitation

10 LAND, SOILS & HYDROGEOLOGY

10.1 Introduction

This chapter presents the findings of an impact assessment of the Proposed Development on the soils, geology, and hydrogeology along the Proposed Development. A detailed description of the Proposed Development is presented in Chapter 4: Project Description.

The objectives of this assessment are:

- To review and characterise the baseline soils, geological and hydrogeological conditions of the existing environment within each study area.
- To evaluate the impact of the road design for the Proposed Development on these attributes and establish the activities associated with the construction and operation of the Proposed Development.
- To identify groundwater vulnerability to assess the impacts of the Proposed Development on the underlying aquifers, and any potential impacts on public/ private water abstractions/ wells.
- To consider the likely hydraulic and hydrochemical impacts that may arise from the construction and operation of the Proposed Development.
- To address interactions with other disciplines (hydrology, ecology, waste) whether there are likely to be any indirect impacts by changes in hydrology/ hydrogeology on terrestrial and aquatic habitats, including annexed species that are designated and thus protected under Irish and European law.
- To identify and assess any potential impacts on any geological heritage sites or sites of geological interest.
- To identify and incorporate appropriate mitigation measures, that would prevent, reduce or remediate the identified impact.
- To conclude any residual impacts that would remain or arise from the mitigation measures identified.

10.2 Methodology

10.2.1 Legislation, Policy and Guidance

10.2.1.1 Legislation

European Legislation

In addition to the EIA Directive and Habitats Directive (see Chapter 1: Introduction and Chapter 9A – Biodiversity: Terrestrial Ecology), the following European legislation has been considered during the preparation of this chapter:

- Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013, amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy;
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (daughter to 2000/60/EC) (Groundwater Daughter Directive); and
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive).

The implementation of the Water Framework Directive (WFD) has resulted in the repeal and/or replacement of other European legislation of relevance to consideration of the water environment. Most notably, this includes the following:

- The Groundwater Directive (80/68/EEC), repealed in 2013; and
- The Dangerous Substances Directive (76/464/EEC) repealed in 2013.

National Legislation

The following national legislation has been considered during the preparation of this chapter:

- Local Government (Water Pollution) Acts 1977 to 1990;
- Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended;
- Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016);
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003), as amended;
- Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009), as amended;
- Water Environment (Abstractions and Associated Impoundments) Act 2022 , as amended and
- Drinking Water Regulations 2014 (S.I. No. 122 of 2014), as amended.

10.2.1.2 Policy

The Proposed Scheme is located in the administrative area of Donegal County Council (DCC) and the Donegal County Development Plan 2024-2030 has been considered in the preparation of this chapter. The chapter also considers the River Basin Management Plan (2022-2027), which is currently available in draft. The key goals of the EU Soil Strategy for 2030 which include sustainable soil management and identification of contaminated sites has been considered in the preparation of this chapter.

10.2.1.3 Guidance

The impact assessment has had regard to the general guidance regarding the undertaking of an EIA (as presented in Section 1.5.2 of Chapter 1: Introduction) and the following topic specific guidance in relation to land, soils, geology and hydrogeology:

- PE-ENV-01116 Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (TII, 2008b).
- CC-ENV-01101 Guidelines for the crossing of watercourses during the construction of National Road Schemes (TII, 2005).
- DN-DNG-03065 Road Drainage and the Water Environment (including Amendment No.1 dated June 2015) (TII, 2015).
- Guidance on Land Contamination Risk Management (Environment Agency UK. 2020).
- Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites (EPA, 2013).
- Guidance on the Authorisation of Discharges to Groundwater (EPA, 2011).
- The Model Procedures for the Management of Land Contamination (CLR 11) (Environment Agency UK. 2004).
- Geology in Environmental Impact Statements – A Guide (Institute of Geologists of Ireland (IGI), 2013).

NRA (TII, 2008b) guidelines were used to conduct the current assessment which has been undertaken over a number of years to establish a robust baseline and assessment. A new Water Impact Assessment Standard PE-ENV-01201 was published by TII on 10 December 2025, after the completion of the assessment undertaken and set out in detail in this chapter. Section 1.4 of the new Standard expressly provides that where a project is well advanced in the design and planning phase such as is the case here, the new Standard shall be applied in a transitional manner, i.e., by using the new Standard as additional guidance and employing it in as much as reasonably practicable. In this regard, a review was conducted which showed the required approach under the new Water Impact Assessment Standard of December 2025 is an evolution of the NRA (TII, 2008b) guidelines, following a very similar framework for identification of receptor sensitivity and assessment of significance in conjunction with the EPA (2022) guidelines. The assessment within this chapter contains all of the key information and assessment required by the new Standard.

The environmental sensitivity of geographical areas likely to be affected by projects must be considered. Particular regard should be made to the following criteria (as set out in EU Habitats Directive):

- The existing and approved land use.
- The relative abundance, availability, quality and regenerative capacity of natural resources (including soil, land, water and biodiversity) in the area and its underground.
- The absorption capacity of the natural environment, paying particular attention to the following areas:
  - i. *Wetlands, riparian areas, river mouths*
  - ii. *Coastal zones and the marine environment*
  - iii. *Mountain and forest areas*
  - iv. *Nature reserves and park*
  - v. *Areas classified or protected under legislation, including Natura 2000 areas designated Pursuant to the Habitats Directive and the Birds Directive and*
  - vi. *Areas in which there has already been a failure to meet the environmental quality standards laid down in legislation of the European Union and relevant to the project, or in which it is considered there is such a failure*
  - vii. *Densely populated areas and*
  - viii. *Landscapes and sites of historical, cultural or archaeological significance.*

10.2.2 Competent Experts

This chapter of the EIAR has been prepared by competent experts. Table 10.1 outlines the chapter authors, their main qualifications and level of experience.

Table 10.1: Statement of Authority

Expert Responsible for this Chapter	Qualifications	Experience
Noreta Daly	▪ MSc Applied Environmental Geology, University of Wales, Cardiff ▪ BSc Earth Science NUI Galway ▪ PGeo, Chartered Member of the Institute of Geologist of Ireland ▪ Member of the International Association of Hydrogeologists	Noreta has twelve years' experience in hydrogeology / environment and nine years' experience working as a hydrogeologist with RPS, specialising in geological and hydrogeological aspects of water supply schemes, transport, waste, contaminated land and commercial/ industrial projects as well as groundwater resource development. She is experienced in the delivery and coordination of environmental programs for groundwater protection, environmental risk assessment, Environmental Impact Assessment (EIA), Environmental Monitoring Programmes
Kate Corcoran	▪ BA Natural Science mod, Geology ▪ Postgraduate Certificate in Environmental Sustainability ▪ MSc Water Resources Engineering ▪ Higher Diploma in Building Information Modelling (BIM) ▪ CEng Chartered Engineers Ireland ▪ PGeo Professional Geologist Institute of Geologists of Ireland ▪ RoGEP ICE Register of Ground Engineering Professionals	Kate is a principal engineer with RPS with 15 years post-graduate experience primarily in the fields of geotechnical and environmental engineering. Kate has extensive and versatile experience in management, supervision and design of geotechnical and environmental works. Her current responsibilities include the earthworks and geotechnical design for national road schemes, railways and other infrastructure projects. Kate also has experience in route selection, preliminary design and Environmental Impact Assessment
Kieran O'Dwyer	▪ Bachelor of Engineering Degree, University College Dublin ▪ Member of the Institution of Engineers of Ireland	Kieran is an Associate Director with Egis with 44 years' post graduate experience in the environmental sector, including hydrogeology. Kieran has directed numerous

Expert Responsible for this Chapter	Qualifications	Experience
	▪ Member of the International Association of Hydrogeologists	groundwater development projects on behalf of public and private clients and has worked in many geological environments found in Ireland. As a divisional manager he is responsible for coordinating project team, budgeting, and reporting on major groundwater supply projects, coordinating
Deirdre O'Hara	▪ BSc Hons Degree in Science, University College, Galway ▪ MSc in Environmental and Geo-Resource Engineering, University of Wales, Cardiff ▪ H Dip in Project Management, Trinity College Dublin ▪ Chartered Member of the Institution of Engineers of Ireland ▪ PGeo – Professional Geologist (2018) ▪ EurGeol – Member of the European Federation of Geologists (2018)	Deirdre is an associate director with Egis with 28 years post graduate experience in land, soils and geotechnical engineering. Deirdre has prepared Land, soils & geology chapters for a numerous EIAR's for national road schemes, motorway service areas, water and wastewater treatment plants and routes, wind farms and other infrastructure projects.

10.2.3 Impact Evaluation Methodology

Impacts may be categorized as one of three types:

- **Direct Impact** - The existing geological or hydrogeological environment along or in close proximity to the route corridor is altered, in whole or in part, as a consequence of road construction and/or operation.
- **Indirect Impact** - The geological or hydrogeological environment beyond the proposed route corridors is altered by activities related to road construction and/or operation.
- **No Predicted Impact** - The proposed route corridor has neither a negative nor a positive impact on the geological or hydrogeological environment.

In accordance with the TII and IGI Guidelines the rating criteria for assessing the importance of geological and hydrogeological features within the study area are outlined in Table 10.2 and Table 10.3.

Table 10.2: Criteria for Soil and Geological Feature Importance Rating (TII, 2008b, IGI, 2013)

Importance	Criteria	Typical Example
Very High	▪ Attribute has a high quality, significance or value on a regional or national scale. ▪ Degree or extent of soil contamination is significant on a national or regional scale. ▪ Volume of peat and / or soft organic soil underlying road development is significant on a national or regional scale.	▪ Geological feature rare on a regional or national scale (NHA) ▪ Large existing quarry or pit ▪ Proven economically extractable mineral resource
High	▪ Attribute has a high quality, significance or value on a local scale. ▪ Degree or extent of soil contamination is significant on a local scale. ▪ Volume of peat and / or soft organic soil underlying road development is significant on a local scale.	▪ Contaminated soil on site with previous heavy industrial usage ▪ Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site) ▪ Well drained and/or highly fertility soils Moderately sized existing quarry or pit ▪ Marginally economic extractable mineral resource
Medium	▪ Attribute has a medium quality, significance or value on a local scale. ▪ Degree or extent of soil contamination is moderate on a local scale. ▪ Volume of peat and / or soft organic soil underlying road development is moderate on a local scale.	▪ Contaminated soil on site with previous light industrial usage ▪ Small recent landfill site for mixed wastes Moderately drained and/or moderate fertility soils Small existing quarry or pit ▪ Sub-economic extractable mineral resource
Low	▪ Attribute has a low quality, significance or value on a local scale. ▪ Degree or extent of soil contamination is minor on a local scale. ▪ Volume of peat and / or soft organic soil underlying road development is small on a local scale*.	▪ Large historical and/or recent site for construction and demolition wastes ▪ Small historical and/or recent landfill site for construction and demolition wastes ▪ Poorly drained and/or low fertility soils Uneconomically extractable mineral resource

*relative to the total volume of inert soil disposed of and/or recovered

Table 10.3: Criteria for Hydrogeological Feature Importance Rating (TII 2008b, IGI, 2013)

Importance	Criteria	Typical Example
Extremely High	• Attribute has a high quality, significance or value on an international scale.	• River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	• Attribute has a high quality, significance or value on a regional or national scale	• River, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes • Quality Class A (Biotic Index Q4, Q5) • Flood plain protecting more than 50 residential or commercial properties from flooding • Nationally important amenity site for wide range of leisure activities
High	• Attribute has a medium quality, significance or value on a local scale	• Salmon fishery • Locally important potable water source supplying >1000 homes • Quality Class B (Biotic Index Q3-4) • Flood plain protecting between 5 and 50 residential or commercial properties from flooding • Locally important amenity site for wide range of leisure activities.
Medium	• Attribute has a medium quality or value on a local scale	• Coarse fishery • Local potable water source supplying >50 homes • Quality Class C (Biotic Index Q3, Q2- 3) • Flood plain protecting between 1 and 5 residential or commercial properties from flooding
Low	• Attribute has a low quality or value on a local scale	• Locally important amenity site for small range of leisure activities • Local potable water source supplying <50 homes • Quality Class D (Biotic Index Q2, Q1) • Flood plain protecting between 1 residential or commercial properties from flooding • Amenity site used by small numbers of local people

The rating criteria for quantifying the magnitude of impacts is outlined in Table 10.4 and Table 10.5. These impact ratings are in accordance with impact assessment criteria provided in the EPA Guidelines and the IGI Guidelines. The criteria apply to potential impacts during both the construction and operational phases.

Table 10.4: Estimation of Magnitude of Impact on Soils/Geology Attribute (TII, 2008b)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	▪ Loss of high proportion of future quarry or pit reserves ▪ Irreversible loss of high proportion of local high fertility soils ▪ Removal of entirety of geological heritage feature ▪ Requirement to excavate / remediate entire waste site ▪ Requirement to excavate and replace high proportion of peat, organic soils and / or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	▪ Loss of moderate proportion of future quarry or pit reserves ▪ Removal of part of geological heritage feature ▪ Irreversible loss of moderate proportion of local high fertility soils ▪ Requirement to excavate / remediate significant proportion of waste site ▪ Requirement to excavate and replace moderate proportion of peat, organic soils and / or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	▪ Loss of small proportion of future quarry or pit reserves ▪ Removal of small part of geological heritage feature ▪ Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils ▪ Requirement to excavate / remediate small proportion of waste site ▪ Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 10.5: Estimation of Magnitude of Impact on Hydrogeology Attribute (TII, 2008b)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	▪ Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. ▪ Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	▪ Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. ▪ Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	▪ Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. ▪ Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	▪ Calculated risk of serious pollution incident <0.5% annually.

The significance of the impacts on soils/geology and hydrogeology attributes are determined by correlating the importance/ sensitivity of the receptor with the magnitude of the impact. The method employed for this assessment is presented in Table 10.6. For the purposes of this assessment, any impacts with a significance level of slight or less have been concluded to be not significant in EIA terms.

Table 10.6: Estimation of Significance of Impact on Attribute (TII, 2008b)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely high	Imperceptible	Significant	Profound	Profound
Very high	Imperceptible	Significant/Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

10.3 Consultation

A number of statutory and non-statutory consultees were contacted to ascertain any commentary or observations in relation to the Proposed Development. Details are provided in Table 10.7.

Table 10.7: Feedback from Statutory Consultees

Consultee	Feedback	Comments Addressed
NI Department of Agriculture, Environment and Rural Affairs	**(1)** Consideration given to transboundary effects in Section 3 as it is located near the Rivers Foyle, Mourne and Finn. **(2)** Identify land uses of the proposed routes and surrounding area (within 250 m) that may result in late contamination. A contaminated land risk assessment should be carried out if required. Remedial measures should be implemented before works begin. If new contamination risk occurs, works should cease. **(3)** Transboundary movement of waste materials generated by the works should be authorised.	**Section 19.13** Transboundary Effects **Regional Overview** Contaminated Land **Section 19.13** Transboundary Effects
Donegal Co. Co. Operations	The current proposal is along solid ground for much of the route. There should be plenty of rock available.	**Regional Overview** Mineral/Aggregate Resources
Geological Survey of Ireland (GSI)	Geological Heritage should be considered. No County Geological Site (CGS) in any of the areas considered. Request significant bedrock cuttings remain visible as rock exposure, in accordance with safety guidelines and engineering constraints. This improves geological knowledge of the subsurface and could be included as additional sites of the geological heritage dataset. Provided maps and datasets applicable to the proposal. **(1)** Provide digital photographic record of significant new excavations. GSI can visit site to personally document exposures. **(2)** Active Quarries database shows one active and one old quarry in close proximity to the study area. **(3)** Aggregates Potential Map records crushed rock aggregate potential ranging from 'high potential' to 'very high potential' and granular aggregate potential of 'moderate potential' in the wider vicinity of the project and consideration to aggregate potential sterilisation should be included as part of the planning process. **(4)** Records show multiple wells and springs within the study area and at least one public water supply (PWS) source protection area. **(5)** Landslide susceptibility mapping shows the study area is generally classified as low susceptibility, but there are discrete areas mapped as moderate and high susceptibility. Advise using our data sets to consider the impact of geohazards and landslides. **(6)** GSI Geotechnical Map viewers show past site investigation work sites. **(7)** GSI request a copy of reports detailing site investigations to be done.	**Regional Overview** Geological Heritage Areas **Regional Overview** Mineral/Aggregate Resources **Regional Overview** Hydrogeology **Regional Overview** Landslide Potential
Donegal Co. Co. Group Water Schemes	Response and image of Groundwater Scheme along corridor received and included in assessment	**Regional Overview** Hydrogeology
Northern Ireland Environment Agency	Project Design must include measures to minimise likely impacts to European & Nationally Designated Sites (River Foyle & Tributaries Special Area of Conservation (SAC)/ Area of Special Scientific Interest and Lough Foyle Special Protection Area / Archaeological Survey of Ireland. Land and Groundwater team recommends that full consideration is given to transboundary effects in Section 3 (N4 Manorcunningham to Lifford/Strabane/A5 Link)	**Regional Overview** Groundwater Dependent Ecosystems **Section 19.13** Transboundary Effects

10.4 Existing Environment from Baseline Studies

Although the wider geomorphology and topography along the Proposed Development has been considered, the primary study area for the purpose of this assessment comprises a 250 m zone either side of the centreline of the proposed alignment. This is in accordance with the recommendation of the National Road's Authority (NRA) (now Transport Infrastructure Ireland (TII)) 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes', TII, 2008b.

Various data sources have been consulted throughout the course of this assessment. These include:

- GSI Spatial Viewer (https://dcenr.maps.arcgis.com) for information on soils, geology and hydrogeology
- Irish Geological Heritage Programme of the GSI (https://www.gsi.ie/en-ie/programmes-and-projects/geoheritage/Pages/default.aspx).
- Ordnance Survey of Ireland online historic mapping and aerial photographs GeoHive (GeoHive Map Viewer).
- Donegal County Council (DCC) (Extent of the PWS schemes within the study area, Extractive Industries Register) (https://www.epa.ie/our-services/compliance--enforcement/waste/extractive-industries-register).
- The Office of Public Works (OPW) (www.opw.ie).
- EPA (https://gis.epa.ie).
- National Parks & Wildlife Service (http://www.npws.ie/).
- The County Donegal Development Plan 2024-2030.

A preliminary ground investigation (GI) comprising of cable percussion boreholes, rotary cores, trial pitting, dynamic probing window sampling and laboratory testing was carried out by Irish Drilling Ltd. (IDL) along the route alignment between February 2020 and September 2021. Geotechnical laboratory testing of selected samples collected during these works was carried out to determine soil properties and strength parameters. Groundwater and permeability data was also provided. Findings are presented in the Factual Reports produced by the GI contractor.

All drawings associated with this chapter can be found in Volume D: Book of Drawings.

10.4.1 Regional Overview - Section 1

A detailed description of the Proposed Development is provided in Chapter 4: Project Description.

10.4.1.1 Topography & Regional Geomorphology

The topography along the road alignment for Section 1 is highly undulating, ranging from 12.3 m–159 m ordnance datum (OD). The areas of highest elevations are in in the locality of Backleas/ Backlees, extending towards Teevickmoy, and southeast along the proposed link road towards Knockfair. The lower elevations are towards the south of the Proposed Development to the northwest of Ballybofey and east of Stranorlar. Regional topography slopes towards the River Finn – the area of lowest elevation along the Proposed Development.

Regional geomorphology comprises predominantly of glacially derived soils (metamorphic till) with rolling hills and ice moulded sediments. The northernmost 3 km comprises more mountainous terrain with drumlin and ribbed moraine features.

Geomorphological features identified include a glacial meltwater channel trending south-west toward the River Finn. A Drumlin located approximately 1.5 km north-east of Stranorlar and streamlined bedrock, trending northwest, adjacent to the N13 tie-in junction (mainline 1.3) at the end of the Proposed Development.

10.4.1.2 Quaternary Geology

Superficial soil deposits are predominantly comprised of metamorphic till, with alluvial deposits present in the river/floodplain areas. The quaternary geology underlying Section 1 is shown in Volume D: Book of Drawings EIAR Drawing 10.08.

Soils

The majority of the study area is characterised by poorly drained acid soils (surface water gleys). In the southern areas, well drained acid soils are also evident. Pockets of blanket bog and rock exposure are present in the area of higher elevations and localised areas of 'Made Ground' are evident in urban areas.

Subsoils

The dominant subsoil type in Section 1 is metamorphic till. Alluvial deposits are associated with the River Finn and the River Daurnett at the south of the study area.

Agricultural Soils

The EPA's CORINE 2018 landcover map consists of an inventory of land cover under various classes. This dataset is replicated in "CORINE 2018 Land Cover" drawing (refer to EIAR Drawing 10.11). It shows that the landcover distribution is principally occupied by agriculture and is dominated by Pastures with areas of natural vegetation in the south-west and western region.

There is a dense clustering of Discontinuous Urban Fabric within the centre of the study area consistent with the population centres of Ballybofey and Stranorlar. Dromboe Wood to the northwest of the Urban fabric is classified as Broad-leaved forests.

10.4.1.3 Bedrock Geology

Underlying bedrock comprises regionally metamorphosed massive Precambrian psammites with minor quartzite and marble units of the Lough Eske Psammite Formation. The northeastern end of the Proposed Development is underlain by the Aghyaran & Killgordon Limestone Formation. A band of Precambrian quartzites, marbles and graphitic psammites of the Killeter Quartzite Formation underlies the Proposed Development Teevickmoy and Gortletteragh.

This Precambrian bedrock stratigraphy trends roughly south-west to north-east. The bedrock geology is summarised in Table 10.8 and illustrated in EIAR Drawing 10.01.

Table 10.8: Bedrock Geology Underlying the Proposed Development – Section 1

Sub-Section	Chainage		Formation	Code	Description
	From	To			
L-6564 Connector	0+000	1+619	Lough Eske Psammite Formation	LE	Typified by pale green, massively bedded, feldspathic psammites with pelitic beds generally <10 cm thick. Occasional minor quartzite units <30 cm thick and marble units <10 m thick.
S1.1 N15 Tie-in South	0+000	0+530			
Ballybofey Link Road	0+000	2+056			
S1.2	0+000	6+850			
N15 Primary Road Connector (PRC)	0+000	1+050			
	1+850	3+086			
L-7084 Connector	0+000	0+700			
N15/N13 Interchange	0+000	0+550			

Sub-Section	Chainage		Formation	Code	Description
	From	To			
S1.2	6+850	7+450	Killeter Quartzite Formation	KT	Fine grained, slightly impure quartzite with beds typically 5 cm thick and occasional graded pebbly beds.
N15/N13 Interchange	0+550	0+747			
N15 PRC	1+050	1+850			
L-7084 Connector	0+700	1+543			
S1.2	7+450	8+606	Aghyaran & Killygordon Limestone Formations	DG	Dark coloured and graphitic marble, and pelitic and psammitic schists with some quartzites and minor basic volcanics
Northern Tie-in Link Rd	0+000	0+840			
Northern tie-in Roundabout	0+000	0+534			
S1.3 N13 Tie-in North	0+000	0+592			

10.4.1.4 Soft and/or Unstable Ground

Soft and/or unstable deposits within the study area consist of blanket peat, alluvium, and soft cohesive materials. Soft deposits were identified along the Proposed Development from a desktop assessment of the Quaternary Geology and from a review of the GI logs. The deepest deposits of soft soil were encountered over 110 m between Ch. 6+550–Ch. 6+600 (S1.2). The location and typical depths of peat and soft soils deposits are identified in Section 10.5.1.

10.4.1.5 Mineral/Aggregate Resources

Based on review of the GSI Spatial viewer, there is one non-metallic mineral locality, a historical disused slate quarry (GSI ref 5,300), located within the townland of Dunwiley approximately 500 m east of the Proposed Development (Ch. 4+900 - S1.2). The location of this mineral locality is illustrated in EIAR Drawing 10.04. There are no metallic mineral localities identified on the GSI Spatial viewer within the study area. There is also a historic quarry located 360 m to the east of Ch. 3+200–Ch. 3+550 (S1.2). The quarry locations are as shown in EIAR Drawing 10.14.

A review of the EPA's Extractive Industries Register revealed no active quarries within the study area. There are however a number of quarries listed in DCC's Quarry Register. The nearest active quarry is Kiltole Quarry in Convoy, approximately 9.6 km north-east of Stranorlar. The quarry locations are as shown in EIAR Drawing 10.14.

Crushed rock aggregate potential mapping, illustrated in EIAR Drawing 10.04 shows the crushed rock potential ranges from 'moderate' in the vicinity of Ballybofey, to 'very high' further north. This is likely due to a combination of the relatively shallow depth to bedrock in places, and the quality of the material. Granular aggregate potential, relevant only to the alluvial areas identified along the floodplains, is classified by the GSI as high where the alignment crosses the River Finn.

10.4.1.6 Geological Heritage Areas

No geological heritage areas were identified in the study area. Therefore, impacts associated with geological heritage areas have not been further considered in the assessment.

10.4.1.7 Karst

No karst features were identified from any of the field observations or from the site investigation data. This is expected given the metamorphic geology of the region.

10.4.1.8 Contaminated Land

OSi historic 25-inch mapping dating back to 1888-1913 indicates that the Donegal Light Railway network extended through Ballybofey and Stranorlar and followed the River Finn northwest of Ballybofey. However, more recent aerial photographs and mapping highlight that the old railway network has since been removed and converted into a pathway leading to nearby farmland. No substantial industrial developments have taken place along the Proposed Development and there is no indication of the existence of historical or currently active landfill sites.

There are no waste licensed facilities within the study area. There are no legacy landfills recorded within the near vicinity of the Proposed Development. There is one EPA licensed facility, McCools Sawmills Limited, located 1.2 km to the east in Stranorlar. This is an Integrated Pollution Control (IPC) industry and is considered sufficiently distant from the Proposed Development to have no impact.

There is no evidence of contaminated land along the Proposed Development. The potential to encounter contaminated land is low to minimal.

10.4.1.9 Landslide Potential

Based on review of the GSI's Landslide Susceptibility mapping, most of the study area is rated as having 'Low' landslide susceptibility. There are small areas of 'Moderately Low' to 'Moderately High' susceptibility in the areas of high elevation in the north-west and south-west of the study area and areas of 'Moderately High' to 'High' susceptibility in the north-east, as shown in EIAR Drawing 10.15.

There are no records of landslide events held by the GSI within the study area. As such the landslide susceptibility potential is low and is not considered a risk to the scheme.

10.4.1.10 Regional Hydrogeology

Bedrock geology in the study area is largely classified by the GSI as a Poor Aquifer (Pu) - Bedrock which is generally unproductive except for local zones. Bedrock geology towards the northernmost end of Section 1 is classified as a Locally Important Aquifer (LI) - bedrock which is moderately productive only in local zones. Groundwater flow in these aquifers is typically concentrated in upper fractured and weathered zones and in the vicinity of fault zones (GSI, 2004a). Flow directions are generally a subdued reflection of the overlying topography and towards the rivers (Finn, the Teevickmoy and the Cloghroe).

Aquifers in the region generally provide little groundwater for water supply (refer to Section 10.4.1.15 Abstractions). Flow paths are short due to the low bedrock permeability and poor connectivity between the limited fissures in the bedrock. There are localised occurrences of groundwater discharging locally to streams and small springs. However, owing to the poor productivity of these aquifers baseflow proportion of total streamflow is considered to be small.

10.4.1.11 Aquifer Classification

The regional aquifer classification is shown in EIAR Drawing 10.18.

The Lough Eske Psammite and Killeter Quartzite bedrock aquifer comprises approximately 85% of the Proposed Development from the start of the Proposed Development to Teevickmoy (S1.2 Ch.0+000–Ch. 7+450). It is classified as Pu: Bedrock which is generally unproductive except for local zones.

The aquifer is primarily composed of low transmissivity bedrock. Yields in this aquifer are generally low. Poor aquifers such as this are attributes of low hydrogeological importance.

The Aghyaran & Killygordon Limestone bedrock aquifer comprises approximately 15% of the Proposed Development from Meencargagh to Teevickmoy (Ch. 7+450–Ch. 8+600 (S1.2) and is classified as a locally important (LI) aquifer which is moderately productive only in local zones. The aquifer is primarily composed of low transmissivity rock. Yields in this aquifer are generally low. Any higher yielding wells are associated with the Marble Unit to the northeast of the Proposed Development in the vicinity of Magherabeg Public Water Scheme. LI aquifers are attributes of medium hydrogeological importance.

10.4.1.12 Groundwater Vulnerability

The GSI have developed a system to classify aquifer vulnerability based on the thickness and permeability of the overburden (see Table 10.9 below). The greater the thickness and permeability, the greater the protection to the groundwater in the underlying aquifer.

Table 10.9: GSI Groundwater Vulnerability Classification

Vulnerability Rating	Hydrogeological Requirements				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type
	High Permeability (Sand/Gravel)	Moderate Permeability (Sandy Till)	Low Permeability (Clayey Till, Clay, Peat)	(Sand & Gravel Aquifers Only)	
Extreme	0-3.0m	0-3.0 m	0-3.0m	0-3.0m	point (>30 m radius)
High	>3.0	3.0-10.0m	3.0-5.0m	>3.0m	diffuse
Moderate	N/A	>10m	5.0-10.0m	N/A	diffuse
Low	N/A	N/A	>10.0m	N/A	diffuse

Notes: i)N/A =not applicable
ii) Precise permeability values cannot be given at present
iii) Release point of contaminants is assumed to be 1-2 m below ground surface

The vulnerability classification within the vicinity of the Proposed Development is shown in EIAR Drawing 10.21 and is tabulated in Table 10.10.

Table 10.10: GSI Groundwater Vulnerability Classification – Section 1

Sub-Section	Chainage From	To	Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
L-6564 Connector	0+000	1+618	High (H)	1,618	7.79
Ballybofey Link Road	0+000	0+125	High (H)	125	0.60
	0+125	0+400	Extreme (E)	275	1.32
	0+400	2+055	High (H)	1,655	7.97
S1.2	0+000	0+600	High (H)	600	2.89
	0+600	0+850	Extreme (E)	250	1.20
	0+850	3+100	High (H)	2,250	10.83
	3+100	3+200	Extreme (E)	100	0.48
	3+200	3+400	Extreme (X)	200	0.96
	3+400	4+350	Extreme (E)	950	4.57
	4+350	4+400	Extreme (X)	50	0.24
	4+400	4+900	Extreme (E)	500	2.41
	4+900	5+025	Extreme (X)	125	0.60

Sub-Section	Chainage From	To	Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	5+025	7+100	Extreme (E)	2,075	9.99
	7+100	8+200	High (H)	1,100	5.30
	8+200	8+600	Moderate (M)	400	1.93
S1.1 N15 Tie-in South	0+075	0+512	High	512	2.46
N15 PRC	0+000	2+000	Extreme (E)	2,000	9.63
	2+000	2+550	High (H)	550	2.65
	2+550	2+650	Moderate (M)	100	0.48
	2+650	3+775	High (H)	1,125	5.42
N15/N13 Interchange	0+000	0+747	Extreme (E)	747	3.60
Northern Tie-in Link Rd	0+000	0+100	Extreme (E)	100	0.48
	0+100	0+250	High (H)	150	0.72
	0+250	0+500	Moderate (M)	250	1.20
	0+500	0+840	High (H)	340	1.64
Northern tie-in Roundabout	0+000	0+250	Moderate (M)	250	1.20
	0+250	0+400	High (H)	150	0.72
	0+400	0+534	Moderate (M)	134	0.65
S1.3 N13 Tie-in North	0+000	0+075	Moderate (M)	75	0.36
	0+075	0+592	High (H)	517	2.49
L-7084 Connector	0+000	0+250	Extreme (E)	250	1.20
	0+250	0+350	Extreme (X)	100	0.48
	0+350	1+500	Extreme (E)	1,150	5.54

10.4.1.13 Groundwater Recharge

The GSI Groundwater recharge mapping across the area indicates low recharge rates (100-200 mm/year). The ability of the bedrock to accept recharge is based generally on the permeability of the weathered/fractured zone of bedrock likely extending 3.0–5.0 m below the bedrock surface.

The areal recharge to the bedrock is low 100 mm to 200 mm/annum respectively for the Locally Important and Poor Aquifers. The GSI recharge data indicates that the recharge is capped for these bedrock aquifers due to the fact they have low transmissivity and storage.

Groundwater recharge in this instance is therefore considered an attribute of low importance.

10.4.1.14 Water Framework Directive (WFD) Groundwater Quality Status

The Water Framework Directive (WFD) establishes a legal framework for the protection and management of water resources in the EU. It requires each member state to implement changes to the management of water bodies taking account of all aspects of the water cycle. Under the WFD, the Groundwater Bodies (GWBs) of the study area that need to be protected are:

- Raphoe GWB
- Upper Deele GWB
- Ballybofey GWB

The WFD Quality Status and Risk Status for each GWB are summarised in Table 10.11. The water quality status is Good for each GWB.

Table 10.11: Groundwater Body Risk & Quality Status – Section 1

GWB	Element	Rating for GWB (WFD Status 2019-2024)	Objectives	Measures to Achieve Objectives
Raphoe	Water Quality Status	Good	▪ Restore_2021 ▪ Prevent Deterioration ▪ Restore Good Status ▪ Reduce Chemical Pollution ▪ Achieve Protected Areas Objectives	▪ Basic Measures ▪ The Bathing Water Directive (2006/7/EC) ▪ The Habitats Directive (92/43/EEC) ▪ The Drinking Water Directive (98/83/EC) ▪ The Major Accidents (Seveso) Directive (96/82/EC) ▪ The Environmental Impact Assessment (EIA) Directive (85/337/EEC) ▪ The Sewage Sludge Directive (86/278/EEC) ▪ The Urban Wastewater Treatment Directive (91/271/EEC) The Plant Protection Products Directive (91/414/EEC) ▪ The Nitrates Directive (91/676/EEC) ▪ The Integrated Pollution Prevention Control Directive (96/61/EEC) ▪ Specific Measures ▪ Cost recovery for water use ▪ Promotion of efficient and sustainable water use ▪ Protection of drinking water sources ▪ Control of abstraction and impoundments ▪ Control of point source discharges ▪ Control of diffuse source discharges ▪ Authorisation of discharges to groundwater ▪ Controls on other activities impacting on water status ▪ Prevention or reduction of the impact of accidental pollution incidents
	Risk Category	Not at Risk		
Upper Deele	Water Quality Status	Good		
	Risk Category	Not at risk		
Ballybofey	Water Quality Status	Good		
	Risk Category	Not at Risk		

10.4.1.15 Abstractions

Public Supply Wells

There is no reliance on groundwater by a public or group water supply within the study area, nor is there any source protection area associated with groundwater protection schemes. The PWS for the Ballybofey/ Stranorlar area is Lough Mourne located eight kilometres (approx.) to the southwest.

There is a former group water scheme located at Galdonagh (15 km distance from the Proposed Development).

Domestic Wells

Data on wells in the study area was collected from the GSI groundwater mapping website. Given that low yielding wells for domestic and farm water supply are relatively common in rural Ireland GSI data was complimented by a well survey to carry out best practice efforts to identify any wells for domestic and farm water supply in the path of the Proposed Development.

It is almost inevitable that any large road project will result in at least a small number of low-yielding water supply wells having to be abandoned. Groundwater supplies will have to be abandoned where they lie on the path of the Proposed Development. When this is the case the usual mitigation measure is the drilling of an alternative supply.

The locations of these wells are illustrated on EIAR Drawing 10.24. The recorded GSI wells in the vicinity of the Proposed Development are shown in Table 10.12.

Domestic wells are considered to be an attribute of low importance.

Table 10.12: GSI Groundwater Well Data – Section 1

GSI Name	Well Type	Depth (m)	Townland	Source Use	Yield Class	Yield (m^3/day)
2039SWW007	**Borehole**	3.5	Cappry	Other	-	22
2039SWW003*	**Dug Well**	1.8	Goland	Unknown	Poor	22
2039SWW001*	**Borehole**	31	Drumboe Lower	Agri & domestic use	-	-
2039SWW013	**Borehole**	-	Dunwiley	Agri & domestic use	-	-
2039SEW036	**Borehole**	50.3	Lisnaree	Domestic Use Only	Poor	1.82
2039SEW042	**Borehole**	7.5	Tircallan	-	Other-	-

** Exact location unknown. Mapped with a locational accuracy of 2 km*

- Information not populated in GSI Database

10.4.1.16 Holywell Spring

A spring/seep known locally as Holywell is located at the edge of the woodland at Holywell Woods in the townland of Drumboe Lower. This is a holy well is a venerated site and of high local reverence (refer to Plate 10-1 and Plate 10-2 below).

Holywell spring discharges from the lower slope of a hill and flows downslope within an existing stream at a steady rate. This flow is ephemeral and is not evident at all times of the year. The spring/ seep likely appears at the surface as a result of a change in the topographic slope, where the water table in the weathered/fractured zone of bedrock, emerges from the side of the hill.

Table 10.13 summarises flow observations at Holywell at various times of the year. Flows are very low or absent during the summer months.

Table 10.13: Flow Observations Holywell (2022)

Date	Flow Rate (l/s)	Flow Rate (l/day)	Rainfall Finner Camp (mm)	Weather Conditions
16 February 2022	0.031	2,678.4	6.2	Cloudy with showers
22 February 2022	0.097	8,380.8	7.4	Cloudy with showers
04 March 2022	0.063	5,443.2	0.1	Dry
11 March 2022	0.070	6,048.0	3.9	Showers
25 March 2022	0.050	4,320.0	0.0	Dry
31 March 2022	0.020	1,728.0	0.0	Dry
28 June 2022	0.000	0	6.1	Cloudy with showers
29 July 2022	0.000	0	1.2	Dry
29 August 2022	0.000	0	0.1	Dry

Based on these averaged monthly flow rates (over a five-month period), the average annual flow rate for Holywell is estimated to be in the order of 1,982.88 l/day or 1.98 m^3/day. The maximum daily flow is 8,380.8 l/s or 8.38 m^3/day.

Plate 10-1: Holywell Spring, Dromboe Lower

Plate 10-2: Holywell Spring Discharge

Holywell stream flows down slope through Drumboe Woods. At the base of the woodland, there is an area of saturated ground and standing water as the land rises slightly into a small embankment. This indicates that there is impermeable bedrock and/or aquiclusive or waterlogged soils beneath, that the water is slow to permeate through. The stream flows westwards through pastureland and feeds into the surface water network before eventually discharging to the River Finn. Flow directions follow the topography as illustrated in Figure 10-1.

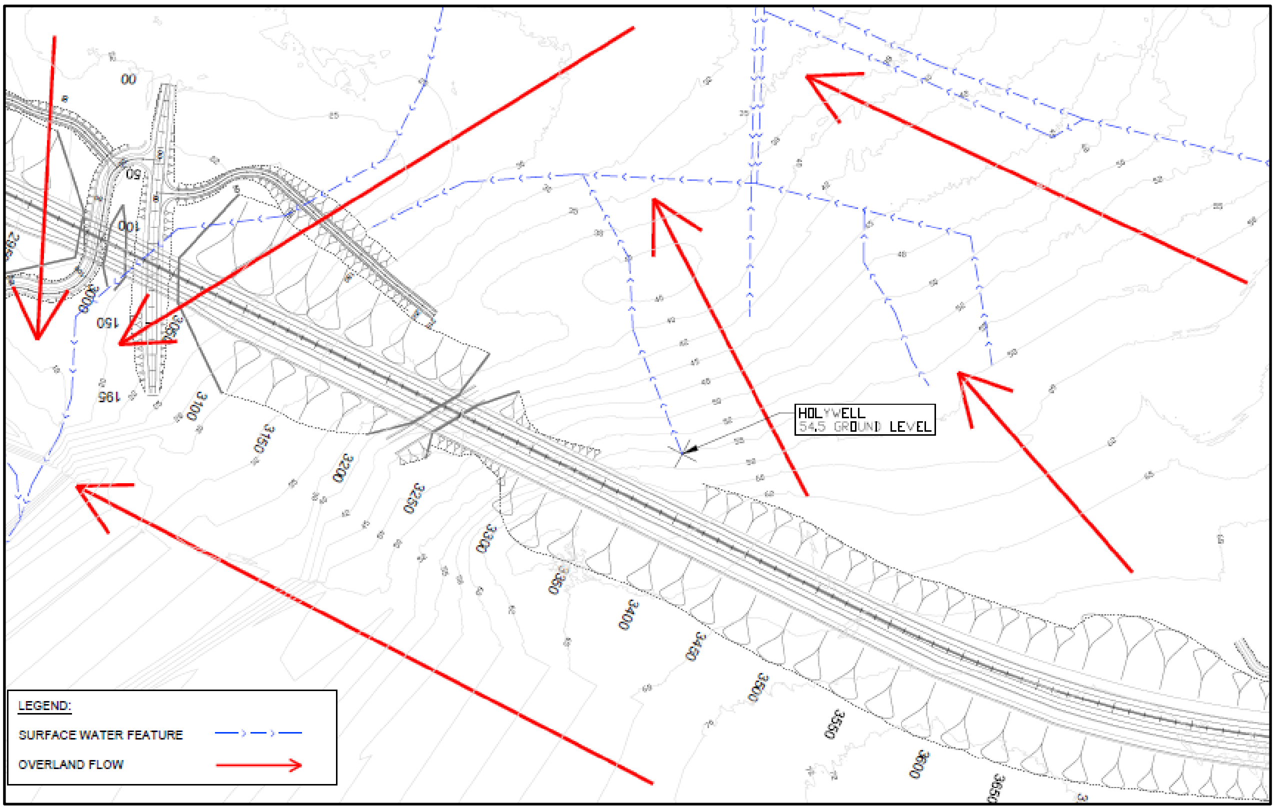


Figure 10-1: Overland Flow Paths in the Vicinity of Holywell

Land further upstream of Holywell comprises well-drained and gently undulating farmland pasture. In this area, there is no evidence of a surface water network supply to Holywell. The land rises gently south of Holywell, before falling again to the south.

The impact to Holywell requires focussed consideration in this chapter (see Section 10.5.1.4 for a discussion on the investigations carried out at Holywell) as it is located 36 m from a significant cut of 9 m depth and 700 m in length.

Holy wells have archaeological, heritage and cultural value and are considered an attribute of high importance.

10.4.1.17 Groundwater Dependant Ecosystems

River Finn SAC Annex I Groundwater Dependent Terrestrial Ecosystem (GWDTE)

The Proposed Development crosses the River Finn SAC at Ch. 2+400 (S1.2). This SAC supports transition mires and quaking bogs [7140] which are an EU Annex I Groundwater Dependent Terrestrial Ecosystem (GWDTE) under the WFD. GWDTE are habitats/ species that are dependent on groundwater to maintain the environmental supporting conditions required to sustain that habitat or species. Annex I ecosystems have a High importance rating.

Transition mire represents groundwater discharge zones and occurs at the interface between bog and waterbodies. Transition mires as assessed by the EPA under the Framework for the Assessment of Groundwater-Dependent Terrestrial Ecosystems under the WFD (EPA, 2008) were classified as having a mixed level of groundwater and rainwater input requiring a stable groundwater level.

An extensive area of this habitat is found at Owendoo/ Cloghervaddy to the west of the Owendoo River (15km upstream of the Proposed Development). It is also known to occur in the quaking bogs associated with Cronakerny and Cronamuck (10km up stream of the Proposed Development).

Whilst these GWDTEs are in the upper river catchment they are located a considerable separation distance from the Proposed Development and therefore no impact is envisaged. The location of the transition mire habitats are illustrated in the EIAR Drawings for Chapter 9A: Biodiversity Terrestrial.

While The River Finn itself is not classified as a groundwater dependent habitat, groundwater however, does contribute to river baseflow, therefore the River Finn is a groundwater receptor. Baseflow contribution to the River Finn supports its designation as: (1) Salmonid Water pursuant to S.I. No. 293 of 1988 - European Communities (Quality of Salmonid Waters) Regulations and (2) European site (River Finn SAC). While shallow groundwater flow is likely to discharge to the River Finn, the baseflow proportion of total streamflow is expected to be small and owing to the poor productivity of the Ballybofey GWB it is unlikely that any major groundwater-surface water interactions occur (GSI, 2004). In addition, a review of the WFD Cycle 2 Subcatchment Assessment (EPA, 2018) of the River Finn and the Cycle 3 Foyle Catchment Report (EPA, 2024) does not identify groundwater as a significant pressure.

10.4.2 Regional Overview - Section 2

The Proposed Development is 9.2 km of mainline and side roads including mainline 2.6 (River Swilly Link), mainline 2.3 (Dry Arch Link), S2.BL (Bonagee Link) located to the south and east of Letterkenny commencing at Ballyraine Junction in Letterkenny, running south eastwards through Ballyraine Townland before crossing the River Swilly and joining the existing N13 via the proposed Bonagee Junction and Dromore Junction. The Proposed Development then runs both southwards and eastwards from the proposed Dromore Junction.

Progressing eastwards, the road follows the existing N13 and crosses the Corkey River, before interfacing with Section 3 near Manorcunningham. Southwards from the proposed Dromore Junction, the Proposed Development runs to the east of and broadly follows the existing N13 through the townland of Drumany before joining the N13 via a proposed junction at Listellian. The Proposed Development continues southwards from Listellian Junction to Knockbrack.

A detailed description of the Proposed Development is provided in Chapter 4: Project Description.

Topography and Regional Geomorphology

The topography along the road alignment for Section 2 is highly undulating ranging from 8.0 m–122 m OD. The areas of highest elevation are at the southern end of the Proposed Development, where the ground elevation rises towards an anticlinal axis trending east-west which is mapped as crossing the Proposed Development at approximately Ch. 0+150 in the vicinity of Listellian. Regional topography slopes towards the River Swilly and the lowest elevations are at the northeast of the Proposed Development at the alluvium plain of the Corkey River.

The geomorphology through Section 2 is glacially derived with rolling ice moulded hills and bedrock including drumlins present in the townland of Bonagee and continuing eastwards and trending south-westwards, mirroring the regional trend of the bedrock stratigraphy of the area. The drumlins are prevalent across the study area of the Proposed Development to the east and south.

Quaternary Geology

Superficial deposits are predominantly comprised of metamorphic till but there are deposits of alluvial present along the watercourses (river/floodplain) which cross the study area with significant deposits of alluvium at the northwest associated with the River Swilly and the northeast along the Corkey River. The quaternary geology underlying Section 2 is shown in EIAR Drawing 10.09.

Soils

The majority of the study area is characterised by poorly drained acid soils (surface water gleys). To the south of the Proposed Development the soil comprises poorly drained acid soils (surface water gleys) mixed with areas of well-drained acid soils. Significant deposits of man-made fill or ‘Urban’ are present along the northwest of the Proposed Development. These deposits are associated with existing roads or areas of urban development corresponding to Letterkenny Town.

Subsoils

The dominant subsoil in Section 2 is metamorphic till. Alluvial deposits dominate the northwest of the study area where they are present along the River Swilly. A pocket of blanket bog is present at Listellian at the south of the study area and rock outcrop at surface are present in the areas of highest elevation and along the Proposed Development at Trimragh.

Agricultural Soils

The CORINE 2018 landcover map consists of an inventory of land cover under various classes. This dataset is replicated in “CORINE 2018 Land Cover”. It shows that the landcover distribution is principally occupied by agriculture and is dominated by Pastures. There is a dense clustering of Discontinuous Urban Fabric at the northwest and northeast of the study area consistent with the population centres of Letterkenny and Manorcunningham.

10.4.2.1 Bedrock Geology

Underlying bedrock comprises regionally metamorphosed Precambrian psammitic schist of the Termon Formation. The northern end of the Proposed Development between Bonagee and Manorcunningham is underlain by Precambrian quartzites, marbles and graphitic psammites the Killeter Quartzite Formation and Aghyaran & Killgordon Limestone Formation. This Precambrian bedrock stratigraphy in this part of Donegal trends roughly south-west to north-east. The bedrock geology is summarised in Table 10.14 and shown in EIAR Drawing 10.02.

Table 10.14: Bedrock Geology Underlying the Proposed Development– Section 2

Sub-Section	Chainage		Formation	Code	Description
	From	To			
S2.1	0+000	0+250	Termon Formation	TE	The lowermost semi-pelitic schists are typically dark and graphitic and interbedded with thin units of dolomitic marble and lenses of psammite. The semi-pelitic schists become greenish and calcareous upwards and are interbedded with thin greenish psammitic units.
S2.2	0+250	2+050			
S2.6	0+000	1+100			
S2.2	2+050	2+364	Killeter Quartzite Formation	KT	Fine grained, slightly impure quartzite with beds typically 5 cm thick and occasional graded pebbly beds.
S2.3	0+000	0+670			
S2.4	0+000	0+700			
S2.BL	0+000	0+250			
S2.6	1+700	1+970			
S2.4	0+700	3+759	Aghyaran & Killygordon Limestone Formations	DG	Both calcitic and dolomitic marble are associated with quartzite and psammite sometimes tending to psephitic. Graphitic varieties of these are widespread, though less common in the south, particularly in the Aghyaran Formation.
S2.6	1+100	1+403			
S2.BL	0+250	0+450			

10.4.2.2 Soft and/or Unstable Ground

Soft and/or unstable deposits within the study area consist of blanket peat and alluvium. Soft deposits were identified along the Proposed Development from a desktop assessment of the Quaternary Geology and from a review of the GI logs. The deepest deposits of soft soil were encountered over 50 m along mainline 2.5 between Ch. 0+000–Ch.0+564 and mainline 2.6 between Ch. 0+650–Ch. 1+403. The location and typical depths of peat and soft soils deposits are identified in Section 10.5.2.

10.4.2.3 Mineral / Aggregate Resources

Based on a review of the GSI Spatial viewer, there are 2 no. non-metallic mineral localities within 500 m of the Proposed Development: GSI ref 258 comprising clay and brick approximately 500 m to the southeast of Ch. 0+750 (mainline 2.6) and GSI ref 3,248 comprising clay and pottery north of S2.2 Ch. 2+100 at Drumardagh. The locations of these features are included in EIAR Drawing 10.05. There are no metallic mineral localities identified on the GSI Spatial viewer within the study area

A review of the EPA's Extractive Industries Register revealed no active quarries within the study area. There are however a number of quarries listed in DCC's Quarry Register. The nearest active quarry is Kiltole Quarry in Convoy, approximately 7 km from the study area. The quarry locations are as shown in EIAR Drawing 10.14.

Crushed rock aggregate potential mapping, shown in EIAR Drawing 10.05, identifies the potential ranges from moderate to very high along the Proposed Development. This is likely due to a combination of the relatively shallow depth to bedrock in places, and the quality of the material. Granular aggregate potential, relevant only to the alluvial areas identified along the floodplains, predominantly ranges from moderate to high, as identified by the GSI.

10.4.2.4 Geological Heritage Areas

The stretch of the River Swilly westwards from Ballyraine extending to Lough Swilly at the northwest of the Proposed Development is classified as a CGS a Geological Heritage Site surveyed through audits. The River Swilly and Lough Swilly gained CGS status due to its standing as the only fjord on Ireland’s north’s coast and is described as ‘a long, wide fjord, bordered by high, bold cliffs in the north, passing to gentler coastal slopes and shallow flats along its southern reaches’. The Proposed Development crosses the CGS at approx. Ch. 0+450–Ch. 0+550 S2.6 where it crosses the River Swilly. This is considered an attribute of High importance. This CGS is shown in EIAR Drawing 10.07.

10.4.2.5 Karst

No karst features were identified from any of the field observations or from the site investigation data. This is expected given the metamorphic geology of the region.

10.4.2.6 Contaminated Land

OSi historic 25-inch map dating back to 1888-1913 indicates that the Letterkenny- Derry and Letterkenny-Burtonport railway lines extended east and west, respectively, from the town. However, more recent aerial photographs and mapping highlight the old railway network has since been removed and largely replaced by the existing N13 across the study area. The most substantial industrial development has taken place along the proposed mainline 2.6 road where industrial and commercial developments have replaced agricultural land. There is no indication of the existence of historical or currently active landfill sites.

There are no waste licensed facilities within the study area. There are no legacy landfills recorded within the near vicinity of the Proposed Development. There is one EPA licensed facility located 100 m west of mainline 2.6 Ch.0+000, which is licensed both as an Industrial Emissions Licensed Industry (IEL) and an IPC facility Unifi Texture Yarns Europe Ltd.

There is no evidence of contaminated land along the Proposed Development. The potential to encounter contaminated land is low to minimal.

10.4.2.7 Landslide Potential

Based on review of the GSI’s Landslide Susceptibility mapping most of the study area is rated as having ‘Low’ landslide susceptibility. There are small areas of ‘Moderately Low’ to ‘Moderately High’ susceptibility in the areas of high elevation in the north-west in the vicinity of Manorcunningham and in the and south-west, west of Listellian, as shown in EIAR Drawing 10.16.

There are no records of landslide events held by the GSI within the study area. As such the landslide susceptibility potential is low and is not considered a risk to the scheme.

10.4.2.8 Regional Hydrogeology

Bedrock geology in the study area is largely classified by the GSI as a Poor Aquifer (Pu)- Bedrock which is generally unproductive except for local zones. The north-western most section of the Proposed Development located in a LI- bedrock which is moderately productive only in local zones. At the northeast, the Proposed Development crosses an aquifer classified as a LI gravel aquifer (Lg).

Groundwater flow in the bedrock aquifers is expected to be concentrated in upper fractured and weathered zones and in the vicinity of fault zones (GSI, 2004b). Groundwater flow directions are expected be a subdued reflection of the overlying topography. Groundwater will generally flow to rivers (the Swilly and Corkey) where it will discharge as baseflow via the rivers and ultimately discharge to the north into Lough Swilly. The groundwater within aquifer is unconfined and flow paths are likely to be short and groundwater will discharge locally to streams and small springs, however owing to the poor productivity of these aquifers baseflow proportion of total streamflow is expected to be small, therefore there is unlikely to be any major groundwater-surface water interaction. Aquifers in the region generally provide little groundwater for water supply.

Groundwater is discussed in further detail in Section 10.5.

10.4.2.9 Aquifer Classification

The regional aquifer classification is shown in EIAR Drawing 10.19.

The regional aquifer classification is shown in “Groundwater Aquifers.” The Termon & Killeter quartzite Formation comprise approximately 57.5% of the Proposed Development from the start at Ballyraine to Listellian in the south. It is classified as Pu: Bedrock which is generally unproductive except for local zones. The aquifer is primarily composed of low transmissivity rock. Yields in this aquifer are generally low. Poor aquifers such as this are attributes of low hydrogeological importance.

The Aghyaran & Killygordon Limestone bedrock aquifer comprises approximately 42.5% of the Proposed Development from Bonagee to Mannorcunningham in the north of the study area, it is classified as LI aquifer which is moderately productive only in local zones. The aquifer is primarily composed of low transmissivity rock. Yields in this aquifer are generally low. Any higher yielding wells are associated with the Marble Unit to the east of the Proposed Development which supply the Magherabeg Public Water Scheme.

The River Swilly sand and Gravel Aquifer comprise approximately 15% of the Proposed Development from the River Swilly crossing to Bonagee (Ch. 0+000–Ch. 0+564 S2.5 & Ch. 0+500–Ch. 1+403 S2.6). These deposits are classified as LI gravel aquifer. The deposit it thought to be >10 m deep with a saturated thickness of >5 m. Yield data indicates that the gravel layers are transmissive and capable of providing yields of in excess of 400 m^3/day. LI aquifers are attributes of medium hydrogeological importance.

10.4.2.10 Groundwater Vulnerability

The GSI have developed a system to classify aquifer vulnerability based on the thickness and permeability of the overburden. The greater the thickness and permeability, the greater the protection to the groundwater in the underlying aquifer, as summarised in Table 10.9 previously.

The vulnerability classification within the vicinity of the Proposed Development is shown in EIAR Drawing 10.21. The vulnerability classification within the vicinity of the Proposed Development is shown in “Groundwater Vulnerability” and is summarised in Table 10.15**.**

Table 10.15: GSI Groundwater Vulnerability Classification – Section 2

Sub Section	Chainage		Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	From	To			
S2.6	0+000	0+050	Extreme (E)	50	0.54
	0+050	0+200	Extreme (X)	150	1.63
	0+200	0+300	Extreme (E)	100	1.08
	0+300	0+350	Extreme (X)	50	0.54
	0+350	0+500	Extreme (E)	150	1.63
	0+500	0+550	High (H)	50	0.54
	0+550	1+403	Moderate (M)	1,175	12.75
S2.5	0+000	0+075	High (H)	75	0.81
	0+075	0+564	Extreme (E)	170	1.84
S2.1	0+000	0+250	High (H)	525	5.69
S2.2	0+250	0+525	High (H)	525	5.69
	0+525	1+650	Extreme (H)	1,125	12.21
	1+650	2+200	High (H)	550	5.97

Sub Section	Chainage		Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	From	To			
	2+200	2+365	Extreme (E)	165	1.79
S2.4	0+000	0+800	Extreme (E)	800	8.68
	0+800	1+150	High (H)	350	3.79
	1+150	1+300	Extreme (E)	150	1.63
	1+300	1+550	Extreme (X)	250	2.71
	1+550	1+625	Extreme (E)	75	0.81
	1+625	1+800	High (H)	175	1.89
	1+800	2+000	Extreme (X)	200	2.17
	2+000	2+775	High (H)	775	8.41
	2+775	3+759	Moderate (M)	984	10.68
S2.3	0+000	0+225	Moderate (M)	225	2.44
	0+225	0+400	High (H)	175	1.89
	0+400	0+670	Extreme (E)	270	2.93
S2.BL	0+000	0+450	Moderate (M)	450	4.88

10.4.2.11 Groundwater Recharge

The GSI Groundwater recharge mapping across the area indicates low recharge rates (100-200 mm/year) to the bedrock aquifers across the entire area. The ability of the bedrock to accept recharge is based generally on the permeability of the weathered/fractured zone of bedrock likely extending 3.0–5.0 m below the bedrock surface.

The areal recharge to the bedrock is low 100 mm to 200 mm/annum respectively for the LI and Poor aquifers. However, the GSI recharge data indicates that the recharge is capped for these bedrock aquifers due to the fact they have low transmissivity and storage.

10.4.2.12 WFD Groundwater Quality Status

The WFD establishes a legal framework for the protection and management of water resources in the EU. It requires each member state to implement changes to the management of water bodies taking account of all aspects of the water cycle. Under the WFD, the GWB of the study area that need to be protected are:

- Lough Swilly GWB
- Manorcunningham GWB
- Swilly Gravel GWB

The WFD Quality Status and Risk Status for each GWB are summarised in Table 10.16.

Table 10.16: Measures to Achieve Water Quality Objectives

GWB	Element	Rating for GWB (WFD Status 2019-2024)	Objectives	Measures to Achieve Objectives
Lough Swilly	Water Quality Status	Good	▪ Restore_2021 ▪ Prevent Deterioration ▪ Restore Good Status ▪ Reduce Chemical Pollution ▪ Achieve Protected Areas Objectives	***Basic Measures*** ▪ The Bathing Water Directive (2006/7/EC) ▪ The Habitats Directive (92/43/EEC) ▪ The Drinking Water Directive (98/83/EC) ▪ The Major Accidents (Seveso) Directive (96/82/EC) ▪ The EIA Directive (85/337/EEC) ▪ The Sewage Sludge Directive (86/278/EEC) ▪ The Urban Waste Water Treatment Directive (91/271/EEC) The Plant Protection Products Directive (91/414/EEC) ▪ The Nitrates Directive (91/676/EEC) ▪ The Integrated Pollution Prevention Control Directive (96/61/EEC) ***Specific Measures*** ▪ Cost recovery for water use ▪ Promotion of efficient and sustainable water use ▪ Protection of drinking water sources ▪ Control of abstraction and impoundments ▪ Control of point source discharges ▪ Control of diffuse source discharges ▪ Authorisation of discharges to groundwater ▪ Controls on other activities impacting on water status ▪ Prevention or reduction of the impact of accidental pollution incidents
	Risk Category	Not at Risk		
Manorcunningham	Water Quality Status	Good		
	Risk Category	Not at risk		
Swilly Gravel	Water Quality Status	Good		
	Risk Category	Not at Risk		

10.4.2.13 Abstractions

Public Supply Wells

The boreholes supplying Mannorcunningham PWS are located approximately 900 m to the east of the Proposed Development. The Letterkenny Water Supply Scheme (WSS) abstracts from a number of excellent yielding wells in the sands and gravels at the west of Letterkenny Town (approx. 3 km to the west of the Proposed Development). There are no delineated source protection areas associated with public groundwater supplies.

There is a former group water scheme located at Galdonagh (four kilometre to the east), although it is no longer in use.

The PWS for the Letterkenny area is pre-dominantly sourced from Lough Salt and Lough Greenan Mourne located to the northwest of the study area.

Domestic Wells

Data on wells in the study area was collected from the GSI groundwater mapping website. Given that low yielding wells for domestic and farm water supply are relatively common in rural Ireland GSI data was complimented by a well survey to carry out best practice efforts to identify any wells for domestic and farm water supply in the path of the Proposed Development.

It is almost inevitable that any large road project will result in at least a small number of low-yielding water supply wells having to be abandoned. Groundwater supplies will have to be abandoned where they lie on the path of the Proposed Development. When this is the case the usual mitigation measure is the drilling of an alternative supply.

The location of these wells are illustrated on the EIAR Drawing 10.25. The recorded GSI wells in the vicinity of the Proposed Development are shown in Table 10.17.

Table 10.17: GSI Groundwater Well Data – Section 2

GSI Name	Well Type	Depth (m)	Townland	Source Use	Yield Class	Yield (m^3/day)
2041SEW010[1]	**Dug Well**	1.2	Kiltoy	Unknown	Poor	15.3
2041SEW019[1]	**Unknown**	1.8	Drumnahoagh	Unknown	Failure	2.2
2041SEW023[2]	**Dug Well**	1.2	Carnmogagh Upper	Unknown	Poor	16.3
2041SEW129	**Borehole**	14	Bonagee	Industrial Use	Excellent	546
2041SEW027	**Borehole**	70.1	Trimragh	Agri & Domestic Use	Poor	6.6
2041SEW144	**Borehole**	3.5	Trimragh	Other	-	-
2039NEW014[1]	**Dug Well**	3.6	Listellian	Unknown	Poor	12

1Exact location unknown mapped with a locational accuracy of two kilometres

2Exact location unknown mapped with a locational accuracy of five kilometres

10.4.2.14 Groundwater Dependant Ecosystems

There are no documented groundwater dependent protected areas in the vicinity of Section 2 and therefore these have not been further considered in the assessment.

10.4.3 Regional Overview - Section 3

The Proposed Development in Section 3 is located between Manorcunningham and Lifford, broadly following the route of the existing N14. Commencing at the existing N13/N14 roundabout junction, the Proposed Development runs offline to the north of the existing N14 and is parallel to the existing road for approximately one kilometre. It then continues in an easterly direction towards Drumoghill, before turning south and crossing the existing N14. The Proposed Development then turns to the east again, crossing the existing N14 a second time near Woodhill and Doorabble. Following this, it turns south-east and crosses the existing road again at Sheskinapoll.

From here, the Proposed Development runs approximately parallel to the existing N14 for about four kilometres, crossing it twice more at the existing N14/R236 junction and at Tullyrap. The Proposed Development then breaks away from the existing N14, continuing south and spanning both the Tullyrap Stream and the Swilly Burn. The Proposed Development then briefly turns eastward, before realigning southeast at Tamnawood and spanning the Deele River. It then loops around the northern side of Croaghan Hill, before continuing to the southeast and crossing the existing N15 near Conneyburrow. There is a roundabout proposed offline to the east of the existing N15 approximately1.3 km south of Lifford with a tie-in to the north and south and east to the proposed River Finn Crossing (A5 Link) which is within the SAC.

10.4.3.1 Regional Geomorphology and Topography

The topography through the first ten kilometres of Section 3 is dominated by two ridges of Precambrian schists and quartzites either side of the existing N14, including Mongorry Hill (284 m OD) to the southwest and Dooish Mountain (266 m OD) to the northeast. Between these runs a pass trending northwest-southeast, through which the existing N14 runs. The Proposed Development generally avoids the higher ground of the ridges and runs within the pass, rising and falling with the terrain, from an initial elevation of 5 m OD to a maximum of 105 m OD.

From here to the southern end of the route, the terrain is more low-lying and undulating. The topography here is dominated by the valleys of the Swilly Burn and the Deele River, both tributaries to the River Foyle to the east. These rivers are separated by a low ridge, with elevations ranging from 2 m to 5 m OD by the rivers and rising to 45 m OD when crossing the ridge. After crossing the Deele River, the Proposed Development rises once more as it curves around the northern end of Croaghan Hill (217 m OD), reaching a maximum elevation of 66 m OD, before falling toward the River Finn at an elevation of 0.02 m OD.

10.4.3.2 Quaternary Geology

Quaternary Geology are superficial deposits of quaternary-aged material which overlie the bedrock geology across most of Section 3 and comprise metamorphic till with alluvial deposits.

Soils

The majority of the study area is characterised by poorly drained shallow and deep acid soils (surface water gleys), interspersed with both shallow and deep well-drained acid and lithosolic soils with some peaty topsoil. Deposits of man-made fill or ‘Urban’ are present at Lifford.

Subsoils

These deposits are predominantly comprised of metamorphic till, though alluvial deposits are present along the numerous watercourses (river/floodplain) which cross the study area. The largest of these alluvial deposits are associated with a tributary to the Corkey River, to the northwest, and the Swilly Burn and the Deele River, to the southeast. Relatively insignificant deposits of man-made fill or ‘Made Ground’ are reported along the Proposed Development project. These are highly localised and restricted deposits, generally associated with existing roads or areas of urban development. The quaternary geology underlying Section 3 is shown in EIAR Drawing 10.09.

Agricultural Soils

The CORINE 2018 landcover for Section 3, shown in EIAR Drawing 10.13 shows Agricultural Areas dominate, with much of the area classified as Pastures (CORINE 2018 code: 231). Minor areas of

Heterogenous Agriculture (CORINE 2018 code: 242) and Non-irrigated Arable Land (CORINE 2018 code: 211) are also present along the Proposed Development. The southeastern end of the Proposed Development passes through an area of Discontinuous Urban Fabric (CORINE 2018 code: 112) in the environs of Lifford.

10.4.3.3 Geology

Section 3 is predominantly underlain by regionally metamorphosed Precambrian marbles, quartzites, and schists, with the southeastern end of the Proposed Development underlain by Precambrian pillow lavas and metavolcanics. The bedrock stratigraphy trends roughly southwest to northeast. There are no recorded karst features in the study area, which is expected given the metamorphic geology of the region.

Rock encountered during the Section 3 GI included variably weathered phyllite, quartzite, schist, limestone, sandstone and shale. The average reported depth to weathered rock and bedrock was approximately 6.5 m and 11.5 m, respectively.

The rock types encountered within the proposed cuttings is described predominantly as very strong to strong, locally moderately weak to weak, thinly foliated fine and medium grained phyllite and strong to moderately strong, locally moderately weak, quartzite. Other rock types encountered intermittently include limestone, meta-sandstone and marble.

The bedrock geology is summarised in Table 10.18 below and shown in the EIAR Drawing 10.03.

Table 10.18: Bedrock Geology Underlying the Proposed Development – Section 3

Chainage		Formation	Code	Description
From	To			
0+000	14+350	Aghyaran & Killygordon Limestone Formations	DG	Dark coloured and graphitic marble, and pelitic and psammitic schists with some quartzites and minor basic volcanics
14+350	17+090	Lough Foyle Succession [Undifferentiated]	LFS	Pelitic and psammitic schists and phyllites, graded grits and pebbly grits and thin marble units
17+090	17+500	Lifford Volcanic member [Aghyaran & Killygordon Limestone Formations]	DGlv	Volcaniclastic green beds with pillow lava
17+500	17+540	Claudy Formation	CY	Psammitic schist with intercalated coarse psammitic and pebbly grit units, thin marble lenses and quartzite

10.4.3.4 Soft or Unstable Ground

Soft and/or unstable deposits within the study area consist of peat, alluvium, and soft cohesive materials. Soft deposits were not identified along the Proposed Development from a desktop assessment of the Quaternary Geology (see Section 10.4.3.2).

10.4.3.5 Mineral / Aggregate Resources

There are no mineral localities, metallic or non-metallic, within the Proposed Development. There are also no active quarries within the Proposed Development. The nearest active quarry is Kiltole Quarry in Convoy, approximately 7 km southwest of the study area. There is one historic quarry underlying the Proposed

Development at Ch. 1+200 m, identified in the GSI pit and quarry areas dataset as being active in the early to mid 20th century. The quarry locations are as shown in EIAR Drawing 10.14.

Crushed rock aggregate potential mapping, shown in EIAR Drawing 10.06 shows the crushed rock potential ranges from moderate to very high along the Proposed Development project. This is likely due to a combination of the relatively shallow depth to bedrock in places, and the quality of the material.

Granular aggregate potential, relevant only to the alluvial areas identified along the floodplains, predominantly ranges from moderate to high, as identified by the GSI. However, the granular alluvium classifies as a granular aquifer, meaning the resource cannot be excavated. Furthermore, the Proposed Development is in embankment at the approaches to the river bridges apart from the River Finn which uses bridge piers set back from the banks of the River Finn to avoid impacts on the Qualifying Interests (QI's) for the SAC.

10.4.3.6 Geological Heritage Areas

No geological heritage areas were identified within the study area. Therefore, impacts associated with geological heritage areas have not been further considered in the assessment.

10.4.3.7 Karst

No karst features were identified within 500 m of the Proposed Development. The area is predominantly metamorphic (although some limestone was found in the site investigation), therefore, impacts associated with karstification have not been further considered in the assessment.

10.4.3.8 Contaminated Land

There is no evidence of contaminated land along the Proposed Development from baseline data sources, GI surveys, or walkover surveys. Deposits of Made Ground encountered through intrusive GIs were typically comprised of embankment fill and/or included construction waste materials, such as wood and plastic.

There are no waste licensed facilities within the study area, as shown in EIAR Drawing 10.14. There are also no EPA licensed facilities or legacy landfills recorded within the study area. There are three EPA licensed facilities within 5 km of the Proposed Development, which are summarised in Table 10.19. All licensed facilities are considered sufficiently distant from the Proposed Development to have no impact. Therefore, impacts associated with these facilities have not been further considered in the assessment.

Table 10.19: EPA Licensed Facilities within Five Kilometres of the Proposed Development – Section 3

License No.	License Type	Facility Name	Facility Type	Distance from Proposed Development Project
P0968	IEL	MS Patterson Ltd	Intensive Agriculture	1.2 km west from Ch. 11+400
P1040	IEL	Robert Smyth and Sons (Strabane and Donegal) Ltd	Food and Drink	900 m west from Ch. 14+100
W0062	Waste	Churchtown Landfill	Landfill	2.5 km southwest from Ch. 17+540

10.4.3.9 Landslide Potential

Based on review of the GSI's Landslide Susceptibility mapping most the study area is rated as having 'Low' landslide susceptibility. There are small areas of 'Moderately Low' to 'Moderately High' susceptibility in the areas of high elevation near Drumoghill, Drumbeg, Tullyrap, Murlough & Townparks as shown in EIAR Drawing 10.17.

There are no records of landslide events held by the GSI within the study area. As such the landslide susceptibility potential is low and is not considered a risk to the scheme.

10.4.3.10 Regional Hydrogeology

Groundwater flow in the bedrock aquifers is expected to be concentrated in upper fractured and weathered zones and in the vicinity of fault zones. Available groundwater levels are mainly 0-5 m below ground level. Groundwater flow directions are expected be a subdued reflection of the overlying topography. Groundwater will generally flow to rivers (the Foyle, the Deele and the Swilly Burn) where it will discharge as baseflow into Lough Swilly. The groundwater within the Foyle gravels is unconfined and contained within the alluvial gravels associated with the River Deele and Swilly Burn. There will be a direct hydraulic connection between the saturated gravel deposits and the water in the river. The flow will be from the gravels to the river. In areas where the hydraulic connection between bedrock groundwater and surface waters is low due to low permeability deposits, groundwater flow paths are likely to be longer and to be parallel, rather than at an angle, to the rivers.

10.4.3.11 Aquifer Classification

This area of Donegal does not have significant groundwater potential. Well yields are generally very poor. The aquifer classification in the vicinity of the Proposed Development is shown in EIAR Drawing 10.20 and the various aquifers are described below.

Aghyaran & Killygordon Limestone Formation – Bedrock Aquifer

The bedrock aquifer underlying Ch. 00+000 to Ch. 14+350 m, which comprises approximately 80% of the Proposed Development, is classified as LI aquifer which is moderately productive only in local zones.

The aquifer is primarily composed of low transmissivity rock. Yields in this aquifer are generally low. Well yields above 100 m^3/day would be regarded as the exception. Generally, the higher yielding wells recorded within the aquifer are associated with the Marble Unit to the east of the corridor. Transmissivity values are not generally expected to be high (<20 m^2/day) and storativity is also considered to be relatively low. Groundwater flow is via fractures and weathered zones. This aquifer is underlain by the Manorcunningham and Raphoe GWBs.

LI aquifers are attributes of medium hydrogeological importance.

Lough Foyle Succession – Bedrock Aquifer

The bedrock aquifer underlying Ch. 14+350 to Ch. 17+584 m, which comprises approximately 20% of the Proposed Development, is classified as PI: Poor aquifer which is generally unproductive except for local zones. Recorded well yields vary from 9-30 m^3/day. Storativity is expected to be low. The groundwater flow is generally within a weathered layer at the rock head. This aquifer is underlain by the Ballybofey GWB.

Poor Aquifers are regarded as low importance hydrogeological attributes.

Foyle Gravels – Gravel Aquifer

The Proposed Development crosses this unconfined aquifer in two places namely in the vicinity of the River Deele and Swilly Burn. It should be noted that the Proposed Development is in fill at the crossings. This gravel aquifer classification is an LI gravel aquifer and is underlain by the Foyle Gravels GWB. The aquifer comprises alluvial deposits located along the floodplain of the River Foyle, extending as far south as Lifford, beyond which it becomes much narrower. The broader section of this deposit, including the adjoining alluvium associated with the lower reaches of the River Deele and Swilly Burn, is in the region of 20 km^2. Many of the steeper sided valleys in this part of Donegal are thought to be infilled with sand and gravel at depth and more superficial fines-dominated material. The transmissivity of the deposits is expected to be 400 m^2/day or less. Aquifer thickness is expected to be approximately ten metres.

LI gravel aquifers have medium importance as a hydrogeological attribute.

10.4.3.12 Groundwater Vulnerability

The vulnerability classification within the vicinity of the Proposed Development is shown in “Groundwater Vulnerability”. It must be noted that groundwater vulnerability classification is not a measure of the impact on groundwater quality but rather the degree of protection afforded to the underlying aquifer and consequently the risk to the groundwater quality in the event of a release of a contaminant. The GSI classification of the vulnerability of an aquifer is based on the thickness and the permeability of overburden, as summarised in Table 10.9 previously. The greater the thickness and permeability, the greater the protection to the groundwater in the underlying aquifer. High and extreme vulnerable subsoils are a feature underlying a high proportion of the Proposed Development (particularly the southern section). In sections of cut the vulnerability will be increased.

Table 10.20 shows the vulnerability classification underlying the Proposed Development project.

Table 10.20: GSI Groundwater Vulnerability Classification – Section 3

Sub-Section	Chainage		Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	From	To			
Mainline	0+000	0+950	Moderate (M)	950	3.32
	0+950	1+110	High (H)	160	0.56
	1+110	1+160	Extreme (E)	50	0.17
	1+160	1+220	Extreme (X)	60	0.21
	1+220	1+250	Extreme (E)	30	0.10
	1+250	1+800	High (H)	550	1.92
	1+800	2+300	Extreme (E)	500	1.75
	2+300	2+400	Extreme (X)	100	0.35
	2+400	2+550	Extreme (E)	150	0.52
	2+550	2+600	Extreme (X)	50	0.17
	2+600	2+660	Extreme (E)	60	0.21
	2+660	3+070	High (H)	410	1.43
	3+070	5+200	Moderate (M)	2130	7.45
	5+200	6+380	High (H)	1180	4.12
	6+380	6+660	Moderate (M)	280	0.98
	6+660	7+470	High (H)	810	2.83
	7+470	7+860	Moderate (M)	390	1.36
	7+860	8+170	High (H)	310	1.08
	8+170	9+380	Extreme (E)	1210	4.23
	9+380	10+010	High (H)	630	2.20
	10+010	10+270	Extreme (E)	260	0.91
	10+270	10+340	Extreme (X)	70	0.24
	10+340	10+390	Extreme (E)	50	0.17
	10+390	11+180	High (H)	790	2.76
	11+180	12+150	Moderate (M)	970	3.39
	12+150	12+750	High (H)	600	2.10
	12+750	14+160	Extreme (E)	1410	4.93
	14+160	14+620	High (H)	460	1.61
	14+620	14+670	Extreme (E)	50	0.17
	14+670	14+730	Extreme (X)	60	0.21
	14+730	14+830	Extreme (E)	100	0.35

Sub-Section	Chainage From	Chainage To	Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	14+830	16+030	High (H)	1200	4.19
	16+030	16+170	Extreme (E)	140	0.49
	16+170	16+360	Extreme (X)	190	0.66
	16+360	16+700	Extreme (E)	340	1.19
	16+700	17+350	High (H)	650	2.27
	17+350	17+540	Extreme (E)	190	0.66
LX 3014 Link North	0+000	0+420	Moderate (M)	420	1.47
L1294 Manorcunningham Local Road	0+000	0+600	Moderate (M)	600	2.10
N13 Derry Tie-In	0+000	0+452	Moderate (M)	452	1.58
L1274 Drumoghill Link	0+000	0+150	High (H)	150	0.52
	0+150	0+431	Extreme (E)	281	0.98
Drumoghill Junction North Link	0+000	0+154	Extreme (E)	154	0.54
LX 3014 Drumoghill West and East	0+000	0+400	Extreme (E) with some areas partially underlain by Rock at or near surface (X)	400	1.40
	0+400	0+482	Moderate (M)	82	0.29
L5574 Moodooey Lower	0+000	0+308	Moderate (M)	308	1.08
LX 3014 Doorable North and South	0+000	0+530	Moderate (M)	530	1.85
Mondooey	0+000	0+392	Moderate (M)	392	1.37
LX 3014 Sheshkinpoll	0+000	0+500	High (H)	500	1.75
	0+500	0+843	Moderate (M)	343	1.20
R236 Ballinalecky	0+000	0+732	Moderate (M)	732	2.56
R236 Ballinalecky Junction Link North A	0+000	0+095	High (H)	95	0.33
R236 Ballinalecky Junction Link South	0+000	0+110	High (H)	110	0.38
LX 3014 Tullyrap	0+000	0+270	Extreme (E)	270	0.94
	0+270	0+900	High (H)	630	2.20
	1+000	1+420	Extreme (E) with some areas partially underlain by Rock at or near surface (X)	400	1.40
	1+420	1+568	High (H)	168	0.59
L2444 Ballindrait Local Road South	0+000	0+147	High (H) / Extreme (E)	240	0.84
L2444 Ballindrait Side Road	0+000	0+300	High (H)	300	1.05
	0+300	1+100	Extreme (E)	800	2.80

Sub-Section	Chainage		Vulnerability GSI Classification	Distance (m)	Percentage of Proposed Development (%) (approx.)
	From	To			
	1+100	1+550	High (H)	450	1.57
	1+550	2+004	Extreme (E)	454	1.59
LX3014 Rossgier South	0+000	0+189	Extreme (E)	189	0.66
R264 Murlog	0+000	0+227	Extreme (E)	227	0.79
N15 Lifford Tie-In East	0+000	0+300	Extreme (E)	300	1.05
	0+300	0+506	High (H)	206	0.72
N15 Lifford Tie-In West	0+000	0+497	Extreme (E)	497	1.74
N14/N15 to A5 Link	0+000	0+306	High (H)	306	1.07
N15-West Link	0+000	0+083	Extreme (E)	83	0.29

10.4.3.13 Groundwater Recharge

The GSI Groundwater recharge map across the area indicates low recharge rates to the bedrock aquifers across the entire area. The ability of the bedrock to accept recharge is based generally on the permeability of the weathered zone of bedrock likely extending 3.0 – 5.0m below the bedrock surface. This is due to the fact that the bedrock offers very little primary porosity with storage occurring predominantly within fractured and weathered zones. Recharge caps are applied to the LI and Poor Aquifers due to their inability to accept large volumes of water. The recharge to the LI aquifer is in the order of 200 mm/year. The recharge to the Poor Aquifer to the south is taken to be 100 mm/year.

10.4.3.14 WFD Groundwater Quality Status

The GWB is the management unit under the WFD. GWBs are subdivisions of large geographical areas of aquifers so that they can be effectively managed in order to protect the groundwater and linked surface waters.

There are four GWBs underlying the Proposed Development project:

- Manorcunningham GWB
- Raphoe GWB
- Ballybofey GWB
- Foyle Gravels GWB (gravel)

The bedrock aquifers are characterised by low transmissivity rocks with low yields. However, there are localised areas where above average yields can be encountered. The hydrogeological characteristics of each of these GWBs is summarised on the GSI's GWB Description Sheets.

Under the WFD large geographical areas of aquifer have been subdivided into smaller GWBs in order for them to be effectively managed. There are four GWBs underlying the Proposed Development project. The WFD Quality Status and Risk Status for each of these GWBs are summarised in Table 10.21.

In terms of water quality status and risk category, all the GWBs are the same, i.e. "Good" and "Not at Risk" respectively.

Table 10.21: GSI Groundwater Vulnerability Classification – Section 3

GWB	Element	Rating for GWB (WFD Status 2019-2024)	Objectives	Measures to Achieve Objectives
Manorcunningham	Water Quality Status	Good	▪ Restore_2021 ▪ Prevent Deterioration ▪ Restore Good Status ▪ Reduce Chemical Pollution ▪ Achieve Protected Areas Objectives	***Basic Measures*** ▪ The Bathing Water Directive (2006/7/EC) ▪ The Habitats Directive (92/43/EEC) ▪ The Drinking Water Directive (98/83/EC) ▪ The Major Accidents (Seveso) Directive (96/82/EC) ▪ The EIA Directive (85/337/EEC) ▪ The Sewage Sludge Directive (86/278/EEC) ▪ The Urban Waste Water Treatment Directive (91/271/EEC) The Plant Protection Products Directive (91/414/EEC) ▪ The Nitrates Directive (91/676/EEC) ▪ The Integrated Pollution Prevention Control Directive (96/61/EEC) ***Specific Measures*** ▪ Cost recovery for water use ▪ Promotion of efficient and sustainable water use ▪ Protection of drinking water sources ▪ Control of abstraction and impoundments ▪ Control of point source discharges ▪ Control of diffuse source discharges ▪ Authorisation of discharges to groundwater ▪ Controls on other activities impacting on water status ▪ Prevention or reduction of the impact of accidental pollution incidents
	Risk Category	Not at Risk		
Raphoe	Water Quality Status	Good		
	Risk Category	Not at Risk		
Ballybofey	Water Quality Status	Good		
	Risk Category	Not at risk		
Foyle Gravels	Water Quality Status	Good		
	Risk Category	Not at Risk		

10.4.3.15 Abstractions

Public Supply Wells

GSI groundwater wells and springs mapping identifies two public supply boreholes supplying Manorcunningham PWS approximately 360m and 320m from the Proposed Development, identified as wells 5 and 6 in Table 10.22. However, these wells are redundant, as Manorcunningham is now served through the same distribution network as Newtowncunningham, part of the Inishowen Regional Water Supply Scheme.

The closest PWS (or group scheme) identified in the GSI public supply source protection area dataset is 1.5 km from the Proposed Development, associated with the Maherabeg Veagh PWS. As there no public groundwater supply wells within 1.5 km of the corridor, these have not been further considered in the assessment.

Domestic Wells

Data on wells in the study area was collected from the GSI groundwater mapping website, and from the well locations shown in Eircode/Address Finder mapping. Given that low yielding wells for domestic and farm water supply are relatively common in rural Ireland, GSI and Eircode/Address Finder data was complimented by a well survey to carry out best practice efforts to identify any wells for domestic and farm water supply in the path of the Proposed Development. During this well survey, many of the wells identified in the desk study were identified as having been removed or made redundant. These disused wells have not been further considered in the assessment.

It is almost inevitable that any large road project will result in at least a small number of low-yielding water supply wells having to be abandoned. Groundwater supplies will have to be abandoned where they lie on the path of the Proposed Development. When this is the case, during construction an alternative supply shall be drilled if required.

The locations of the recorded GSI wells and Eircode/Address Finder mapped wells in the vicinity of the Proposed Development that have not been identified during the well survey as removed or redundant are shown in Table 10.22 and on EIAR Drawing 10.26. Domestic wells are considered an attribute of low importance.

Table 10.22: Groundwater Well Data, Excluding Removed and Redundant Wells – Section 3

Drawing Number	GSI Name	Well Type	Depth (m)	Townland	Source Use	Yield Class	Yield (m^3/day)
1	**N/A**			Raymoghy			
2	**N/A**			Raymoghy			
3	**N/A**			Raymoghy			
4	**N/A**			Raymoghy			
5	**2041SEW049**	**Borehole**	90	Raymoghy	Public Supply/ Redundant	Good	333
6	**2041SEW140**	**Borehole**	0	Raymoghy	Public Supply/ Redundant	Good	327
7	**N/A**			Carrickballydooey			
8	**N/A**			Drumoghill			
9	**2041SEW137**	**Borehole**	61	Tullybogly	Domestic	Excellent	1090
10	**N/A**			Drumoghill			
11	**N/A**			Drumoghill			
12	**N/A**			Drumoghill			
13	**N/A**			Drumcarn			
14	**N/A**			Drumcarn			
15	**2039NEW051**	**Borehole**	6	Drumcarn	Other		0
16	**2039NEW040**	**Borehole**	10.5	Mondooey Lower	Other		0
17	**N/A**			Mondooey Lower			
18	**N/A**			Mondooey Middle			
19	**N/A**			Mondooey Middle			
20	**2039NEW048**	**Borehole**	2	Drumatoland	Other		0

Drawing Number	GSI Name	Well Type	Depth (m)	Townland	Source Use	Yield Class	Yield (m^3/day)
21	**N/A**			Sheskinapoll			
22	**N/A**			Carnshannagh			
23	**2039NEW011**	**Dug Well**	4.6	Oakfield Demesne	Unknown	Poor	19.6
24	**N/A**			Drumbeg			
25	**N/A**			Drumbeg			
26	**2039NEW045**	**Borehole**	10	Drumfad	Other		0
27	**N/A**			Feddyglass			
28	**N/A**			Feddyglass			
29	**N/A**			Feddyglass			
30	**N/A**			Feddyglass			
31	**N/A**			Tullyrap			
32	**2039NEW046**	**Borehole**	4	Broadlea	Other		0
33	**2039NEW034**	**Spring**	0	Broadlea	Unknown		0
34	**N/A**			Mulnaveagh			
35	**N/A**			Mulnaveagh			
36	**2339NWW019**	**Borehole**	10	Mulnaveagh	Other		0
37	**N/A**			Gortin North			
38	**N/A**			Tamnawood			
39	**2039NEW047**	**Borehole**	3	Guystown	Other		0
40	**N/A**			Ballindrait			
41	**N/A**			Cavanacor			
42	**N/A**			Cavanacor			
43	**N/A**			Moneen			
44	**N/A**			Murlough			
45	**N/A**			Murlough			
46	**N/A**			Murlough			
47	**N/A**			Lifford Common			
48	**2339SWW001**	**Dug Well**	3.1	Portinure	Unknown	Poor	3.1

10.4.3.16 Groundwater Dependent Ecosystems

The River Finn is not classified as a groundwater dependent habitat, however, groundwater contributes to river baseflow, hence it is a groundwater receptor. Baseflow contribution to the River Finn supports its designation as: (1) Salmonid Water pursuant to S.I. No. 293 of 1988 - European Communities (Quality of Salmonid Waters) Regulations and (2) European site (River Finn SAC).

There are no documented groundwater dependent terrestrial ecosystems (GWDTEs) in the zone of influence of the Proposed Development and therefore these have not been further considered in the assessment.

10.4.4 Summary of Geological, Quaternary & Hydrogeological Features Importance

10.4.4.1 Section 1

The criteria for rating site importance of a geological, quaternary or hydrogeological feature is based on the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes published by the TII (2008b) which is reproduced in the IGI guidelines. Initial assessment is based on the findings of the information listed above. These ratings are used to inform Table 10.23.

Table 10.23: Geological, Quaternary & Hydrogeological Feature Importance within Study Area – Section 1

Importance	Feature	Criteria
Low	Overburden	Attribute has a low quality, significance or value on a local scale
Low	Bedrock	Attribute has a low quality, significance or value on a local scale
Very High	River Finn SAC/ GWDTE	Attribute has a high quality due to presence of EU Annex I GWDTE
High	Dromboe Holywell	Attribute has a high-quality value due to status of local heritage and cultural importance
Medium	Bedrock aquifer classified by the GSI as a LI Aquifer Be	Attribute has a medium quality or value on a local scale
Low	Aggregate Resources	Loss of potential quarry and pit reserves along the Proposed Development Use of Aggregates within the Proposed Development
Low	Bedrock Aquifer Classified as Poor	Attribute has a low quality or value on a local scale
Low	Domestic Groundwater Wells (Potable water source supplying <50 homes)	Attribute has a low quality or value on a local scale

10.4.4.2 Section 2

The criteria for rating site importance of a geological, quaternary or hydrogeological feature is based on the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes published by the TII (2008b) which is reproduced in the IGI guidelines. Initial assessment is based on the findings of the information listed above. These ratings are used to inform Table 10.24.

Table 10.24: Geological, Quaternary & Hydrogeological Feature Importance within Study Area – Section 2

Importance	Feature	Criteria
Low	Overburden	Attribute has a low quality, significance or value on a local scale
Low	Bedrock	Attribute has a low quality, significance or value on a local scale
High	CGS	Attribute has a high quality, significance or value on a local scale.
Medium	Bedrock aquifer classified by the GSI as an LI Aquifer	Attribute has a medium quality or value on a local scale.
Medium	Gravel aquifer classified by the GSI as an LI Aquifer	Attribute has a medium quality or value on a local scale.
Low	Aggregate Resources	Loss of potential quarry and pit reserves along the Proposed Development. Use of Aggregates within the Proposed Development.
Low	Bedrock Aquifer Classified as Poor	Attribute has a low quality or value on a local scale.
Low	Domestic Groundwater Wells (Potable water source supplying <50 homes)	Attribute has a low quality or value on a local scale.

10.4.4.3 Section 3

The criteria for rating site importance of a geological, quaternary or hydrogeological feature is based on the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes published by the TII (2008b) which is reproduced in the IGI guidelines. Initial assessment is based on the findings of the information listed above. These ratings are used to inform Table 10.25.

Table 10.25: Geological, Quaternary & Hydrogeological Feature Importance within Study Area – Section 3

Importance	Feature	Criteria
Low	Overburden soils	Attribute has a low quality, significance or value on a local scale
Low	Bedrock	Attribute has a low quality, significance or value on a local scale
Low	Aggregate Resources	Attribute has a low quality, significance or value on a local scale
Medium	Bedrock aquifer classified by GSI as an LI Aquifer	Attribute has a medium quality or value on a local scale
Medium	Gravel aquifer classified by GSI as an LI Aquifer	Attribute has a medium quality or value on a local scale
Low	Bedrock Aquifer Classified as Poor	Attribute has a low quality or value on a local scale
Low	Domestic Groundwater Wells (Potable water source supplying <50 homes)	Attribute has a low quality or value on a local scale
Extremely High	River Finn SAC	Attribute has a high quality or value on an international scale

10.5 Ground Investigations (GI)

10.5.1 Section 1 – N15/N13 Ballybofey/ Stranorlar Urban Region

A route specific ground investigation (GI) was carried out by IDL between the period of February 2020 and September 2021. The purpose of the GI was to provide detailed factual geotechnical information for the underlying ground conditions along the proposed 9 km of road. This information has been used to establish subsurface conditions along the route and to inform the geotechnical design for the route. As of September 2025, it is considered that baseline conditions in the study are not considered to have changed (geologically stable environment) since 2021, there were no major project design changes impacting Soils, Geology or Groundwater and no unexpected conditions were previously identified that require validating of the initial route specific ground investigation (GI) carried out by IDL.

The GI comprised:

- 40 no. cable percussion boreholes
- 45 no. rotary core holes
- 212 no. machine dug trial pits
- 18 no. window samples
- 4 no. variable head permeability test
- Groundwater level monitoring
- Geophysical Survey

GI locations are illustrated on the GI and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3) in Volume D: Book of Drawings. Results of the GI show that ground conditions are typical and as expected for this region. They predominantly consist of Topsoil overlying Glacial Tills, overlying Bedrock.

Topsoil was typically recorded from ground surface to a depth of 0.30 m.

Made Ground was encountered in a number of localised areas. It was generally described as gravelly peaty clay and peaty gravelly silt with cobbles, boulders, and waste items such as wood and plastic.

Glacial Till is the most predominant overburden material encountered along the route. In general, it consists of slightly sandy slightly gravelly silt/clay with cobbles and boulders and/or silty sands and/or gravels with cobbles and boulders.

Deposits encountered comprise a highly variable, stratified mixture of cohesive and granular materials. Cohesive Glacial Till was proved to a maximum depth of 12 m at Ch. 3+900 S1.2.

Granular Glacial Till was proved to a maximum depth of 7.5 m at Ch. 2+450 S1.2.

Peat and/or very soft silt ('marl') was also frequently encountered in the boreholes and trial pits to depths ranging from 0.40 m to 5.70 m below ground level. Peat deposits are typically described as being very soft to soft, black to dark brown, pseudo-fibrous peat. Peat is most prevalent approximately 400 m south-west of Ch. 0+000 along the proposed L6564 Connector Road. Other areas include Ch. 6+250-Ch. 6+450 S1.2 and at the end of the Proposed Development between Ch. 8+200-Ch.8+250 S1.2.

Intact bedrock was encountered in the rotary core boreholes at depths varying from 1.1 m to 12 m b.g.l. In some boreholes, intact bedrock was not encountered in boreholes BS RC1013, BS SP115 and BS SP1116 (located along S1.2 Ch 0.3+500- Ch. 3+900) at depths of up to 16 m b.g.l.

Bedrock is predominantly described as very strong, locally strong and medium strong thinly foliated grey fine and medium grained Phyllite, with traces of Quartzite and Schist.

Weathered/fractured bedrock was also encountered in many of the boreholes and trial pits at shallower depths, often forming part of the bedrock transition.

10.5.1.1 Groundwater

Standpipes were installed in 32 no. exploratory holes to facilitate groundwater monitoring which was carried out over a 16-month period from September 2020 to January 2022. Groundwater levels are generally reflective of the ground topography, with elevated levels in areas of higher ground and lower levels in the low-lying flood plains of the River Finn.

The full suite of groundwater monitoring data is provided in Appendix C10.01. In general groundwater levels in the individual boreholes are highest in the winter months and show a fluctuation of 0.5 m – 1 m over the course of a year.

10.5.1.2 Permeability Testing

Permeability testing, carried out between July 2021 and May 2022, in the form of falling head tests and rising head tests was carried out on selected boreholes to determine the permeability of the subsoil and rock and the ease of groundwater flow through these mediums. Results are presented in Appendix C10.02. Table 10.26 summarises the results and how they align with the permeability ranges for Irish subsoils (Geographical Survey Ireland, 2015).

Generally, permeability will decrease with depth therefore the subsoil and transition zone will tend to comprise higher permeability values than the shallow or deep bedrock zones.

Table 10.26: Permeability Testing Results-Section 1

Borehole	Permeability (K)	Permeability Range	Overburden	Chainage/Cut
BSBHRC3009	▪ Falling Head: 7.55 x 10-8 m/s (0.006 m/d) ▪ Falling Head: 6.56 x 10-8 m/s (0.005 m/d)	Low/ Moderate	Gravel	Ch. 3+400 S1.2 Cut 3
BSBHRC3009A	▪ Falling Head: 8.85 x 10-7 m/s (0.007 m/d) Rising Head: 1.06 x 107m/s (0.009 m/d) ▪ 1.97 x 10-7m/s (0.017 m/d)	Low/ Moderate	Gravel	Ch.3+550 S1.2 Cut 3
BSBHSP1118	▪ Falling Head: 9.17 x 10-6 m/s (0.8 m/d) ▪ Rising Head: 1.65 x 10-5m/s (1.42 m/d)	Moderate/ High	Gravel overlying Silt/Clay with cobbles	Ch. 5+300 S1.2 Cut 4
BSBHRC3003	▪ Falling Head: 1.24 x 10-6 m/s (0.1 m/d) ▪ Rising Head: 2.6 x 10-5 m/s (2.24 m/d)	Moderate	sandy Clay with cobbles	Ch. 5+600 S1.2 Cut 4
BSBHRC1018	▪ Falling Head: 4.91 x 10-6 m/s (0.42 m/d)	Moderate	-	Ch. 6+850 S1.2 Cut 5

10.5.1.3 Geophysical Survey

Minerex Geophysics Ltd. carried out a geophysical survey consisting of 2D Resistivity, seismic refraction (p wave) and Multi-channel Analysis of Surface Waves (MASW) (s-wave) surveying at eight separate locations between 28th September and 8th October 2020. The main objectives of the survey were to help determine the ground conditions, the depth to rock head and the overburden thickness, and to estimate the strength/ stiffness/ compaction of the overburden and the rock quality.

The geophysical survey site pertaining to Section 1 was carried out at the River Finn Crossing North. Five profiles were carried out across two fields north of the River Finn in the townland of Dromboe Lower. The seismic refraction data was modelled with a three-layer model for all profiles comprising two top layers of topsoil and sandy gravelly clay or sand and gravel subsoil underlain by a third layer of weathered metamorphic bedrock at 4.5-6.5 mbgl.

The depth to bedrock in rotary coreholes BSBHRC1009 and BSBHRC1010 (5.8 and 7.5 mbgl) which were carried out close to the north of the survey lines ties in well with the interpreted rock depth from the survey.

10.5.1.4 Holywell Groundwater Investigations

Due to the significance of Holywell as a site of local reverence and its close proximity to a significant large cutting, focussed field and groundwater investigations were carried out in the area. These comprised:

- Groundwater monitoring in boreholes drilled adjacent to the cutting (BSBHRC3009 and BSBHRC3009A) and in the centre of the cutting (BSBHRC3010). This included piezometers to capture groundwater arising from surface water infiltration only and bentonite screened standpipes to top of rockhead to measure the water table reflective of the bedrock aquifer. The purpose of this approach is to help determine the water source for Holywell (i.e. whether it is surface water fed or groundwater fed).

- Permeability testing (BSBHRC3009 in May 2022 and BSBHRC3009A in August 2022) to determine the hydraulic conductivity (permeability) of the aquifer.

- Pump testing (BSBHRC3009A) to determine potential well yields (28th August 2022).

Water sampling and analysis (February 2022) to help ascertain the chemical signature of Holywell water and compare with both groundwater (BSBHRC3009) and surface water in the area including another culverted underground stream in the area (Dromboe Stream) and the River Finn.

Permeability Test Results

Permeability testing, carried out between July 2021 and May 2022, in the form of falling head and rising head tests were carried out on BSBHRC3009 to determine the permeability of the subsoil and the ease of groundwater flow through the shallow groundwater pathway. Results are presented in Table 10.26.

Water Sampling Results

Water sampling was carried out on January 28th 2022 at BSBHRC3009, BSBHRC3010, at Holywell, at another culverted stream in the locality (referred to as Dromboe Stream), and at the River Finn to review the range in values and their chemical signatures to help ascertain whether Holywell is predominantly groundwater fed (i.e. bedrock aquifer) or surface water fed.

The locations of BSBHRC3009, BSBHRC3010, Holywell, and the sampling location of the culverted stream and the River Finn are identified in Figure 10-2.

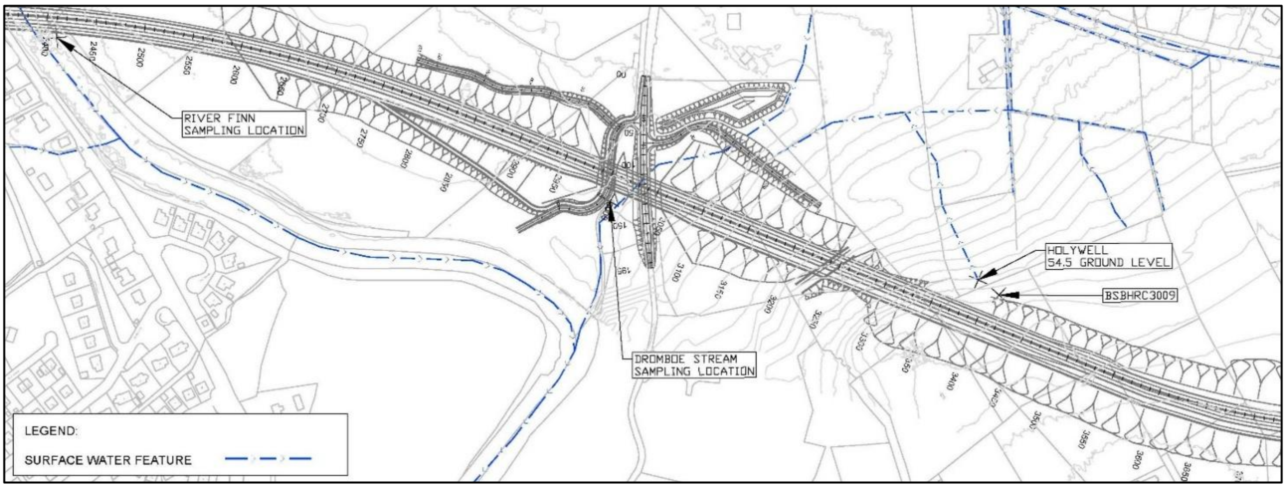


Figure 10-2: Water Sampling Locations at Holywell (Section 1)

Field values obtained on site using a handheld multi-meter are tabulated in Table 10.27.

Table 10.27: Field Water Sample Analysis

Parameter	BSBHRC 3009	BSBHRC 3010	Holywell	River Finn	Drumboe Stream	EPA IGV (EPA, 2003)	SI No.9 2010 (Groundwater Regulations)
Temperature (^{0}C)	10.3	10.6	10	8.7	8.3	25	-
Electrical Conductivity (mS/m)	71	112	147	116	108	1	0.8-1.75
Dissolved O_2 mg/L)	1.65	3.1	2.97	5.33	6.8	No abnormal change	-
Dissolved O_2 %/L	22.7	43	40.7	70.2	89.8	No abnormal change	-
pH	7.12	6.73	6.39	7.6	7.4	6.6-9.5	-

- No threshold value established for this parameter

Water samples were also obtained for laboratory analysis on January 27th 2022 and are tabulated in Table 10.28. The water sample results indicate elevated levels of ammoniacal nitrogen, sulphate, magnesium, manganese, calcium, sodium and potassium from samples taken from BSBHRC3009 together with a relatively high Hardness value of 220 mg/l (compared with other samples).

The elevated Hardness value for BSBHRC3009 is consistent with values for groundwater which tend to be harder than surface water. The bedrock at Dromboe is comprised of Precambrian Phylitte, which was originally a sandstone rock that was subsequently metamorphosed. Precambrian basement rocks in these units in Donegal have a 'natural' water quality that includes high iron and/or manganese, as these rocks are overlain by peat, which increases the likelihood of metals being leached from the rock, and higher Manganese values (GSI, 2014).

While the EPA does not discuss the aquifer hydrochemistry of aquifer types older than Ordovican volcanics (EPA, 2003) the values obtained from BSBHRC3090 for hardness, calcium and sodium are consistent with those of groundwater from Devonian Sandstones. The water quality results are included in full in Appendix C10.03.

Groundwater Monitoring Results

Water levels monitored in the piezometers were largely dry. Groundwater level monitoring carried out to date indicates that groundwater is approximately 4.16 m bgl in the vicinity of Holywell.

Table 10.28: Water Sample Analysis

Parameter	River Finn	Dromboe Stream	Holywell	BSBHRC3009	EPA Interim Guideline Value (EPA, 2003)	SI No.9 2010 (Groundwater Regulations)
pH	7.31	7.44	**6.28**	6.9	6.5-9.5	-
Total Hardness (CaCo^{3}) mg/l	18.4	77.8	101	**220**	200	-
Total Alkalinity (CaCo^{3}) mg/l	10.1	63.9	70.5	163	NAC	-
Ammoniacal Nitrogen (mg/l)	<0.01	0.059	0.049	**0.896**	0.15	0.065-0.175 (as Ammonium)
Calcium (mg/l)	3.8	21.9	29.2	53.6	200	-
Nitrate (mg/l)	0.63	4.54	10.3	2.61	25	37.5
Nitrite (mg/l)	<0.05	0.066	<0.05	<0.05	0.1	0.375
Chloride (mg/l)	14	17	15	15.7	30	24-187.5
Sulphate (mg/l)	<2	7.6	4.9	14.1	200	187.5
Orthophosphate (mg/l)	<0.02	<0.02	<0.02	<0.02	0.03	0.035
Magnesium (mg/l)	1.2	3.01	3.31	5.28	50	-
Manganese (ug/l)	4.26	47.9	<3	**514**	50	-
Sodium (mg/l)	6.55	9.72	8.17	15.6	150	150
Potassium (mg/l)	0.563	2.04	1.25	**5.19**	5	-
Iron (mg/l)	**0.258**	0.196	<0.019	<0.019	0.2	-
Arsenic (ug/l)	<0.05	<0.05	<0.05	<0.05	100	-
Boron (ug/l)	<10	<10	<10	<10	1000	750
Cadmium (ug/l)	<0.08	<0.08	<0.08	<0.08	5	3.75
Chromium (ug/l)	<1	<1	<1	<1	30	37.5
Copper (ug/l)	0.339	0.798	0.367	4.68	30	1,500
Mercury (ug/l)	<0.01	<0.01	<0.01	<0.01	1	0.75
Nickel (ug/l)	<0.4	0.566	<0.4	6.78	20	15
Zinc (ug/l)	2.14	2.49	4.78	36.7	100	-
Lead (ug/l)	0.206	<0.2	<0.2	<0.2	10	18.75
Phenol (ug/l)	<0.5	<0.5	<0.5	<0.5	0.5	-
Total Cyanide (ug/l)	<5	<5	<5	<5	10	37.5

*Exceedances of EPA interim guideline values are in bold text.

- No threshold value established for this parameter.

10.5.2 Section 2 - N56/N13 Letterkenny to Manorcunningham

A route specific GI was carried out by IDL between the period of March 2020 and July 2021. The purpose of the GI was to provide detailed factual geotechnical information for the underlying ground conditions along the proposed nine kilometre of road. This information has been used to establish subsurface conditions along the route and to inform the geotechnical design for the route. As of September 2025, it is considered that baseline conditions in the study are not considered to have changed (geologically stable environment) since 2021, there were no major project design changes impacting Soils, Geology or Groundwater and no unexpected conditions were previously identified that require validating of the initial route specific ground investigation (GI) carried out by IDL. The GI comprised:

- 47 no. cable percussion boreholes
- 23 no. rotary core holes
- 104 no. machine dug trial pits
- 10 no. window samples
- 2 no. variable head permeability test
- Groundwater level monitoring
- Geophysical Survey

GI locations are illustrated on the GI and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). Results of the GI show that ground conditions are typical and as expected for this region. They predominantly consist of Topsoil overlying Glacial Tills, overlying Bedrock.

Topsoil was typically recorded from ground surface to a depth of 0.30 m.

Made Ground was encountered in a number of localised areas. It was generally described as gravelly silty clay, gravelly clayey SILT and gravel fill with cobbles, boulders, and waste items such as wood, plastic and traces of concrete and tarmac.

Glacial Till is the most predominant overburden material encountered along the route. In general, it consists of slightly sandy slightly gravelly silt/clay with cobbles and boulders and/or silty sands and/or gravels with cobbles and boulders.

Deposits encountered comprise a highly variable, stratified mixture of cohesive and granular materials. Cohesive Glacial Till was proved to a maximum depth of 26.8 m at Ch. 0+750 of mainline 2.6.

Granular Glacial Till was proved to a maximum depth of 7.0 m between Ch. 2+700–Ch. 3+000 S2.4.

Peat and/or very soft silt (‘marl’) was also frequently encountered in the boreholes and trial pits to depths ranging from 0.60 m to 15.10 mbgl. Peat deposits are typically recorded as being very soft to soft, black to dark brown, pseudo-fibrous peat.

Peat is most prevalent at the proposed L-1064 Connector road (Ch. 0+000–Ch. 0+400) and at the beginning of S2.4 (Ch. 0+900–Ch. 1+100) where peat layers lie close to the ground surface and have an average thickness of 1.4 m. A thin layer of peat was identified at a depth ranging from 9.2 m–15.8 mbgl between Ch. 0+600–Ch. 0+750 of the proposed mainline 2.6 road and has an average thickness of 0.4 m.

Alluvium was recorded at mainline 2.6 between Ch. 0+600–Ch. 1+750. The average thickness of these deposits was 8 m, reaching a depth of up to 20 m and consisting of mainly soft sandy SILT with marine and bivalve shell fragments on account of the material deposition derived from the River Swilly.

South-east of the River Swilly, adjacent to mainline 2.3 and Bonagee Tie-In, thin deposits of alluvium were identified ranging from 1.9 m to 4.6 m and an average thickness of 3.5 m. Two localised areas along the S2.4 of the Proposed Development containing alluvium were also identified with a soft SILT layer of thickness 8.7 m noted at Ch. 1+650 and soft clayey SILT of thickness 2.7 m at Ch. 2+800.

Intact bedrock was encountered in the rotary core boreholes at depths varying from 0.7 m to 36.5 mbgl (LKRC2020 at Ch. 0+240 on the Bonagee link where soft soil is present along the length of the link road). In some boreholes, intact bedrock was not encountered in LKCP2215 (mainline 2.6 Ch. 1+050) and LKRC2013 (mainline 2.2 Ch. 1+100) up to depths of 11.20 to 20.50 mbgl.

Bedrock is predominantly described as strong and very strong, locally medium strong thinly foliated grey fine and medium grained Phyllite and/or very strong locally strong brown fine-grained Quartzite.

Bedrock is predominantly described as strong and very strong, locally medium strong thinly foliated grey fine and medium grained Phyllite and/or very strong locally strong brown fine-grained Quartzite.

10.5.2.1 Groundwater

Standpipes were installed in 10 no. exploratory holes to facilitate groundwater monitoring which was carried out over a 16-month period from October 2020 to November 2021. The full suite of groundwater monitoring data is provided in Appendix C10.01.

Groundwater levels are generally reflective of the ground topography, with elevated levels in areas of higher ground and lower levels in the low-lying flood plains of the River Swilly.

In general groundwater levels in the individual boreholes are highest in the winter months and show a fluctuation of 0.5 m – 2 m over the course of a year.

10.5.2.2 Permeability Testing

Permeability testing in the form of a falling head test / rising head testing was carried out on Borehole LKRC4001 to determine the permeability of the subsoil and rock and the ease of groundwater flow through these mediums. Results are presented in Appendix C10.02.

Table 10.29 presents the results of the permeability testing in terms of a value of K and where this value falls in terms of permeability ranges for Irish subsoils (GSI, 2015). Generally, permeability will decrease with depth therefore the subsoil and transition zone will tend to comprise higher permeability values than the shallow or deep bedrock zones.

Table 10.29: Permeability Testing Results-Section 2

Borehole	Permeability, K, m/s (Hydraulic Conductivity)	Permeability Range*	Overburden	Chainage/Cut
LKRC4001	▪ Falling Head: 2.35 x10-6 m/s (0.2 m/d) ▪ Rising Head: 1.8 x10-5 m/s (1.5 m/d)	Moderate	Fine to Medium Gravel	S2.2 Ch. 0+800 Cut 1

Geophysical Surveying – Section 2

Minerex Geophysics Ltd. carried out a geophysical survey consisting of 2D Resistivity, seismic refraction (p-wave) and MASW (s-wave) surveying at eight separate locations between 28 September and 8 October, 2020. The main objectives of the survey were to help determine the ground conditions, the depth to rock head and the overburden thickness, and to estimate the strength/ stiffness/ compaction of the overburden and the rock quality.

The geophysical survey site pertaining to Section 2 was carried out at the River Swilly Crossing North. Five profiles were carried out in Ballyraine along the floodplain, north of the River Swilly. Three profiles were surveyed perpendicular to the river, starting close to the riverbank while two profiles were surveyed parallel to the river. The seismic refraction data was modelled with a four-layer model for all profiles a topsoil layer between 1 and 2.5 m thick (layer 1). A predominantly sand and gravel layer on the higher ground changing to clay and silt rich alluvium towards the river (layer 2) between 1.5 and 3.5 m thick. A weathered rock layer between 1 and 4.5 m thick (layer 3) and a good rock layer 3.5-8.5 mbgl (layer 4).

Rotary Corehole LKRC2001 tie in well with the geophysical interpretation and indicate weathered rock within layer 3 and good rock in layer 4.

10.5.3 Section 3 – N14 Manorcunningham to Lifford/Strabane/A5 Link

A route specific GI was carried out by IDL between the period of June 2020 and September 2021. The purpose of the GI was to provide detailed factual geotechnical information for the underlying ground conditions along the proposed 17 km. This information has been used to establish subsurface conditions along the route and to inform the geotechnical design and soils & geology, including hydrogeology for the route. As of September 2025 it is considered that baseline conditions in the study are not considered to have changed (geologically stable environment) since 2021, there were no major project design changes impacting Soils, Geology or Groundwater and no unexpected conditions were previously identified that require validating of the initial route specific ground investigation (GI) carried out by IDL. The GI comprised:

- 84 no. cable percussion boreholes
- 80 no. rotary core holes
- 208 no. machine dug trial pits
- 8 no. window samples
- 9 no. variable head permeability test
- Groundwater level monitoring
- Geophysical Survey

Other historic site investigations were used to inform the geotechnical design and soils & geology, including hydrogeology for the route include the following:

- Geotech Specialists Limited, N14/N13 Junction, (Manorcunningham) to Lifford/Strabane Scheme. Final Report on Ground Investigation Report No. KD5078, Issue No. 3, Volumes 1-3. 2006.

- Mott MacDonald N14/N13 (Manorcunningham) to Lifford/Strabane Scheme, Additional Ground Investigation Geotechnical Interpretative Report-Volume 2, December 2008 (Factual Ground Investigation and additional volumes unavailable).

- Soil Mechanics, N14-N15 to A5 Link, Factual Report on Ground Investigation. Report No. Y0802, February 2011, including a 'Geophysical Report for the N14-N15 to A5 Link for Environmental Scientifics Group' Project No. AGL 10263, Version 1, by Apex Geoservices Ltd, dated 3 December 2010.Geophysical Survey.

- Minerex Geophysics Ltd. (Project Ref. 6,400, dated 30 October 2020).

- Minerex Geophysics Ltd. (Project Ref. 6,588, dated 5 October 2021).

GI locations are illustrated on the Ground Investigation and Earthworks Plan and Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). Results of the GI show that ground conditions are typical and as expected for this region. They predominantly consist of Topsoil overlying Glacial Tills, overlying Bedrock.

Topsoil was typically recorded from ground surface to a depth of 0.30 m.

Made Ground or Uncontrolled Fill was reported in just six exploratory hole locations and is described as gravelly silty clay to clayey silt with cobbles, boulders, and waste items such as wood, plastic and ash. The thickness of Made Ground encountered ranged from 0.40 m to 2.70 m.

Glacial Till is the most predominant overburden material encountered during the GI throughout Section 3. The glacial deposits encountered comprise a highly variable, stratified mixture of cohesive and granular materials. The boundaries between these material types varies from sharp to gradational both laterally and vertically. A detailed review of the available GI data for the site indicates that, although glacial deposits occur as either 'cohesive' or 'granular', they comprise a heterogenous mixture of materials.

Peat was reported in 25 exploratory hole locations along the Section 3 corridor, being most prevalent within Ch. 5+600 to 8+400 Ch. 11+300 to 12+400 and Ch. 15+200 to 16+100. Deposits were encountered to depths ranging from 0.40 m to 9.60 m, with a median layer thickness of 0.85 m. There are only two boreholes that identify peat deeper than 2.4mBGL, both in Fill 9. In these boreholes, peat at depth is overlain by organic silts and clays; peat is identified from 2.4 – 4.2 and 8.5 – 9.6 mBGL in one borehole, and from 4.6 – 5.5 mBGL in the other. Deposits were typically described as being very soft to soft, black to dark brown, pseudo-fibrous peat. Peat encountered was typically wet or damp and was noted to have incorporated elements of the underlying glacial deposits, including clays, silts and gravels.

Alluvium deposits encountered comprise grey and brown fine-grained soils described as soft silts or clays with varying amounts of sand and gravel and brown/grey loose to medium dense silty sandy gravel. Quantities of peat and other organic matter may also be present. These deposits typically have low strength and exhibit high compressibility characteristics. As such, these deposits are generally considered unsuitable and must be removed and replaced with alternative fill or undergo ground improvement techniques.

Soft silt and clay and loose granular deposits encountered were distributed throughout Section 3 with the most substantial deposits generally located in proximity to existing water courses. Geophysical survey along the A5 link (Ch. 17+540) interpreted up to 45 m of soft silt and clay and loose to medium dense granular deposits in an area extending approximately 300 m from the River Finn. Elsewhere along Section 3, these deposits ranged in thickness from 0.20 m to 4.50 m, with an average thickness of 1.50 m. Significant deposits were encountered in the area of Sheshkinapoll (Ch. 5+900 to 6+900) Ballinalecky Junction (Ch. 7+400 to Ch. 8,100) and the area which straddles the Swilly Burn River (Ch. 10+400 to Ch. 12+800) and at the A5 Link Ch. 17+540)

Bedrock encountered during the Section 3 Ground Investigation included variably weathered phyllite, quartzite, schist, limestone, sandstone and shale. The average reported depth to weathered rock and bedrock was approximately 6.5 m and 11.5 m, respectively.

10.5.3.1 Groundwater

Standpipes were installed in 25 no. exploratory holes (the standpipe in MCL-BHSP-3,113 was removed after installation) to facilitate groundwater monitoring which was carried out over a 16-month period from September 2020 to January 2022. The full suite of groundwater monitoring data is provided in Appendix C10.01. Groundwater levels are generally reflective of the ground topography, with elevated levels in areas of higher ground and lower levels in the low-lying flood plains. In general groundwater levels in the individual boreholes are highest in the winter months and show a fluctuation of 0.5 m – 3 m over the course of a year.

10.5.3.2 Permeability Testing

Permeability testing in the form of a falling head tests to determine the permeability of the subsoil and rock and the ease of groundwater flow through these mediums. Results are presented in Appendix C10.02.

Table 10.30 presents the results of the permeability testing in terms of a value of K and where this value falls in terms of permeability ranges for Irish subsoils (GSI, 2015). Generally, permeability will decrease with depth therefore the subsoil and transition zone will tend to comprise higher permeability values than the shallow or deep bedrock zones.

Table 10.30: Permeability Test Results-Section 3

Borehole	Permeability, K, m/s (Hydraulic Conductivity)	Permeability Range*	Overburden	Chainage/Cut
MCL-SP-3101	Falling Head: 1.8E-8 m/s	Low	Stiff Clay	0+150 Cut 1
MCL-RC-3001	Falling Head: 4.1E-8 m/s	Low	Stiff Clay	Ch. 0+360 Cut 1
MCL-SP-3109	Falling Head: 3.0E-8 m/s)	Low	Stiff Clay	3+950 Cut 3
MCL-SP-3114	Falling Head: 1.4E-5 m/s	Moderate/high	Limestone	Ch. 7+190 Cut 6
MCL-SP-3115	Falling Head: 7.9E-6 m/s	Moderate	Stiff Silt & Phyllite	Ch. 7+640 Fill 6
MCL-SP-3118	Falling Head: 1.2E-5 m/s	Moderate/high	Phyllite	Ch. 10+570 Cut 9
MCL-SP-3123	Falling Head: 2.2E-6 m/s	Moderate	Fine Sand	15+010 Cut 11
MCL-SP-3124	Falling Head: 7.4E-8 m/s	Low	Firm Silt	Ch. 15+280 Cut 11
MCL-SP-3125	Falling Head: 6.6E-7 m/s	Low	Stiff Silt	Ch. 15+380 Cut 11

10.5.3.3 Geophysical Survey

Minerex Geophysics Ltd. (Project Ref. 6,400, dated 30 October 2020) carried out a geophysical survey consisting of 2D Resistivity, seismic refraction (p wave) and MASW (s-wave) surveying for the GI for Section 3 of the Proposed Development at eight locations. The main objectives of the survey were to determine the ground conditions under the site, determine depth to rock head and the overburden thickness and to estimate the strength/stiffness/compaction of the overburden and the rock quality. The location of the geophysical testing is identified in the Ground Investigation and Earthworks Plan and Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). The location of the geophysical testing is identified in the Earthworks Plan Drawings as Location A-E.

Minerex Geophysics Ltd. (Project Ref. 6,588, dated 5 October 2021) carried out a geophysical survey consisting of ten metres spaced 2D Resistivity and Microtremor Array Measurement surveys. Previous geophysical surveys (referenced above) were included in the interpretation for the report. This survey comprised three profiles verified with existing borehole and trial pit data to develop an interpreted ground model. The survey geometry comprised two transects parallel to the river and one perpendicular, the latter in approximate alignment with the proposed A5 link. The location of the geophysical testing is identified in the Ground Investigation and Earthworks Plan and Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3).

10.5.4 Groundwater Protection Risk Assessment

A Groundwater Risk Assessment in accordance with DN-DNG-03065 was carried out to determine the requirement for the provision of sealed road drainage on the Proposed Development. The assessment is based on Method C in the Standard and generates a Response Category as per Table A.4 in Appendix A of the Standard. The results of the assessments are presented in the following sections.

10.5.4.1 Section 1

Table 10.31: Groundwater Protection Response Matrix - Section 1

Sub-Section	Chainage From	Chainage To	Vulnerability GSI Classification	Aquifer GSI Classification	Groundwater Protection Response	Requirement for Sealed Drainage
L-6564 Connector	0+000	1+618	High (H)	PI	R2 (1)	No
Ballybofey Link Road	0+000	0+125	High (H)	PI	R2 (1)	Yes
	0+125	0+400	Extreme (E)	PI	R2 (1)	Yes
	0+400	0+700	High (H)	PI	R2 (1)	Yes
	0+700	1+000	High (H)	PI	R2 (1)	Yes
	1+000	1+1600	High (H)	PI	R2 (1)	Yes
	1+600	2+055	High (H)	PI	R2 (1)	Yes
S1.2	0+000	0+600	High (H)	PI	R2 (1)	Yes
	0+600	0+850	Extreme (E)	PI	R2 (1)	Yes
	0+850	1+600	Extreme (E)	PI	R2 (1)	Yes
	1+600	3+100	High (H)	PI	R2 (1)	No
	3+100	3+200	Extreme (E)	PI	R2 (1)	No
	3+200	3+400	Extreme (X)	PI	R3 (1)	Yes
	3+400	4+000	Extreme (E)	PI	R2 (1)	Yes
	4+000	4+350	Extreme (E)	PI	R2 (1)	No
	4+350	4+400	Extreme (X)	PI	R3 (1)	Yes
	4+400	4+900	Extreme (E)	PI	R2 (1)	No
	4+900	5+025	Extreme (X)	PI	R3 (1)	No
	5+025	5+950	Extreme (E)	PI	R2 (1)	Yes
	5+950	6+500	Extreme (E)	PI	R2 (1)	No
	6+500	7+100	Extreme (E)	PI	R2 (1)	Yes
	7+100	7+450	High (H)	PI	R2 (1)	Yes
	7+450	8+200	High (H)	LI	R2 (2)	Yes
	8+200	8+600	Moderate (M)	LI	R2 (1)	Yes
S1.1 N15 Tie-in South	0+075	0+512	High	PI	R2 (1)	No
N15 PRC	0+000	0+300	Extreme (E)	PI	R2 (1)	Yes
	0+300	2+000	Extreme (E)	PI	R2 (1)	No
	2+000	2+250	High (H)	PI	R2 (1)	No
	2+250	2+550	High (H)	PI	R2 (1)	Yes
	2+550	2+650	Moderate (M)	PI	R1	No

Sub-Section	Chainage From	Chainage To	Vulnerability GSI Classification	Aquifer GSI Classification	Groundwater Protection Response	Requirement for Sealed Drainage
	2+650	2+950	Moderate (M)	PI	R1	No
	2+950	3+775	High (H)	PI	R2 (1)	Yes
N15/N13 Interchange	0+000	0+747	Extreme (E)	PI	R2 (1)	Yes
Northern Tie-in Link Rd	0+000	0+100	Extreme (E)	PI	R2 (1)	Yes
	0+100	0+250	High (H)	PI	R2 (1)	Yes
	0+250	0+500	Moderate (M)	PI	R1	No
	0+500	0+650	Moderate (M)	PI	R1	No
	0+650	0+840	High (H)	PI	R2 (1)	Yes
Northern tie-in Roundabout	0+000	0+250	Moderate (M)	PI	R1	No
	0+250	0+400	High (H)	PI	R2 (1)	No
	0+400	0+534	Moderate (M)	PI	R1	No
S1.3 N13 Tie-in North	0+000	0+075	Moderate (M)	PI	R1	No
	0+075	0+592	High (H)	PI	R2 (1)	Yes
L-7084 Connector	0+000	0+100	Extreme (E)	PI	R2 (1)	Yes
	0+100	0+250	Extreme (E)	PI	R2 (1)	No
	0+250	0+350	Extreme (X)	PI	R3 (1)	Yes
	0+350	0+525	Extreme (E)	PI	R2 (1)	Yes
	0+525	1+050	Extreme (E)	PI	R2 (1)	Yes
	1+050	1+500	Extreme (E)	PI	R2 (1)	No

10.5.4.2 Section 2

Table 10.32: Groundwater Protection Response Matrix - Section 2

Sub-Section	Chainage		Vulnerability	Aquifer GSI Classification	Groundwater Protection Response	Requirement for Sealed Drainage
	From	To	GSI Classification			
S2.6	0+000	0+050	Extreme (E)	LI	R2 (2)	Yes
	0+050	0+200	Extreme (X)	LI	R3 (1)	Yes
	0+200	0+300	Extreme (E)	LI	R2 (2)	Yes
	0+300	0+350	Extreme (X)	LI	R3 (1)	Yes
	0+350	0+500	Extreme (E)	LI	R2 (2)	Yes
	0+500	0+550	High (H)	LI	R2 (2)	Yes
	0+550	1+100	High (H)	LI	R2 (2)	Yes
	1+100	1+403	Moderate (M)	Pu	R1	No
S2.5	0+000	0+075	High (H)	Lg	R2 (2)	No
	0+075	0+564	Extreme (E)	Lg	R3 (2)	Yes
S2.1	0+000	0+250	High (H)	LI	R2 (2)	Yes
S2.2	0+250	0+525	High (H)	LI	R2 (2)	Yes
	0+525	1+650	Extreme (E)	LI	R2 (2)	Yes
	1+650	2+050	High (H)	LI	R2 (2)	Yes
	2+050	2+200	High (H)	LI	R2 (2)	Yes
	2+200	2+365	Extreme (E)	LI	R2 (2)	Yes
S2.4	0+000	0+700	Extreme (E)	LI	R2 (2)	Yes
	0+700	0+800	Extreme (E)	LI	R2 (2)	Yes
	0+800	1+150	High (H)	Pu	R2 (1)	No
	1+150	1+300	Extreme (E)	Pu	R2 (1)	No
	1+300	1+550	Extreme (X)	Pu	R3 (1)	Yes
	1+550	1+625	Extreme (E)	Pu	R2 (1)	No
	1+625	1+800	High (H)	Pu	R2 (1)	No
	1+800	2+000	Extreme (X)	Pu	R3 (1)	Yes
	2+000	2+775	High (H)	Pu	R2 (1)	No
	2+775	3+759	Moderate (M)	Pu	R1	No
S2.3	0+000	0+225	Moderate (M)	LI	R2 (1)	No
	0+225	0+400	High (H)	LI	R2 (2)	Yes
	0+400	0+670	Extreme (E)	LI	R2 (2)	Yes
S2.BL	0+000	0+450	Moderate (M)	Pu	R1	No

10.5.4.3 Section 3

Table 10.33: Groundwater Protection Response Matrix - Section 3

Sub-Section	Chainage		Vulnerability GSI Classification	Aquifer GSI Classification	Groundwater Protection Response	Requirement for Sealed Drainage
	From	To				
N13 Derry Tie-In	0+000	0+452	Moderate (M)	LI	R2(1)	Yes
Mainline	0+000	0+400	Moderate (M)	LI	R2(1)	Yes
Mainline	0+400	0+410	Moderate (M)	LI	R2(1)	No
Mainline	0+410	0+420	Moderate (M)	LI	R2(1)	Yes
Mainline	0+420	0+840	Moderate (M)	LI	R2(1)	No
Mainline	0+840	0+890	Moderate (M)	LI	R2(1)	Yes
Mainline	0+890	0+900	Moderate (M)	LI	R2(1)	Yes
Mainline	0+900	0+950	Moderate (M)	LI	R2(1)	Yes
Mainline	0+950	0+970	High (H)	LI	R2(2)	No
Mainline	0+970	1+110	High (H)	LI	R2(2)	No
Mainline	1+110	1+160	Extreme (E)	LI	R2(2)	No
Mainline	1+160	1+220	Extreme (X)	LI	R3(1)	Yes
Mainline	1+220	1+250	Extreme (E)	LI	R2(2)	No
Mainline	1+250	1+800	High (H)	LI	R2(2)	No
Mainline	1+800	2+300	Extreme (E)	LI	R2(2)	Yes
Mainline	2+300	2+400	Extreme (X)	LI	R3(1)	Yes
Mainline	2+400	2+500	Extreme (E)	LI	R2(2)	No
Mainline	2+500	2+530	Extreme (E)	LI	R2(2)	Yes
Mainline	2+530	2+550	Extreme (E)	LI	R2(2)	No
Mainline	2+550	2+600	Extreme (X)	LI	R3(1)	Yes
Mainline	2+600	2+660	Extreme (E)	LI	R2(2)	No
Mainline	2+660	3+070	High (H)	LI	R2(2)	No
Mainline	3+070	3+700	Moderate (M)	LI	R2(1)	Yes
Mainline	3+700	4+100	Moderate (M)	LI	R2(1)	No
Mainline	4+100	5+200	Moderate (M)	LI	R2(1)	Yes
Mainline	5+200	6+380	High (H)	LI	R2(2)	Yes
Mainline	6+380	6+660	Moderate (M)	LI	R2(1)	Yes
Mainline	6+660	6+670	High (H)	LI	R2(2)	No
Mainline	6+670	6+700	High (H)	LI	R2(2)	Yes
Mainline	6+700	7+110	High (H)	LI	R2(2)	No
Mainline	7+110	7+300	High (H)	LI	R2(2)	Yes
Mainline	7+300	7+320	High (H)	LI	R2(2)	Yes
Mainline	7+320	7+470	High (H)	LI	R2(2)	No
Mainline	7+470	7+860	Moderate (M)	LI	R2(1)	Yes

Sub-Section	Chainage		Vulnerability GSI Classification	Aquifer GSI Classification	Groundwater Protection Response	Requirement for Sealed Drainage
	From	To				
Mainline	7+860	8+170	High (H)	LI	R2(2)	Yes
Mainline	8+170	8+200	Extreme (E)	LI	R2(2)	No
Mainline	8+200	8+220	Extreme (E)	LI	R2(2)	Yes
Mainline	8+220	8+640	Extreme (E)	LI	R2(2)	No
Mainline	8+640	8+900	Extreme (E)	LI	R2(2)	Yes
Mainline	8+900	9+380	Extreme (E)	LI	R2(2)	No
Mainline	9+380	10+010	Extreme (E)	LI	R2(2)	No
Mainline	10+010	10+270	High (H)	LI	R2(2)	No
Mainline	10+270	10+340	Extreme (X)	LI	R3(1)	Yes
Mainline	10+340	10+390	Extreme (E)	LI	R2(2)	Yes
Mainline	10+390	11+180	High (H)	LI	R2(2)	Yes
Mainline	11+180	11+220	High (H)	LI	R2(2)	No
Mainline	11+220	11+230	High (H)	LI	R2(2)	Yes
Mainline	11+230	12+150	Moderate (M)	LI	R2(1)	No
Mainline	12+150	12+180	High (H)	LI	R2(2)	Yes
Mainline	12+180	12+750	High (H)	LI	R2(2)	Yes
Mainline	12+750	14+160	Extreme (E)	LI	R2(2)	Yes
Mainline	14+160	14+240	High (H)	PL	R2(1)	No
Mainline	14+240	14+370	High (H)	LI	R2(2)	No
Mainline	14+370	14+560	High (H)	PL	R2(1)	Yes
Mainline	14+560	14+620	Extreme (E)	PL	R2(1)	No
Mainline	14+620	14+640	Extreme (X)	PL	R3(1)	Yes
Mainline	14+640	14+730	Extreme (E)	PL	R2(1)	No
Mainline	14+730	16+030	High (H)	PL	R2(1)	Yes
Mainline	16+030	16+170	Extreme (E)	PL	R2(1)	Yes
Mainline	16+170	16+360	Extreme (X)	PL	R3(1)	Yes
Mainline	16+360	16+700	Extreme (E)	PL	R2(1)	No
Mainline	16+700	17+350	High (H)	PL	R2(1)	Yes
Mainline	17+350	17+540	Extreme (E)	PL	R2(1)	No
N15 Lifford Tie-In West	0+000	0+083	Extreme (E)	PL	R2(1)	Yes

10.6 Conceptual Site Model

A conceptual site model has been developed with embankment height (average and maximum), cut depth (average and maximum) and the encountered soils and geology based on the GI data. The information is presented in Table 10.34 for Section 1, Table 10.35 for Section 2 and Table 10.36 for Section 3.

Table 10.34: Conceptual Site Model – Section 1

Earthworks Section 1	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock head (mBGL)
S1.1 **(N15 Tie-in South)** **Fill 1**	Ch. 0+120-0+530 410 m	N/A	N/A	4.2	2.9	Gravelly sand and silt with cobbles and boulders	Bedrock not met
S1.2 **Fill 1**	Ch. 0+000-0+150 150 m	N/A	N/A	1.25	0.68	Gravelly, sandy, silt with cobbles and boulders	Bedrock not met
Cut 1	Ch. 0+150-1+000 850 m	7.36	3.70	N/A	N/A	Gravelly, silty sandy clay with cobbles, lenses of peat	4.3
Cut 2	Ch. 1+100-1+600 500m	4.37	2.34	N/A	N/A	Subrounded metamorphic gravel with cobbles	2.5
Fill 2	Ch. 1+600-2+270 670 m	N/A	N/A	15.94	8.22	Sandy, gravelly clay with cobbles	2.65
Fill 3a	Ch. 2+680-2+900 310 m	N/A	N/A	15.21	9.44	Gravelly, sandy silt with cobbles and boulders grading to silty, sandy pelite gravel	1.2
Fill 3b	Ch. 3+040-3+300 260 m	N/A	N/A	17.93	11.80	Silty, sandy, subangular to subrounded coarse psammite and schist gravel	1.5
Cut 3	Ch. 3+300-4+000 700 m	12.01	8.02	N/A	N/A	Gravelly, sandy silt with cobbles and boulders	3.5-11.5
Fill 4	Ch. 4+000-4+950 950 m	N/A	N/A	10.07	4.34	Gravelly, clayey, silt with cobbles and boulders	Bedrock not met
Cut 4	Ch. 4+950-6+000 1,050 m	13.75	7.25	N/A	N/A	Gravelly, silty clay with cobbles and boulders	2.0-4.0
Fill 5	Ch. 6+000-6+550 550 m	N/A	N/A	9.13	5.37	Gravelly, sandy silt and gravelly silty sand with cobbles	2.7
Cut 5	Ch. 6+550-7+450 900 m	13.52	7.42	N/A	N/A	Gravelly, silty sand with cobbles and boulders	2.5

Earthworks Section 1	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock head (mBGL)
Fill 6	Ch. 7+450-8+550 1,100 m	N/A	N/A	2.88	1.93	Gravelly, sandy silt with cobbles and boulders	3.6
S1.3 (N13 Tie-in North) Fill 1	Ch. 0+000-0+430 430 m	N/A	N/A	3.65	2.32	Sandy gravelly clay with cobbles	Bedrock not met
S1.PRC Cut 1	Ch. 0+000-0+300 300 m	3.40	2.29	N/A	N/A	Silty Sand and sandy clay with cobbles	3.00
Fill 1	Ch.0+300-1+300 1,000 m	N/A	N/A	10.65	5.79	Gravelly, sandy clay with cobbles and boulders	Bedrock not met
Fill 1	Ch.1+300-2+250 950 m	N/A	N/A	7.91	4.9	Gravelly, sandy silt with cobbles and boulders with fine to coarse gravel	3.5
Cut 2	Ch.2+250-2+900 650 m	5.20	3.43	N/A	N/A	Fine to coarse subangular metamorphic gravel	7.5
Fill 3	Ch.2+900-3+085 185 m	N/A	N/A	2.55	2.053	Gravelly, sandy silt and silty gravelly sand with cobbles and boulders	4.5

Table 10.35: Conceptual Site Model – Section 2

Earthworks Section 2	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock Head (mBGL)
S2.1 **Cut 1**	Ch. 0+050-0+250 200 m	3.1	1.6	N/A	N/A	Angular to subangular, fine to medium to coarse metamorphic gravelly clay/silt or silty gravel with cobbles and boulders.	2.6
S2.2 **Cut 1(a-e)**	Ch. 0+250-2+364 2,114 m	9.6	5.2	N/A	N/A	Subrounded to subangular, fine to medium to coarse metamorphic gravel with clay	3.0-5.0
S2.6 River Swilly Link **Fill 1**	Ch. 0+150-0+220 70 m	N/A	N/A	0.70	0.42	Subrounded to subangular, fine to medium to coarse metamorphic gravel with cobbles	2.7-3.0
Cut 1	Ch. 0+220-0+350 130 m	5.06	2.62	N/A	N/A	Fine to coarse metamorphic gravel with cobbles and boulders	2.7-5.3
Fill 2	Ch. 0+350-0+450 100 m	N/A	N/A	7.79	4.83	Fine to coarse metamorphic gravel with cobbles and boulders	19.00
Fill 3	Ch. 0+600-0+980 380 m	N/A	N/A	7.79	4.83	Fine to coarse metamorphic gravel with cobbles and boulders	19.00
Fill 4	Ch. 0+980-1+403 423 m	N/A	N/A	7.79	4.83	Fine to coarse metamorphic gravel with cobbles and boulders	19.00
S2.5 **Fill 1**	Ch. 0+000-0+564 564 m	N/A	N/A	13.31	8.49	Sandy silt with lenses of peat overlying subrounded to subangular fine to coarse metamorphic gravel	19.00
S2.BL **Fill 1**	Ch. 0+000-0+450 450 m	N/A	N/A	10.87	6.22	Slightly sandy silt with lenses of peat	32.00
S2.3 **Fill 1**	Ch. 0+350-0+668 318 m	N/A	N/A	1.49	1.21	Silty, gravelly sand with cobbles and boulders	1.6

Table 10.36: Conceptual Site Model – Section 3

Earthworks Section 3	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock Head (mBGL)
Cut 1	Ch. 0-410 410 m	19.6	12.4	0.7	N/A	Firm to stiff cohesive glacial till tending to a more granular glacial till with depth.	21.0-22.0
Fill 1	Ch. 410-1330 920 m	1.5	N/A	10.2	6.6	Soft to firm alluvial deposits to firm to stiff cohesive glacial tills. Granular glacial till is also encountered towards the eastern end.	10.3
Cut 2	Ch. 1330-1750 420 m	10.0	6.8	0.2	N/A	Firm to very stiff cohesive glacial till.	>16.0
Fill 2	Ch. 1750-3530 1,780 m	2.0	N/A	14.2	10.2	Generally firm to stiff cohesive or granular glacial till. Localised sections of soft to very soft cohesive deposits are also present.	2.5->25.5
Cut 3	Ch. 3530-4070 540 m	15.2	11.3	0.5	N/A	Soft to firm cohesive glacial till tending to firm cohesive glacial till with lenses of granular glacial till.	>21.0
Fill 3	Ch. 4070-4610 540 m	0.2	N/A	8.8	5.1	Soft alluvial material overlying firm to stiff cohesive and granular glacial till.	12-16.2
Cut 4	Ch. 4610-5250 640 m	11.5	7.5	0.6	N/A	Soft to very stiff with depth cohesive and granular glacial till.	37.6-39.0
Fill 4	Ch. 5250-5830 580 m	0.2	N/A	4.1	2.4	Soft to firm alluvial material to overlying firm to stiff cohesive and granular glacial till.	39.0
Cut 5	Ch. 5830-6450 620 m	7.6	4.1	0.9	N/A	Granular glacial till and soft to firm cohesive glacial till tending to firm to stiff cohesive glacial till with depth. Peat was reported in the upper one metre in sections of the cutting.	35-46.5

Earthworks Section 3	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock Head (mBGL)
Fill 5	Ch. 6450-7110 660 m	0.1	N/A	3.4	1.4	Soft to firm alluvial material to overlying firm to stiff cohesive/granular glacial till and weathered rock.	1.4 - >4.5
Cut 6	Ch. 7110-7310 200 m	5.7	3.2	2.2	N/A	soft to firm cohesive glacial till tending to stiff to very stiff cohesive glacial till with depth.	5.6
Fill 6	Ch. 7310-7690 380 m	0.4	N/A	4.7	2.1	Soft to firm alluvial material overlying firm to stiff cohesive/granular glacial till.	43.3
Cut 7	Ch. 7690-8070 380 m	2.6	1.3	1.4	0.1	soft to firm cohesive glacial till (sandy gravelly CLAY with low cobble content).	>8.0
Fill 7	Ch. 8070-8590 520 m	0.2	N/A	2.8	0.7	Firm to stiff cohesive material underlain by granular glacial till until bedrock. Some localised areas of peat/soft cohesive material.	0.95->4.8
Cut 8	Ch. 8590-8930 340 m	8.4	4.5	0	N/A	Firm to stiff cohesive glacial till tending to granular glacial till and weathered rock material.	1.4-3.4
Fill 8	Ch. 8930-10170 1.240 m	1.4	N/A	11.8	4.8	Soft to firm cohesive material (recorded up to 3.0m bgl) overlying firm to stiff cohesive glacial tills and/or granular glacial till over bedrock.	2.5->5.0
Cut 9	Ch.10170-11010 840 m	6.9	4.4	2.1	N/A	Soft to firm increasing to stiff very stiff cohesive glacial till. Rock is expected in the cutting from approx. Ch.10+540 to Ch.10+720.	3.9-19.6
Fill 9	Ch.11010-12470 1,460 m	0.1	N/A	8.8	4.6	Soft interbedded organic silts/clays and peat (recorded to depths of up to 9.6 m bgl) underlain by firm to stiff cohesive material or sand and gravel until bedrock.	12.0->36.0

Earthworks Section 3	Chainage & Length	Max Cut (m)	Average Cut (m)	Max Fill (m)	Average Fill (m)	Generalised Soils and Geological Description	Average Depth to Rock Head (mBGL)
Cut 10	Ch.12470-13950 1,480 m	9.8	5.1	0.6	N/A	Granular glacial till and soft to firm cohesive glacial till tending to firm to stiff cohesive glacial till with depth. Rock is expected in the cutting from approx. Ch.12+860 to Ch.13+920.	3.2-4.6
Fill 10	Ch.13950-14970 1,480 m	0.7	N/A	16.6	8.1	Firm cohesive material underlain by sand and gravels to bedrock apart from both north and south of the Deele River which comprises soft alluvial material (recorded depths of up to six metres bgl)	1.2-19.2
Cut 11	Ch. 14970-16610 1,640 m	19.1	7.4	1.7	N/A	Granular glacial till and soft to firm cohesive glacial till tending to firm to stiff cohesive glacial till with depth. Rock is expected in the cutting from approx. Ch.15+360 to Ch.15+420 and Ch.16+040 to Ch.16+440.	0.8 -15.5
Fill 11	Ch. 16610-17540 930 m	1.1	N/A	3.7	1.4	Generally, comprises firm to stiff cohesive glacial till or medium dense to dense granular glacial till until bedrock. Localised sections of soft cohesive deposits are also present.	2.8-7.9
A5 Link	Ch. 0-306 306 m	0	N/A	13.6	9.2	Interbedded very soft to soft organic silts and loose organic sands to 21 m, firm to stiff clays to 28 m, very dense sands and gravels to rockhead which ranges in depth from 30-50 m bgl.	30.0-50.0

10.7 Potential Impacts

10.7.1 Characteristics of the Proposed Development likely to result in significant effects on the geological and hydrogeological environment

The impact assessment is based on the preliminary design and specifically the geotechnical design as set out in the Geotechnical Design Report for the Proposed Development.

The Ground Investigation and Earthworks Plan and Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3) are also a useful reference to review the alignment in the context of ground conditions as revealed by the GI.

The Proposed Development will result in the following construction activities:

- Cut excavation
- Embankment construction
- Overburden & rock slope construction
- Importation of fill. Exportation and disposal of unsuitable soils
- Reuse and processing of site won material
- Excavation of areas to be used as material extraction and deposition areas
- Foundations for structures (pad and piled foundations at river crossings)
- Disturbance of soft soil and peat
- Dewatering/Drainage activities

The Proposed Development will impact on the quaternary, geological and hydrogeological environments through these activities. This is an unavoidable consequence. The extent of impact is quantified in the earthworks schedules (as set out in Sections 10.7.1.1 - 10.7.1.3 - Causes of Impacts) showing the extent of cut, fills, rock excavation and soft soils in the vicinity of river crossings.

Cuttings are formed when the Proposed Development is below the existing ground level. The material within the cutting will be either reused on site, stored or moved elsewhere. The material will be generally used in the formation of embankments. It must comply with material properties and constituents as outlined in the TII Series 600 Earthworks Specification. Of the material that will not be suitable for reuse, some may require treatment, and some will be deemed unsuitable. Unsuitable material will be deposited in Material Extraction and Deposition Areas (MED) or used as landscape fill. Mitigation for managing of unsuitable material is addressed under Section 10.8.1.1 Subsoil & Bedrock Removal.

In these areas of cut, the routes (for Section 1, 2 and 3) have the potential to impact on the hydrogeological environment through hydraulic impact (i.e. change in water levels, supply, flow rates and flow regime) or hydrochemical impact (change in water chemistry or water quality where artificial contaminants may be released into the water environment).

Groundwater flow to domestic wells could be affected due to excavations and cuts, and groundwater chemistry could be impacted by introduced contaminants.

These mechanisms of impact are discussed in the context of different causes of impact and in the context of sensitive receptors and attributes of importance (See Section 10.7.3).

Earthworks Quantities

Earthworks volumes have been derived from the existing ground profile and incorporating the earthworks design and are summarised in Table 10.37, Table 10.38 and Table 10.39.

10.7.1.1 Section 1 – Causes of Impacts

Earthworks

The cut and fill earthworks will change the overburden thickness along the alignment of the Proposed Development. This will alter the existing groundwater protection to the underlying aquifer (vulnerability). In fill areas, the groundwater protection will be increased and in cut areas, the level of protection afforded to groundwater will be reduced. The profile of the Proposed Development is presented in the Ground Investigation and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). Table 10.37 summarises the cut and fill elements. The groundwater vulnerability along the route is Extreme to High on the most part. The longest and deepest cut is Cut 4 at 1.05 km in length and 13.75 m deep between Ch. 4+950–Ch.6+000. In areas where cut levels are below the water table, there will be an alteration in the groundwater flow regime. The water table will be directly impacted. These areas are summarised in Table 10.37.

Excavation of Soft Soils & Peat

Deposits of soft soils and peat underlying the Proposed Development will require excavation and replacement with suitable fill materials. Deposits of soft soils and peat identified are summarised in Table 10.38. Due to its compressibility and high moisture content, this material is not suitable for reuse in earthworks and may have to be deposited in Material Extraction and Deposition Areas or off site.

Rock Excavation

Rock excavation will be required where cuttings are greater than the depth to bedrock. Areas where rock excavation has been identified as required are summarised in Table 10.39.

Material Extraction and Deposition Areas

Material extraction and deposition areas are summarised in Table 10.40 which identifies each material extraction and deposition area, its earthwork section, location in terms of approximate chainage and the estimated volume of extraction, where applicable). There are a total of sixteen deposition areas located within the Section 1 Compulsory Purchase Order (CPO) boundary and the location of these deposition areas will be in close proximity to the permanent works in areas with the least environmental/ ecological impact. The proposed deposition areas are intended to provide sufficient capacity to cater for surplus material.

There is one material extraction area located within the Section 1 route corridor, south of the River Finn. This material extraction area has been proposed to cater for the approach embankment leading up to the River Finn so as to mitigate the need for haulage across the river to construct the southern embankment. The material extraction area has an average depth of 8m and an estimated volume recovery of 104,000 to 120,000m^3. Volumes have been estimated based on the proposed road levels. However, if additional material is required the contractor may advance deeper to win more suitable material for construction. Similarly, deposition area height has been estimated based on the proposed ground level. The impacts of material extraction and deposition areas is addressed in terms of overburden removal and bedrock removal under Construction Phase Impacts.

Excavation works for Drainage Design

The drainage design, consisting of a primary mainline conveyance system and secondary attenuation is outlined in Chapter 4: Project Description. The drainage system has been designed to provide protection for the receiving environment from pollutants generated in surface water runoff from carriageways.

Shallow ground excavations are required to install the proposed drainage system for the route.

Table 10.37: Earthworks Cut & Fill Details- Section 1

Earthworks Section	Chainage		Length	Average Depth / Height (m)	Max Depth / Height (m)	Chainage @ Max Depth / Height	Impact on Water Table
	Start	End					
S1.1 (N15 Tie-in South) Fill 1	0+050	0+450	400	2.9	4.2	0+300	n/a
S1.2 Fill 1	0+000	0+150	150	0.68	1.25	0+000	n/a
Cut 1	0+150	1+000	850	3.7	7.36	0+680	Yes. Cut level is below the water table Estimated drawdown of 4.8 m required at Ch. 0+480
Cut 2	1+100	1+600	500	2.34	4.37	1+280	Yes. Cut level is below the water table Estimated drawdown of 2.7 m required at Ch. 1+300
Fill 2	1+600	2+270	670	8.22	15.94	2+180	n/a
Fill 3a	2+680	2+990	310	9.44	15.21	2+940	n/a
Fill 3b	3+040	3+300	260	11.80	17.93	3+040	n/a
Cut 3	3+300	4+000	700	8.02	12.01	3+540	Yes. Cut level is below the water table Estimated drawdown of 4.5 m required at Ch.3+400
Fill 4	4+000	4+950	950	4.34	10.07	4+140	n/a
Cut 4	4+950	6+000	1,050	7.25	13.75	5+600	Yes. Cut level is below the water table Estimated drawdown of 12.4 m required at Ch.5+600
Fill 5	6+000	6+550	550	5.37	9.13	6+630	n/a

Earthworks Section	Chainage		Length	Average Depth / Height (m)	Max Depth / Height (m)	Chainage @ Max Depth / Height	Impact on Water Table
	Start	End					
Cut 5	6+550	7+450	900	7.42	13.52	6+880	Yes. Cut level is below the water table Estimated drawdown of 13.48 m required at Ch.6+840
Fill 6	7+450	8+550	1,100	1.93	2.883	7+740	n/a
S1.3 (N13 Tie-in North) Fill 1	0+000	0+300	300	2.32	3.65	0+100	n/a
Cut 1	0+300	0+500	200	0.68	1.231	0+300	
S1.PRC Cut 1	0+000	0+300	300	2.29	3.408	0+120	No groundwater data available
Fill 1	0+300	1+300	100	5.79	10.655	0+760	n/a
Fill 2	1+300	2+250	950	4.9	7.91	1+520	n/a
Cut 2	2+250	2+900	650	3.43	5.20	2+680	Yes. Cut level is below the water table Estimated drawdown of 4.07 m required at Ch.2+600
Fill 3	2+900	3+085	185	2.053	2.548	3+080	n/a

Table 10.38: Deposits of Soft Soils & Peat Underlying Section 1

Sub-Section	Earthworks Section	Chainage		Material	Deposit Thickness	
		From	To		Typical (m)	Max (m)
L-6564		0+450	1+150	Peat	0.4	1.0
S1.1 N15 Tie-in South		0+00	0+250	Peat	1.1	1.1
Ballybofey Link Rd		1+600	1+700	Peat	0.4	0.4
S1.2	Fill 1	0+200	0+300	Soft Cohesive	2.00	2.40
	Cut 1	0+800	1+000	Peat	0.50	0.50
	Cut 2	1+000	1+600	Soft Cohesive	1.0	1.7
	Fill 2/3	1+700	2+400	Soft Cohesive	1.0	2.1
	Fill 3	2+700	2+900	Soft Cohesive	1.1	1.3
	Cut 3	3+200	4+100	Soft Cohesive	0.30	4.5
	Cut 4	5+800	6+000	Soft Cohesive	0.50	2.1
	Fill 4	6+250	6+450	Peat	0.80	1.80
	Cut 5	6+550	6+660	Soft Cohesive	1.20	2.90
		6+900	7+100	Soft Cohesive	0.60	2.20
		7+300	7+400	Soft Cohesive	1.10	1.4
	Fill 5	7+700	7+900	Peat	0.80	1.50
		7+900	8+100	Soft Cohesive	0.50	1.80
		8+200	8+400	Peat	0.5	0.5
L-6584 Connector		0+000	0+225	Soft Cohesive	1.0	1.0
L-7084 Connector		0+100	0+250	Peat	0.4	0.4
		1+350	1+500	Peat	0.6	0.6

Note: Max deposit is anticipated to be thicker however, the excavation will be halted at this depth and the remaining soft ground will be surcharged

Table 10.39: Anticipated Rock Excavation Along Section 1

Earthworks Section	Chainage		Bedrock	Deposit Thickness	
	From	To		Typical (m)	Max (m)
S.1.2 **Cut 1**	0+300	0+650	Phylitte	3.7	7.36
Cut 2	1+200	1+550	Phylitte	2.34	4.37
Cut 4	5+250	5+800	Phylitte &Quartzite	7.25	13.75
Cut 5	6+650	7+250	Quartzite	7.42	13.52
S1.PRC					
Ballybofey Link Road	0+000	0+650	Phylitte	4.43	7.56
Ballybofey Interchange	0+000	0+325	Phylitte	6.62	8.67
Teevickmoy Interchange	0+050	0+400	Phylitte	3.74	9.08

Table 10.40: Potential Material Extraction and Deposition Areas - Section 1

Material Extraction and Deposition Area	Earthworks Section	Approx. Chainage	Estimated Extraction Volume (m^3)
S1.MED01	Cut 2	1+600	104,000
S1.MED03	L-2794 Connector	0+150–0+200	N/A
S1.MED04	S1.2 Fill 2	1+800–1+850	N/A
S1.MED05	S1.2 Fill 2	2+000–2+100	N/A
S1.MED06	S1.2 Cut 3	3+950–4+050	N/A
S1.MED07	L-2734 Tie-in	0+050–0+150	N/A
S1.MED08	L-2734 Tie-in	0+200–0+250	N/A
S1.MED09	L-2724 Connector	0+150–0+250	N/A
S1.MED10	S1.2 Fill 6	8+100–8+200	N/A
S1.MED11	S1.2 Fill 6	8+350–8+600	N/A
S1.MED12	LX-1011 Connector	0+050–0+250	N/A
S1.MED13	L-6674 Connector	0+150–0+250	N/A
S1.MED14	LX-1004	0+000–0+100	N/A
S1.MED15	Primary Road Connector	1+350–1+550	N/A
S1.MED17	L-7084 Connector	0+850–0+950	N/A

Note : Additional potential material extraction and deposition areas S1.MED02 and S1.MED16 were identified and have been excluded from this impact assessment, as they were deemed unsuitable

10.7.1.2 Section 2 – Causes of Impacts

Earthworks

The cut and fill earthworks will change the overburden thickness along the line of the Proposed Development. This will alter the existing groundwater protection to the underlying aquifer (vulnerability). In fill areas, the groundwater protection will be increased and in cut areas, the level of protection afforded to groundwater will be reduced. The profile of the Proposed Development is presented in the Ground Investigation and Earthworks Plan and Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). Table 10.41 summarises the cut and fill elements. The groundwater vulnerability along the route is Extreme to High for the most part.

The longest cut is S2.2 Cut 1 at 2.11 km in length, which also comprises the deepest cut of 9.6 m at Ch. 0+250–Ch.2+364. In areas where cut levels are below the water table there will be an alteration in the groundwater flow regime. The water table will be directly impacted in this area.

Excavation of Soft Soils & Peat

Deposits of soft soils and peat underlying the Proposed Development will require excavation and replacement with suitable fill materials. Deposits of soft soils and peat identified are summarised in Table 10.42. Due to its compressibility and high moisture content, this material is not suitable for reuse in earthworks and will be disposed in Material Extraction and Deposition Areas or off site.

Rock Excavation

Rock excavation will be required where cuttings are greater than the depth to bedrock. Areas where rock excavation has been identified as required are summarised in Table 10.43.

Material Extraction and Deposition Areas

Material extraction and deposition areas have also been proposed as sources of additional material and/or temporary deposition areas for excess earthworks materials. Areas where these have been proposed are summarised in Table 10.44, which identifies each material extraction and deposition area, its earthwork section, location in terms of approximate chainage and the estimated volume of extraction, where applicable)**.**There is a total of seven deposition areas located within the Section 2 CPO boundary and the location of these deposition areas will be in close proximity to the permanent works in areas with the least environmental/ ecological impact. The proposed deposition areas are intended to provide sufficient capacity to cater for surplus material.

There are sixteen material extraction areas located within the section 2 route corridor (as set out in Table 10.44). The material extraction areas have been proposed to cater for the deficit of suitable material within the earthworks balance. The depth of material extraction areas ranges from 1m to 8m and have a total estimated volume recovery of 687,500 to 790,000 m^3. Volumes have been estimated based on the proposed road levels. However, if additional material is required the contractor may advance deeper to win more suitable material for construction. Similarly, deposition area height has been estimated based on the proposed ground level. The impacts of material extraction and deposition areas is addressed in terms of overburden removal and bedrock removal under Construction Phase Impacts.

Excavation Works for Drainage Design

The drainage design, consisting of a primary mainline conveyance system and secondary attenuation is outlined in Chapter 4: Project Description. The drainage system has been designed to provide protection for the receiving environment from pollutants generated in surface water runoff from carriageways.

Shallow ground excavations are required to install the proposed drainage system for the route.

Table 10.41: Earthworks Cut & Fill Details- Section 2

Earthworks Section	Chainage		Length	Average Depth / Height (m)	Max Depth / Height (m)	Chainage @ Max Depth / Height	Impact on Water Table
	Start	End					
S2.1 Cut 1	0+050	0+245	200	1.6	3.1	0+200	Minimal impact on water level anticipated Estimated drawdown of 0.7 m required at Ch. 0+200
S2.2 Cut 1	0+245	2+364	2,114	5.2	9.6	1+900	Yes, water table will be impacted Estimated drawdown of 7.64 m required at Ch. 1+060
S2.6 Fill 1	0+150	0+220	70	0.42	0.7	0+200	n/a
Cut 1	0+220	0+350	130	2.62	5.06	0+300	No groundwater data available
Fill 2	0+350	0+450	100	4.83	7.79	0+460	n/a
Fill 3	0+600	0+980	380	6.31	7.2	0+600	n/a
Fill 4	0+980	1+403	423	7.7	11.2	1+380	n/a
S2.5 Fill 1	0+000	0+564	564	8.49	13.31	0+280	n/a
S2.BL Fill 1	0+000	0+450	450	6.22	10.87	0+420	n/a
S2.3 Fill 1	0+350	0+670	320	1.215	1.489	0+520	n/a

Table 10.42: Deposits of Soft Soils & Peat Underlying Section 2

Earthworks Section	Chainage	Material	Deposit Thickness	
	From To		Typical (m)	Max (m)
S2.2 Cut 1	0+5000+800	Soft	0.60	1.40
	1+0001+200	Soft	2.30	2.30
	1+4001+500	Soft	0.60	0.60
	2+0002+100	Soft	1.00	1.00
	2+2002+290	Soft	0.70	0.70
S2.4 At Grade	0+9001+100	Peat	0.30	0.30
	1+1001+300	Soft	2.20	1.65
	2+4002+600	Soft	0.20	0.2
S2.6 At Grade Fill 3	0+1000+200	Soft	0.40	1.60
	0+6500+750	Peat	0.4	0.5
	0+7501+403	Soft	3.30	4.70
S2.5 Fill 1	0+0000+564	Soft	3.30	4.70
S2.3	0+1000+250	Soft	1.90	1.90
S2.BL Fill	0+0000+440	Soft	1.20	1.20
L-1,064 Connector	0+0000+400	Peat	1.5	2.0
L-11,141 Connector	0+9001+150	Soft	4.4	4.4

*Note: Max deposit is anticipated to be thicker. However, the excavation will be halted at this depth and the remaining soft ground will be surcharged.

Table 10.43: Anticipated Rock Excavation - Section 2

Earthworks Section	Chainage		Bedrock	Deposit Thickness	
	From	To		Typical (m)	Max (m)
S2.2 Cut 1	0+800	0+1800	Semi-pelitic schists with units of psammite and marble	5.2	9.6
	2+100	2+2290	Fine grained Quartzite		

Table 10.44: Potential Material Extraction and Deposition Areas - Section 2

Material Extraction and Deposition Area	Earthworks Section	Approx. Chainage	Estimated Extraction Volume (m^3)
S2.MED01	S2.2 Cut 1	0+200	17,000
S2.MED02	S2.2 Cut 1	0+250	8,000
S2.MED03	S2.2 Cut 1	0+450	4,000
S2.MED04	S2.2 Cut 1	0+700	25,000
S2.MED05	S2.2 Cut 1	0+800	87,000
S2.MED06	S2.2 Cut 1	1+200	2,000
S2.MED07	S2.2 Cut 1	1+250	24,000
S2.MED08	S2.2 Cut 1	1+900	18,000
S2.MED09	S2.2 Cut 1	2+200	11,000
S2.MED10	S2.2 Cut 1	2+250	18,000
S2.MED11	S2.6 Cut 1	0+300	11,000
S2.MED12	S2.4 AG1	0+750	1,500
S2.MED13	S2.4 AG1	1+200	2,000
S2.MED14	S2.4 AG1	1+150	38,000
S2.MED15	S2.2 Cut 1	0+900	112,000
S2.MED16	S2.4 AG1	0+900	285,000
S2.MED17	S2.6 Fill 1	0+150	N/A
S2.MED19	S2.5 Fill 1	0+200	N/A
S2.MED21	S2.BL	0+150	N/A
S2.MED22	L-1064 Connector	0+150	N/A
S2.MED23	L-1064 Connector	0+200	N/A

Note : Additional potential material extraction and deposition areas S2.MED18 and S2.MED20 were identified and have been excluded from this impact assessment, as they were deemed unsuitable

10.7.1.3 Section 3- Causes of Impacts

Earthworks

The cut and fill earthworks will alter the overburden thickness along the line of the Proposed Development, which will change the existing groundwater protection to the underlying aquifer (vulnerability). The profile of the Proposed Development is presented in the Ground Investigation and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3). Table 10.45 summarises the cut and fill elements along the Proposed Development and lists the pre-construction vulnerability classification along the Proposed Development. The longest cut is Cut 11 at 1.64 km in length, while the deepest cut is 19.1 m at Ch. 15+380 in Cut 11. Where the cut is below the water table there will be an alteration in the groundwater flow regime as a result of the dewatering via drainage.

Excavation of Soft Soils & Peat

Deposits of soft soils and peat underlying the Proposed Development will require excavation and replacement with suitable fill materials. Deposits of soft soils and peat identified are summarised in Table 10.46.

Rock Excavation

Rock excavation will be required where cuttings are greater than the depth to bedrock. Areas where rock excavation has been identified as required are summarised in Table 10.47.

Material Extraction and Deposition Areas

Material extraction and deposition areas have been proposed as sources of additional material and/or deposition areas for excess earthworks materials. Areas where these have been proposed are summarised in Table 10.48 which identifies each material extraction and deposition area, its earthwork section and location in terms of approximate chainage). The impacts of material extraction and deposition areas is addressed in terms of overburden removal and bedrock removal under Construction Phase Impacts.

Excavation Works for Drainage Design

The drainage design, consisting of a primary mainline conveyance system and secondary attenuation is outlined in Chapter 4: Project Description. The drainage system has been designed to provide protection for the receiving environment from pollutants generated in surface water runoff from carriageways.

Shallow ground excavations are required to install the proposed drainage system for the route.

Table 10.45: Earthworks Cut & Fill Details

Earthworks Section	Chainage		Average Depth / Height (m)	Max Depth / Height (m)	Chainage Max Depth / Height	Impact on Water Table?
	From	To				
Cut 1	0+000	0+410	12.4	19.6	0+200	Yes
Fill 1	0+410	1+330	10.2	6.6	1+100	No
Cut 2	1+330	1+750	10	6.8	1+500	Yes
Fill 2	1+750	3+530	14.2	10.2	3+280	No
Cut 3	3+530	4+070	15.2	11.3	3+900	Yes
Fill 3	4+070	4+610	8.8	5.1	4+440	No
Cut 4	4+610	5+250	11.5	7.5	4+640	Yes
Fill 4	5+250	5+830	4.1	2.4	5+720	No
Cut 5	5+830	6+450	7.6	4.1	6+040	Yes
Fill 5	6+450	7+110	3.4	1.4	6+820	No

Earthworks Section	Chainage		Average Depth / Height (m)	Max Depth / Height (m)	Chainage Max Depth / Height	Impact on Water Table?
	From	To				
Cut 6	7+110	7+310	5.7	3.2	7+240	Yes
Fill 6	7+310	7+690	4.7	2.1	7+420	No
Cut 7	7+690	8+070	2.6	1.3	7+780	No
Fill 7	8+070	8+590	2.8	0.7	8+540	No
Cut 8	8+590	8+930	8.4	4.5	8+780	Yes
Fill 8	8+930	10+170	11.8	4.8	9+860	No
Cut 9	10+170	11+010	6.9	4.4	10+620	Yes
Fill 9	11+010	12+470	8.8	4.6	12+140	No
Cut 10	12+470	13+950	9.8	5.1	13+440	Yes
Fill 10	13+950	14+970	16.6	8.1	14+580	No
Cut 11	14+970	16+610	19.1	7.4	15+380	Yes
Fill 11	16+610	17+540	3.7	1.4	16+760	No

Table 10.46: Deposits of Soft Soils & Peat underlying Section 3

Earthworks Section	Chainage		Material	Deposit Thickness	
	From	To		Typical (m)	Max (m)
Fill 1	0+420	0+660	Soft cohesive	1.25	2.00
	0+780	0+860	Soft cohesive	0.50	0.50
	0+980	1+100	Soft cohesive	0.50	0.50
Fill 2	2+100	2+300	Soft cohesive	0.50	0.50
	2+800	3+080	Soft cohesive	0.55	0.60
Fill 3	4+260	4+580	Soft cohesive	0.50	0.60
Fill 4	5+260	5+320	Soft cohesive	0.60	1.00
	5+500	5+800	Peat	0.70	1.60
Fill 5	6+540	6+660	Soft cohesive	0.60	1.60
	6+760	6+960	Peat	1.00	2.00
Cut 7 / Fill 7	8+060	8+440	Peat	0.65	0.80
Fill 8	8+940	9+000	Soft cohesive	0.90	1.30
Fill 9	11+020	12+440	Soft cohesive & Peat	0.50	4.00 *
Fill 10	14+200	14+620	Soft cohesive	2.00	4.00 *
Fill 11	16+620	17+020	Soft cohesive	2.30	3.00
	17+360	17+540	Soft cohesive	0.45	0.60
A5 Link	0	360	Soft Alluvium	21	25

*Note: Max deposit is anticipated to be thicker however, the excavation will be halted at this depth and the remaining soft ground will be surcharged.

Table 10.47: Anticipated Rock Excavation Along Section 3

Earthworks Section Chainage	Bedrock		Rock Excavation	
	From	To		
Cut 6	7+160	7+260	Limestone	Minimal rock excavation required
Fill 7 / Cut 8	8+580	8+920	Phyllite, Metalimestone & Shale	Relatively high proportion of rock in the cutting
Cut 9	10+540	10+720	Phyllite & Metasandstone	Moderate proportion of rock in the cutting
Cut 10	12+860	13+920	Phyllite & Shale	Relatively high proportion of rock in the cutting
Cut 11	15+360	15+420	Phyllite, Quartzite & Marble	Relatively high proportion of rock in the cutting
	16+040	16+440	Phyllite, Quartzite & Marble	Relatively high proportion of rock in the cutting

Table 10.48: Proposed Material Extraction and Deposition Areas - Section 3

Material Extraction and Deposition Area	Earthworks Section	Approx. Chainage
S3.MED01	Fill 2	Section 3 - Ch.2+360 – Ch.2+520
S3.MED02	Cut 8	Section 3 - Ch.8+700 – CH.8+900
S3.MED03	Cut 10	Section 3 - Ch.12+800 – Ch.13+020
S3.MED04	Cut 10	Section 3 - Ch.13+120 – Ch.13+240
S3.MED05	Cut 10	Section 3 - Ch.13+640 – Ch.13+740
S3.MED06	Cut 10	Section 3 - Ch.13+780 – Ch.13+900
S3.MED07	Cut 11	Section 3 - Ch.15+300
S3.MED08	Cut 11	Section 3 - Ch.16+000
S3.MED09	Cut 11	Section 3 - Ch.16+200

10.7.2 Do Nothing

10.7.2.1 Section 1, 2, 3

In the event that the Proposed Development is not constructed, there would be no resulting impacts on the Soils, Geology, or Hydrogeology along the Proposed Development. However, in the absence of the Proposed Development traffic density will continue to increase on the existing road network, resulting in localised and small scale project wide negative impacts on the land, soils and groundwater environment within the study area. This increased traffic may result in increased fuel run-off and additional accidental spillages due to vehicle crashes. Currently, the runoff from the existing road drains is untreated.

10.7.3 Construction Phase Impacts

10.7.3.1 Section 1

Soils and Geology

Importation of Road Construction Materials

It is not anticipated that there will be a requirement to import materials to achieve the proposed design levels, as, where possible, all excavated materials generated during the works will be reused within the project area. Should there be a need, the importation of surplus clean and inert excavated material from quarries or as a by-product from other sites will be undertaken. By-product will be subject to an Article 27 notification to the EPA in accordance with relevant waste legislation and taking account of the findings of the current EPA public consultation document '*Regulatory position on soil & stone by-products*' published in October 2018. As per Table 10.23 in Section 10.4.4.1, the receptor is low importance as the aggregate resources in the study area are largely an uneconomical extractable resource.

This activity would have an indirect, negative, temporary, **Negligible Impact** of **Imperceptible Significance (i.e. not significant)** (NRA,2008) on the geological environment during the construction phase.

Overburden Removal

The removal of soil during excavation works is a direct and permanent impact. The construction of the Proposed Development will require the permanent removal of subsoil. Soil excavation can potentially result in disturbance to groundwater flow in the shallow subsoil (if encountered) and strain to existing subsoil structure as a result of loading and reloading during construction. Soil removal has implications for climate change in terms of carbon sequestration and increased soil erosion. As per Table 10.23 in Section 10.4.4.1, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This is a direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance** (i.e. not significant) on the soils of the area.

Bedrock Removal

Approximately 506,000 m^3 of bedrock will require removal (as set out in Table 10.37). The removal of bedrock during excavation works is a direct and permanent impact. Given the localised nature of the excavation, the bedrock encountered will be ripped or broken using an excavator. Blasting (if required) shall be carried out in accordance with the mitigation measures outlined in Chapter 14: Noise & Vibration.

Depending on the extent of the exposure of rock faces along roads (the length of anticipated exposure ranges from 325m along the Ballybofey Interchange to 650m along the Ballybofey Link Road, refer to Table 10.37), this is considered to have a direct, positive, long-term, **Minor to Major Beneficial Impact** (i.e. significant) as there is potential for rock exposures or ground excavations to expose features of geological interest which would, depending on the degree of exposure and level of interest, be a potentially Minor, Moderate or Major Beneficial impact (NRA, 2008). This addresses the feedback from GSI regarding Geological Heritage (refer to Table 10.7).

Material extraction and deposition areas are summarised in Table 10.40. There is one material extraction area located within the Section 1 route corridor which, it is anticipated, will provide sufficient capacity to cater for surplus material. The re-use of rock from excavation works and material extraction areas reduces the subsequent need to import road construction materials. Therefore, this impact is considered to be a direct, positive, permanent, **Moderate Beneficial Impact**, i.e. significant.

The potential impacts of the design on the agricultural soils of the region are associated with the loss of agricultural potential. These impacts are further discussed in Chapter 15: Material Assets: Agriculture.

Erosion, Storage & Stockpiles

Earthworks surfaces will be exposed during the excavation of cuttings. These earthworks surfaces could be subject to erosion if left exposed over a long period of time. Similarly excavated soil and rock will require temporary treatment and storage until re-used or disposed off-site. Stored and stockpiled materials will be subject to erosion if left exposed over a long period of time. As per Table 10.23 in Section 10.4.4.1, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be direct, negative, temporary, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant.

Sealing of Overburden Material

During construction, vehicles and plant will track over areas of topsoil and subsoil. The vehicle and plant movements have the potential to compact the subsoil (following topsoil removal). As per Table 10.23 in Section 10.4.4.1, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be direct, negative, temporary, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant.

Soil Pollution

During the construction phase, localised accidental spillages of fuel or chemicals on the site have the potential to contaminate the underlying soils by exposure, dewatering, or construction related spillages. As per Table 10.23 in Section 10.4.4.1, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be a direct, negative, short-term, **Small Adverse Impact** of **Imperceptible Significance** on soils, i.e. not significant.

Removal of Waste Material

Should any waste material be encountered during construction, it will be removed to a suitably licensed facility.

This would be considered to be a direct, positive, permanent, **Minor Beneficial Impact** i.e. significant on soils by removing a potential source of contamination.

Hydrogeology

Groundwater Vulnerability Background

The earthworks associated with the construction of the Proposed Development will change the vulnerability of the underlying aquifers by altering the thickness of the overlying soil profile. Subsoils with ‘High’ and ‘Extreme’ groundwater vulnerability underlie a high proportion of the Proposed Development (particularly the southern section). Refer to Table 10.9 for the GSI’s Aquifer Vulnerability Classification System.

In areas of cut, the vulnerability will be locally increased (refer to Table 10.37). This would increase the ease at which recharge can percolate downward. The potential hazards will be associated with construction plant and activities within the area where the protective soil cover has been reduced. Therefore, during the initial excavation phase there will be potential to cause groundwater contamination. This is also true in areas of embankments, where fill will be imported although there may still be the potential for untreated runoff (refer to Section 10.6 Conceptual Site Model for specific areas of fill). The changes in the vulnerability are a reflection of the changes in the pathway in the source-pathway-receptor model and these changes will be taken into account the assessment of impacts on receptors such as groundwater quality and wells.

Groundwater Quality

Activities which may impact the groundwater quality on site during the construction phase are:

- Accidental spillages of polluting materials on site.
- Release of fines into the groundwater.
- The potential for contaminated runoff to enter groundwater.

Although there is no evidence of this, there may also be a risk of mobilising residual contamination in the aquifer due to any required dewatering (via drainage) of cuts or increased recharge across the route.

As per Table 10.23 in Section 10.4.4.1, the importance of the Locally Important (LI) and Poor (PI) aquifers are medium and low respectively. In the event that pollutants do enter the underlying aquifer the impact is considered to be indirect, negative, short-term, **Small Adverse Impact** of **Slight Significance** on LI Aquifer and **Imperceptible Significance** on PI aquifer, i.e. not significant.

Domestic Water Supplies

No wells have been identified along the centreline of the route. There are 22 no. wells identified within 250 m of the alignment. These are identified in Wells & Springs Drawing (EIAR Drawings 10.24 to 10.26). Of these, there are 7 no. domestic wells which may have the potential to be impacted by a lowering of the water table.

The extent of impact on domestic and other wells can be ascertained by calculating the Radius of Influence (Ro) of the cutting. The 'Radius of Influence (Ro)' is defined as the maximum distance from the excavation at which drawdown can be detected. This distance of influence from a cutting is calculated using the Sichardt equation for the radius of influence for a well.

$$R_0 = C(H - h_w) \times \sqrt{K}$$

Where C is a constant taken to be 3,000. The term (H – hw) represents the drawdown required to dewater the cutting.

Table 10.49 sets out a broad-brush approach using published transmissivity values (Irish Aquifer Properties Manual). From these, the hydraulic conductivity (K) can be derived (i.e. transmissivity divided by the aquifer thickness). The maximum depth of drawdown in the Lough Esker Psammite & Killeter Quartzite Aquifer is anticipated to be 12.5 m, based on a review of the Ground Investigation and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3), and known average groundwater levels gleaned from groundwater monitoring data.

Based on these published values, a conservative estimate of the zone of influence from the edge of a cutting is in the order of 31 m. A well within this zone would not necessarily have its yield significantly compromised. The standing water level would be reduced by less than the drawdown in the cutting.

The Radius of influence (Ro) is established in Table 10.50 for wells identified in proximity to cuts and using permeability data and groundwater level data obtained from the Ground Investigation (where available and relevant). Where there is no site-specific permeability data, values from Table 10.49 are used.

There are no areas of cut identified in the Aghyaran and Killygordon Limestone Formation.

The data illustrates that wells W1-1, W1-2 and 2039SWW013 are likely to be located within the Ro of the excavation and therefore are likely to be impacted by a lowering of the water table.

The NRA Guidelines stipulate that little or no weighting should be given to wells along the centreline of proposed routes, therefore, as per Table 10.23 in Section 10.4.4.1 these receptors are of low importance. The impact on these low importance receptors will be direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant.

Table 10.49: Radius of Influence (Ro) – Section 1

Aquifer	Transmissivity (m/d)	Aquifer Thickness (m)	Permeability (K) (m/s)	Permeability (K) (m/d)	Ro (m)
Lough Esker Psammite & Killeter Quartzite Formation	1.2	20	6.9×10^{-7}	0.06	31 m
Aghyaran & Killygordon Limestone Formation	3	20	1.74×10^{-6}	0.15	50.9 m

Table 10.50: Groundwater Wells Within Zone of Influence of Section 1 Cuts

GSI Ref/ Well No.	Nearest Exploratory hole/Cut	Hydraulic Conductivity (m/s)	Distance from Centreline (m)	Depth of Cut (m)	Average Water Level (m bgl)	Drawdown (H-Hw) (m)	Ro (m)
W1-1	BSSP1119/Cut 4	6.9×10^{-7}**	20	9.87	0.73	9.14	**22.77**
W1-2	BSSP1119/Cut 4	6.9×10^{-7}**	23	11.03	0.73	10.3	**25.66**
2039SWW013	BSBHRC3003/Cut 4	2.6×10^{-5}**	150	12.33	0.63	11.7	**178.97**
W1-3	BSSP1119/Cut 4	6.9×10^{-7}**	152	13.75	0.73	12.85	32.02
W1-4	BSSP1119/Cut 4	6.9×10^{-7}**	74	10.23	0.73	9.33	23.25
W1-5	BSBHRC1016/Cut 4	6.9×10^{-7}**	195	3.7	0.37	3.33	8.29
W1-6	BSBHBSP1140/Cut 5	6.9×10^{-7}**	135	6.13	-	-	-

*Site Specific Value from Rising Head Test- Refer to **Table 10.26.**

**Published value for Lough Eske Psammite & Killeter Quartzite Formation.

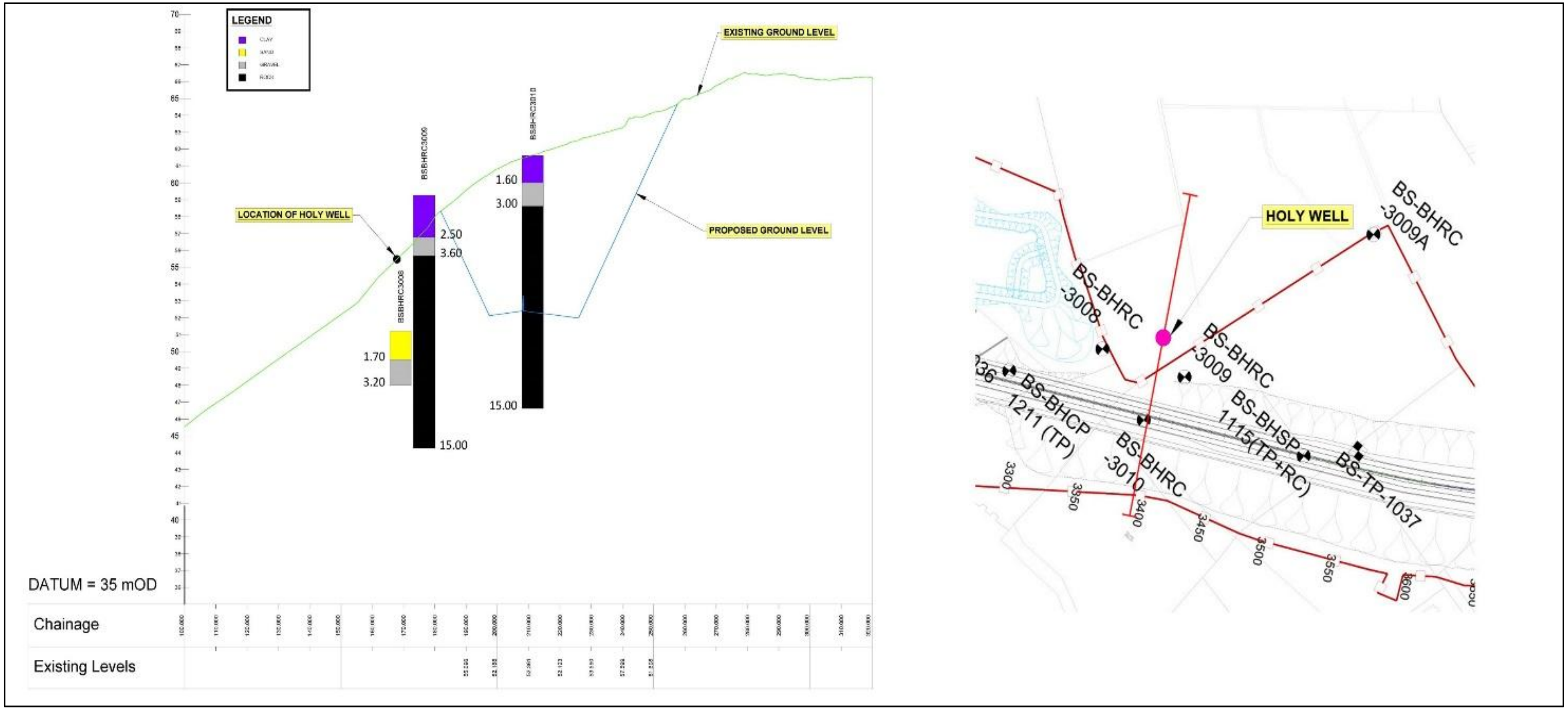
- Groundwater level monitoring data not available for W1-6

Holywell Spring

Earthworks associated with the construction of the road in the vicinity of Holywell, where the mainline will incorporate cut, has the potential to alter the groundwater flow path feeding the spring, if the cut intercepts the water table.

Holywell Spring is located close to a 700 m long cut (Cut 3) with an excavation depth of up to 9.02 mbgl. Groundwater levels taken from standpipes installed in BSBHRC3009, BSBHRC3009A and BSBHRC3010 in the vicinity of Holywell average at 4.16 mbgl. The cut will intercept the water table. The required drawdown (H-Hw) will be in the order of 4.86 m.

The scenario and ground conditions are illustrated in a schematic site model which was developed based on the desktop and field assessments at Holywell spring. This is illustrated in Figure 10-3.



* Not to scale. Vertical exaggeration has been applied to the cross section for illustrative purposes
* Not to scale Borehole marker size has been exaggerated for illustrative purposes

Figure 10-3: Schematic Site Model, Holywell

In order to help ascertain the impact of the construction of the nine metres deep cutting at Holywell on the local groundwater regime, calculations have been carried out using:

Published permeability data for Irish Aquifers gleaned from GSI's Irish Aquifer Properties Manual for bedrock lithology in the region (GSI, 2015) where there is no site-specific permeability data from the Ground Investigation carried out near Holywell.

Table 10.51: Permeability Data from Ground Investigation

	Permeability (m/s) Published	Permeability (m/s) Site Specific	Drawdown (H-Hw)	Ro (m) Published	Ro (m) Site Specific
BSBHRC3009	6.9×10^{-7}	7.05×10^{-8} (Falling Head)	4.86	12.1	3.9
BSBHRC3009A	6.9×10^{-7}	8.85×10^{-8} (Falling Head)	4.86	12.1	13.7
BSBHRC3009A	6.9×10^{-7}	1.52×10^{-7} (Rising Head)	4.86	12.1	5.7
BSBHRC3010	6.9×10^{-7}	No data	4.86	12.1	-

- No permeability testing carried out in BSBHRC3010, therefore Ro not available

There is some variability in the results presented, as would be expected given that the permeability testing was carried out at different times of the year (refer Appendix C10.02). It is also noted that the permeabilities derived from the published data are based on a broad dataset of transmissivity values.

Using the Sichardt equation, the extent of the influence of the cutting at Holywell per unit of drawdown can be ascertained. As illustrated in Table 10.51 the distance of influence from the edge of the cutting is anticipated to be in the range of 3.9 m to 13.7 m. Although Holywell itself is located 35 m from the centre of the cutting, it is most likely that the groundwater supply to it will be intercepted by the cut.

As expected for the bedrock geology in the area and its Poor Aquifer characteristics, the Ro in this low transmissivity aquifer is small and groundwater flow paths would be expected to be short. It is noted that the higher permeability gravels overlying bedrock in both boreholes, may have influenced permeability results.

Further focussed permeability and pump testing and subsequent analysis is required at detailed design stage to better quantify this estimate and inform pre-construction alignment and drainage plans to facilitate dewatering. Dewatering in this case refers to the lowering of the groundwater level locally during construction by the installation of road drainage.

Given the attribute importance of Holywell (High on a local scale, as per Table 10.23 in Section 10.4.4.1) the overall potential impact is assessed as a direct, negative, permanent, **Moderate Adverse Impact** of **Significant/Moderate Significance** impact, i.e. significant.

10.7.3.1.1 Summary of Section 1 Construction Phase Impacts

Table 10.52: Summary of Section 1 Potential Impacts

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Importation of Road Construction Materials	Low	Negligible	Imperceptible
Overburden Removal	Low	Small Adverse	Imperceptible
Bedrock Removal	Low	Minor to Major Beneficial	n/a
Erosion, Storage & Stockpiles	Low	Small Adverse	Imperceptible
Sealing of Overburden Material	Low	Negligible	Imperceptible
Soil Pollution	Low	Small Adverse	Imperceptible
Removal of Waste	Low	Minor Beneficial	n/a
Groundwater Quality	Low (PI aquifer) Medium (LI aquifer)	Small Adverse Small Adverse	Imperceptible Slight
Domestic Wells	Low	Small Adverse	Imperceptible
Holywell Spring	High	Moderate Adverse	Significant/Moderate

10.7.3.2 Section 2

Soils and Geology

Importation of Road Construction Materials

It is not anticipated that there will be a requirement to import materials to achieve the proposed design levels as, where possible, all excavated materials generated during the works will be reused within the project area. Should there be a need, the importation of surplus clean and inert excavated material from quarries or as a by-product from other sites will be undertaken. By-product will be subject to an Article 27 notification to the EPA in accordance with relevant waste legislation and taking account of the findings of the current EPA public consultation document '*Regulatory position on soil & stone by-products*' published in October 2018. As per Table 10.24 in Section 10.4.4.2, the receptor is low importance as the aggregate resources in the study area are largely an uneconomical extractable resource.

This activity would have an indirect, negative, temporary, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant on the geological environment during the construction phase.

Overburden Removal

The construction of the Proposed Development will require the permanent removal of subsoil during excavation works. This will be a direct and permanent impact. Soil excavation can potentially result in disturbance to groundwater flow in the shallow subsoil (if encountered) and strain to existing subsoil structure as a result of loading and reloading during construction. Soil removal has implications for climate change in terms of carbon sequestration and increased soil erosion. As per Table 10.24 in Section 10.4.4.2, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale

This is a direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant on the soils of the area.

Bedrock Removal

Approximately 410,000 m³ of bedrock will require removal (as set out in Table 10.43). The removal of bedrock during excavation works is a direct and permanent impact. Given the localised nature of the excavation, the bedrock encountered will be ripped or broken using an excavator. Blasting (if required) shall be carried out in accordance with the mitigation measures outlined in Chapter 14: Noise & Vibration.

Depending on the extent of the exposure of rock faces along roads (the length of anticipated exposure is 3,190 m along Section S2.2 refer to Table 10.41), this is considered to have a direct, positive, long-term, **Minor to Major Beneficial Impact** as there is potential for rock exposures or ground excavations to expose features of geological interest which would, depending on the degree of exposure and level of interest, be a potentially Minor, Moderate or Major Beneficial impact (NRA, 2008). This addresses some of the feedback from the GSI (Refer to Table 10.7).

Material extraction and deposition areas are summarised in Table 10.44. There are sixteen material extraction areas located within the Section 2 route corridor which, it is anticipated, will provide sufficient capacity to cater for surplus material. The re-use of rock from excavation works and material extraction areas reduces the subsequent need to import road construction materials. Therefore, this impact is considered to be is a direct, positive, permanent, Moderate Beneficial Impact i.e. potentially significant or potentially not significant.

The potential impacts of the design on the agricultural soils of the region are associated with the loss of agricultural which means a loss of soil. These impacts are further discussed in Chapter 15: Material Assets: Agriculture.

The impact of overburden and bedrock removal on the hydrogeological environment is discussed below.

Erosion, Storage & Stockpiles

Earthworks surfaces will be exposed during the excavation of cuttings. These earthworks surfaces could be subject to erosion if left exposed over a long period of time.

Similarly excavated soil and rock will require temporary treatment (such as the use of runoff control measures) and storage until re-used or disposed off-site. Stored and stockpiled materials will be subject to erosion if left exposed over a long period of time. As per Table 10.24 in Section 10.4.4.2, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be direct, negative, temporary, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant.

Sealing of Overburden Material

During construction, vehicles and plant will track over areas of topsoil and subsoil. The vehicle and plant movements have the potential to compact the subsoil (following topsoil removal). As per Table 10.24 in Section 10.4.4.2, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be direct, negative, temporary, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant.

Soil Pollution

During the construction phase, localised accidental spillages of fuel or chemicals on the site have the potential to contaminate the underlying soils by exposure, dewatering, or construction related spillages. As per Table 10.24 in Section 10.4.4.2, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be a direct, negative, short-term, **Small Adverse Impact** of **Imperceptible Significance** on soils, i.e. not significant.

Removal of Waste Material

Should any waste material be encountered during construction, it will be removed to a suitably licensed facility.

This would be considered to be a direct, positive, permanent, **Minor Beneficial Impact**, i.e. significant on soils by removing a potential source of contamination.

Geological Heritage

The GSI requests that any bedrock cuttings remain visible as rock exposure, in accordance with safety guidelines and engineering constraints.

This would be considered to be a direct, positive, permanent, **Moderate Beneficial Impact**, i.e. significant on geological heritage by exposure and/or visibility of heritage feature improving geological knowledge of the subsurface.

Hydrogeology

Groundwater Vulnerability Background

The earthworks associated with the construction of the prosed development will effect changes in the vulnerability of the underlying aquifers by altering the thickness of the overlying soil profile. Subsoils with ‘High’ and ‘Extreme’ groundwater vulnerability underlie a high proportion of the Proposed Development. Refer to Table 10.9 for the GSI’s Aquifer Vulnerability Classification System.

In areas of cut the vulnerability will be locally increased (refer to Section 10.6 Conceptual Site Model for specific areas of cut). This would increase the ease at which recharge can percolate downward. The potential hazards will be associated with construction plant and activities within the area where the protective soil cover has been reduced, therefore, during the initial construction phase, there will be potential to cause groundwater contamination. This is also true in areas of embankments, where fill will be imported although there may still be the potential for untreated runoff (refer to Section 10.6 Conceptual Site Model for specific areas of fill). The changes in the vulnerability are a reflection of the changes in the pathway in the source-pathway-receptor model and these changes will be taken into account the assessment of impacts on receptors such as groundwater quality and wells.

Groundwater Quality

Activities which may impact the groundwater quality on site during the construction phase are:

- Accidental spillages of polluting materials on site.
- Release of fines into the groundwater.
- The potential for contaminated runoff to enter groundwater.

As per Table 10.24 in Section 10.4.4.2, the importance of the LI aquifers are medium. In the event that pollutants do enter the underlying aquifer the impact is considered to be indirect, negative, short-term, **Small Adverse Impact** of **Slight Significance** on the LI Aquifer, i.e. not significant.

Domestic Water Supplies

No wells have been identified along the centreline of the route. 8 no. domestic wells have been identified within 250 m of the alignment. Of these, there are three domestic wells located in cut areas, and so may have the potential to be impacted by a lowering of the water table.

The extent of impact of this can be ascertained by calculating the Radius of Influence (Ro) of the cutting. The 'Radius of Influence (Ro)' is defined as the maximum distance from the excavation at which drawdown can be detected. This distance of influence from a cutting is calculated using the Sichardt equation for the radius of influence for a well.

$$R_0 = C(H - h_w) \times \sqrt{K}$$

Where C is a constant taken to be 3,000. The term (H – hw) represents the drawdown required to dewater the cutting.

Table 10.53 sets out a broad-brush approach using published transmissivity values (Irish Aquifer Properties Manual). From these, the hydraulic conductivity (K) can be derived (i.e. transmissivity divided by the aquifer thickness). The maximum depth of drawdown in the Termon Formation & Killter Quartzite Aquifer is anticipated to be 7.64 m, based on review of in the Ground Investigation and Earthworks Plan & Profile drawings contained in EIAR Drawing 4.60 (Section 1), 4.61 (Section 2) and 4.62 (Section 3), and known average groundwater levels gleaned from groundwater monitoring data.

A conservative estimate of the zone of influence from the edge of the cutting is therefore in the order of 39 m. A well within this zone would not necessarily have its yield significantly compromised. The standing water level would be reduced by less than the drawdown in the cutting.

The Ro is established in Table 10.54 for wells identified in proximity to the centreline using conductivity values derived from published permeability data obtained from the GSI (GSI, 2015). Water levels have been obtained from the groundwater monitoring data provided as part of the Ground Investigation.

There are no areas of cut identified in the Swilly Sands & Gravels.

Table 10.53: Radius of Influence (Ro) - Section 2

Aquifer	Transmissivity (m/d)	Aquifer Thickness (m)	Permeability (K) (m/s)	Permeability (K) (m/d)	Ro (m)
Termon Formation & Killeter Quartzite Formation	2.47	10	2.86×10^{-6}	0.247	38.7 m
Aghyaran & Killygordon Limestone Formation **Bedrock Aquifer**	3	20	1.74×10^{-6}	0.15	50.85 m
Swilly Sands & Gravels	200	15	1.54×10^{-6}	13.33	372 m

Table 10.54: Groundwater Wells Within Zone of Influence of Section 2 Cuts

	Nearest Exploratory hole/Cut	Hydraulic Conductivity (m/s)	Distance from Centreline (m)	Depth of Cut (m)	Average water level (m bgl)	Drawdown (H-Hw) (m)	Ro (m)
W2-1	LKRC2013/Cut 1	$2.86 \times 10^{-6*}$	90	6.96	1.99	4.96	25.16
W2-2	LKRC4002/Cut 1	$2.86 \times 10^{-6*}$	80	4.01	2.42	1.59	8.06
W2-3	LKSP2237/LX-5824 Connector Road	$1.74 \times 10^{-6*}$	120	2.56	2.68	0.12	0.47

*Conductivity derived from published values- Refer to Table 10-50

The data illustrates that none of the wells are likely to be located within the zone of influence of the excavation and therefore are unlikely to be impacted by a lowering of the water table.

The NRA Guidelines stipulate that little or no weighting should be given to wells along the centreline of proposed routes, therefore, as per Table 10.24 in Section 10.4.4.2, these receptors are of low importance. The impact on these low importance receptors will be direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant.

10.7.3.2.1 Summary of Section 2 Construction Phase Impacts

Table 10.55: Summary of Section 2 Potential Impacts

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Importation of Road Construction Materials	Low	Negligible	Imperceptible
Overburden Removal	Low	Small Adverse	Imperceptible
Bedrock Removal	Low	Minor to Major Beneficial	n/a
Erosion, Storage & Stockpiles	Low	Small Adverse	Imperceptible
Sealing of Overburden Material	Low	Negligible	Imperceptible
Soil Pollution	Low	Small Adverse	Imperceptible
Removal of Waste	Low	Minor Beneficial	n/a
Geological Heritage	High	Moderate Beneficial	n/a
Groundwater Quality	Medium (LI aquifer)	Small Adverse	Slight
Domestic Wells	Low	Small Adverse	Imperceptible

10.7.3.3 Section 3

Soils and Geology

Importation of Road Construction Materials

It is not anticipated that there will be a requirement to import materials to achieve the proposed design levels as, where possible, all excavated materials generated during the works will be reused within the project area. Should there be a need, the importation of surplus clean and inert excavated material from quarries or as a by-product from other sites will be undertaken. By-product will be subject to an Article 27 notification to the EPA in accordance with relevant waste legislation and taking account of the findings of the current EPA public consultation document '*Regulatory position on soil & stone by-products*' published in October 2018. As per Table 10.25 in Section 10.4.4.3, the receptor is low importance as the aggregate resources in the study area are largely an uneconomical extractable resource.

This activity would have an indirect, negative, temporary, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant on the geological environment during the construction phase.

Overburden Removal

The construction of the Proposed Development will require the permanent removal of subsoil during excavation works. Soil excavation can potentially result in disturbance to groundwater flow in the shallow subsoil (if encountered) and strain to existing subsoil structure as a result of loading and reloading during construction. Soil removal has implications for climate change in terms of carbon sequestration and increased soil erosion. As per Table 10.25 in Section 10.4.4.3, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale. Though localised peat is identified in the GI, the volume of peat is small on a local scale, and therefore the receptor is of low importance.

This is a direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant, on the soils of the area.

Bedrock Removal

Approximately 240,000 m^3 of bedrock will require removal. Locations where rock excavation is required have been identified in Table 10.47. Given the localised nature of the excavation, the bedrock encountered will be ripped or broken using an excavator. Blasting (if required) shall be carried out in accordance with the mitigation measures outlined in Chapter 14: Noise & Vibration.

The length of anticipated exposure of rock faces along roads ranges from 60 m to 1,060 m along the mainline, (refer to Table 10.47). This is considered to have a direct, positive, permanent impact, as there is potential for rock exposures or ground excavations to expose features of geological interest. Depending on the degree of exposure and level of interest, this would result in a potentially **Minor, Moderate or Major Beneficial Impact**, i.e. potentially either not significant or significant (NRA, 2008). This addresses the feedback from GSI regarding Geological Heritage (refer to Table 10.7).

The re-use of rock from excavation works and the subsequent reduction of the need to import road construction materials is both a direct and an indirect, positive, permanent, **Moderate Beneficial Impact**, i.e. significant (NRA, 2008).

The potential impacts of the design on the agricultural soils of the region are associated with the loss of agricultural potential. These impacts are further discussed in Chapter 15: Material Assets: Agriculture.

Erosion, Storage & Stockpiles

Earthworks surfaces will be exposed during the excavation of cuttings. These earthworks surfaces are subject to erosion if left exposed over a long period of time.

Similarly excavated soil and rock will require temporary treatment (such as the use of runoff control measures) and storage until re-used. Stored and stockpiled materials will be subject to erosion if left exposed over a long period of time. As per Table 10.25 in Section 10.4.4.3, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be direct, negative, temporary, **Small Adverse Impact** of **Slight Significance**, i.e. not significant (NRA, 2008).

Sealing of Overburden Material

During construction, vehicles and plant will track over areas of topsoil and subsoil. The vehicle and plant movements have the potential to compact the subsoil (following topsoil removal), which reduces the surface area of the ground able to absorb rainwater. As per Table 10.25 in Section 10.4.4.3, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This impact is considered to be a direct, negative, temporary, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant (NRA, 2008).

Soil Pollution

During the construction phase, localised accidental spillages of fuel or chemicals on the site have the potential to contaminate the underlying soils by exposure, dewatering, or construction related spillages. As per Table 10.25 in Section 10.4.4.3, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale. Localised accidental spillages may result in the requirement to excavate/remediate a small proportion of contamination or result in a low risk of pollution to soils.

This impact is considered to be a direct, negative, short term, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant, on soils (NRA, 2008).

Removal of Waste Material

Should any waste material be encountered during construction, it will be removed to a suitably licensed facility.

This would be considered to be a direct, positive, permanent, **Minor Beneficial Impact**, i.e. not significant on soils by removing a potential source of contamination.

Geological Heritage

As discussed in Section 10.4.3.6, no geological heritage areas were identified within the study area. However, GSI requests that any bedrock cuttings remain visible as rock exposure, in accordance with safety guidelines and engineering constraints.

This would be considered to be a direct, positive, permanent, **Moderate Beneficial Impact** on geological heritage by exposure and/or visibility of heritage feature improving geological knowledge of the subsurface.

Hydrogeology

The elements of the Proposed Development that will interact with the hydrogeological environment are those activities that have the capacity to change the groundwater regime in terms of recharge, groundwater levels and water quality. Impacts are principally associated with the effects of the Proposed Development in cuttings and the potential for accidental spillages entering the groundwater environment.

Groundwater Vulnerability Background

The earthworks associated with the construction of the prosed development will effect changes in the vulnerability of the underlying aquifers by altering the thickness of the overlying soil profile. Subsoils with 'High' and 'Extreme' groundwater vulnerability underlie a high proportion of the Proposed Development (refer to Table 10.9 for the GSI's Aquifer Vulnerability Classification System.)

In areas of cut the vulnerability will be locally increased (refer to Section 10.6 Conceptual Site Model for specific areas of cut). This would increase the ease at which recharge can percolate downward. The potential hazards will be associated with construction plant and activities within the area where the protective soil cover has been reduced, therefore, during the initial construction phase, there will be potential to cause groundwater contamination. This is also true in areas of embankments, where fill will be imported, although there may still be the potential for untreated runoff (refer to Section 10.6 Conceptual Site Model for specific areas of fill). The changes in the vulnerability are a reflection of the changes in the pathway in the source-pathway-receptor model and these changes are taken into account the assessment of impacts on receptors such as groundwater quality and wells.

Groundwater Quality

Activities which may impact the groundwater quality on site during the construction phase are:

- Accidental spillages of polluting materials on site.
- Release of fines into the groundwater.
- The potential for contaminated runoff to enter the groundwater.

As per Table 10.25 in Section 10.4.4.3, the importance of the Locally Important (LI) and Poor (PI) aquifers are medium and low respectively. In the event that pollutants do enter the underlying aquifer the impact is considered to be indirect, negative, short-term, **Negligible Impact** of **Imperceptible Significance** on both the PI and LI Aquifer, i.e. not significant (NRA, 2008).

As per Table 10.25 in Section 10.4.4.3, the importance of the River Finn SAC, which is supported by groundwater, is extremely high. The impact of pollutants entering the River Finn, with the groundwater as the pathway, is considered to be an indirect, negative, short-term, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant (NRA, 2008).

Domestic Water Supplies

Two domestic wells have been identified within the Section 3 CPO boundary; wells 8 and 38. A replacement water supply will be required and will be provided as a connection to the mains or a replacement well provided. There are 22 no. domestic wells located adjacent to cut areas, which were assessed to determine whether or not they will be impacted by a lowering of the water table.

The extent of impact of this can be ascertained by calculating the Radius of Influence (Ro) of the cutting. The 'Radius of Influence (Ro)' is defined as the maximum distance from the excavation at which the drawdowns can be detected. The distance of influence from each cutting was calculated using the Sichardt equation for the radius of influence for a well.

$$R_0 = C(H - h_w) \times \sqrt{K}$$

Where C is a constant taken to be 3,000. The term (H – hw) represents the drawdown required to dewater the cutting.

Table 10.56 sets out a broad-brush approach using published transmissivity values (Irish Aquifer Properties Manual). From these, the hydraulic conductivity (K) can be derived (i.e. transmissivity divided by the aquifer thickness).

Table 10.56 lists the extent of the influence of the cutting per unit drawdown. It should be noted that there will be no cuttings in the gravel aquifer. However, the table clearly shows that radius of influence in the lower transmissive aquifers is very small reflecting a steep groundwater gradient into the cutting. For example, if the drawdown in the Lough Foyle Aquifer is 15 m the length of influence from the edge of the cutting would be 37.4 m only. A well within this zone will not necessarily have its yield significantly compromised. The standing water level will be reduced by less than the drawdown in the cutting, and the reduction will decrease to zero at the edge of the radius of influence. Consequently, shallow dug wells will be more at risk.

The radius of influence has been calculated for each well identified in Section 10.4.3.15, adopting a conservative groundwater level of ground level. There is only one well located within the radius of influence of the Proposed Development, which is underlying the Proposed Development. There is also a second well within the CPO boundary. These two wells within the CPO boundary will have to be abandoned. Section 10.8.1.2 addresses mitigation for abandoned wells.

There will not be impacts on the other wells assessed.

Table 10.56: Radius of Influence per Metres Drawdown-Section 3

Aquifer	Transmissivity (m/d)	Aquifer Thickness (m)	Permeability (m/s)	Permeability (m/d)	Ro (per metre drawdown) (m)
Aghyaran & Killygordon Limestone Formation Bedrock Aquifer	3	20	1.74E-06	0.15	3.96
Lough Foyle Succession Bedrock Aquifer	1.2	20	6.94E-07	0.06	2.49
Foyle Gravels Aquifer	350	15	4.05E-04	35	60

The Ro is established in Table 10.57 for wells identified in proximity to the centreline, where the road is in cutting, using the Ro per metre drawdown identified in Table 10.56. Water levels have been conservatively taken at ground level, and an additional metre of drawdown included to account for drainage and excavation to the base of the road box during construction.

Table 10.57: Groundwater Wells Relative to the Radius of Influence Within Section 3

Drawing Number	Permeability (m/s)	Distance from Mainline Centreline (m)	Distance from nearest Cut (m)	Depth of Cut (m)	Adopted Depth to Groundwater (mBGL)	Drawdow n (H-Hw)	Ro (m)
8	**3.96**	**70**	210	23	0	24	95.04
38	**3.96**	**50**	26	13	0	14	55.44

The data illustrates that only well 38 is located within the zone of influence of the closest excavation and therefore impacted by a lowering of the water table. Well 8 is also within the CPO boundary, so will need to be decommissioned.

The NRA Guidelines stipulate that little or no weighting should be given to wells along the centreline of proposed routes, therefore, as per Table 10.25 in Section 10.4.4.3, these receptors are of low importance. The impact on these low importance receptors will be direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance**, i.e. not significant (NRA, 2008).

10.7.3.3.1 Summary of Section 3 Construction Phase Impacts

Table 10.58: Summary of Section 3 Potential Impacts

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Importation of Road Construction Materials	Low	Negligible	Imperceptible
Overburden Removal	Low	Small Adverse	Imperceptible
Bedrock Removal	Low	Minor to Major Beneficial	n/a
Erosion, Storage & Stockpiles	Low	Small Adverse	Slight
Sealing of Overburden Material	Low	Negligible	Imperceptible
Soil Pollution	Low	Small Adverse	Imperceptible
Removal of Waste	Low	Minor Beneficial	n/a
Groundwater Quality	Low (PI aquifer) Medium (LI aquifer) Extremely High (River Finn SAC)	Negligible Negligible Negligible	Imperceptible Imperceptible Imperceptible
Domestic Wells	Low	Small Adverse	Imperceptible

10.7.3.4 Project Wide Impacts of the Proposed Development

The overall predicted cut and fill volumes for Section 1, Section 2 and Section 3 are summarised, respectively, in Table 10.59,

Table 10.60, and Table 10.61. For Section 1 fill quantities are less than the cut quantities so the route is in surplus. This is based on interrogation of the Ground Investigation data and predicted reusability factors.

Table 10.59: Earthworks Quantities - Section 1

Element	Volumes (m³)
Total Cut	2,700,000
Total Cut available for reuse	2,056,000
Over excavation for soft areas	172,000
Unsuitable	473,000
Total volume of material requiring deposition	645,000
Additional material to fill soft areas	172,000
Fill to meet alignment requirements	1,873,000
(Import to site)	(74,000)
Total volume of Fill required	2,045,000
Excavation and backfill to MEDs	104,000
Material placed as non-structural fill	645,000

Table 10.60: Earthworks Quantities - Section 2

Element	Volumes (m³)
Total Cut	1,913,000
Total Cut available for reuse	1,530,000
Over excavation for soft areas	56,000
Unsuitable	328,000
Total volume of material requiring deposition	384,000
Additional material to fill soft areas	56,000
Fill to meet alignment requirements	1,469,000
(Import to site)	(69,000)
Total volume of Fill required	1,525,000
Excavation and backfill to MEDs	687,500
Material placed as non-structural fill	56,000

Table 10.61: Earthworks Quantities - Section 3

Element	Volumes (m^3)
Total Cut	3,964,000
Total Cut available for reuse	3,347,000
Over excavation for soft areas	449,000
Unsuitable	66,000
Total volume of soft and unsuitable	515,000
Additional material to fill soft areas	449,000
Fill to meet alignment requirements	2,974,000
(Import to site)	(76,000)
Total volume of Fill required	3,423,000
Excavation and backfill to MEDs	516,000
Material placed as non-structural fill	315,000

Notes

(1) All excavated rock assumed to be processed into compliant fill.

(2) Excludes capping volumes.

(3) Non-compliant material generally comprises soft glacial till, peat and alluvium.

(4) An allowance has been made for an import of sub - pavement fill material which is not included in cumulative fill volume

(5) Total cut includes unsuitable material, over excavation, and excavation from MEDs.

10.7.3.4.1 Summary of Project Wide Construction Phase Impacts on Soils and Geology

Table 10.62: Predicted Construction Phase Impacts on soils and geology (Sections 1, 2 and 3)

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Importation of Road Construction Materials	Low	Negligible	Imperceptible
Overburden Removal	Low	Small Adverse	Imperceptible
Bedrock Removal	Low	Minor to Moderate Beneficial	n/a
Erosion, Storage & Stockpiles	Low	Small Adverse	Slight
Sealing of Overburden Material	Low	Negligible	Imperceptible
Soil Pollution	Low	Small Adverse	Imperceptible
Removal of Waste	Low	Minor Beneficial	n/a
Geological Heritage	High	Moderate Beneficial	n/a

As noted above, the site is underlain by a number of groundwater bodies but as noted in Section 10.4.3.11 this area of Donegal does not have significant groundwater potential. The aquifer classification in the vicinity of the Proposed Development is shown in EIAR Drawings 10.18 to 10.20 and described in Section 10.4 of this chapter. In light of the potential for dynamic fluctuations and seasonal flow, there will be ongoing monitoring of groundwater bodies in the vicinity of the Proposed Development. In the event that ongoing monitoring and/or discharge calculations indicate that that dewatering activities for cuttings or other excavations in bedrock could result in abstraction from a water body within the meaning of the Water Environment (Abstractions and Associated Impoundments) Act 2022 (the “2022 Act”), this will be undertaken in compliance with the 2022 Act.

10.7.3.4.2 Summary of Project Wide Construction Phase Impacts on Hydrogeology

Table 10.63: Predicted Construction Phase Impacts on Hydrogeology (Sections 1, 2 and 3)

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Groundwater Quality	Low (PI aquifer) Medium (LI aquifer) Extremely High (River Finn SAC)	Small Adverse Small Adverse Negligible	Imperceptible Slight Imperceptible
Domestic Wells	Low	Small Adverse	Imperceptible
Holywell Spring	High	Moderate Adverse	Significant/Moderate

10.7.4 Operational Phase Impacts

The potential Operational Phase Impacts Sections 1, 2 and 3 are presented together in the following sections.

Soils and Geology

Soil Pollution

During the operational phase, there is a low risk of spillages of chemicals and fuels/lubricants, from an accident for example. All mainline run-offs will be treated in attenuation facilities as identified in Chapter 4: Project Description. The attenuation ponds will be hybrid wetlands and will be lined to ensure they meet the requirements of the groundwater vulnerability assessment and to ensure that they maintain a permanent water level. As per Table 10.23 to Table 10.25 in Section 10.4.4, the receptor is of low importance as the soils are predominantly poorly draining with a low value on a local scale.

This is a direct, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance** (i.e. not significant) on the soils of the area.

Hydrogeology

Aquifer Recharge

The introduction of paved impermeable surface will reduce the recharge area of the aquifer and consequently the volume of the of groundwater throughput.

A high-level estimate of paved area for Section 1 is estimated at 374,00 m² for the road and an additional 72,000 m² for cycle pavement. The loss in recharge will be very small (0.05%–0.2%).

For Section 2, a high-level estimate of paved area is 328,500 m² for the road and an additional 25,000 m² for cycle pavement. The loss in recharge will be very small (0.026%–0.09%) for both bedrock aquifers with an estimated 1% loss in recharge estimated for the Swilly Gravels.

For Section 3, loss in recharge will be very small (0.17%-0.71%) for all aquifers.

These are very conservative estimates and represent a worst-case scenario. They assume all recharge along the Proposed Development will be lost and do not include for recharge from permeable drainage (there is 1 no. infiltration basin proposed in Section 1). With the addition of paved impermeable surfaces, the Proposed Development will result in a combined loss of an estimate of 2.4% of recharge area of the aquifers over the region.

As per Section 10.4.4, the importance of the LI bedrock and gravel aquifers are medium and the PI aquifers are low. In the event that pollutants do enter the underlying aquifer the impact is considered to be an indirect, negative, permanent, **Small Adverse Impact** of **Slight Significance** on the LI bedrock and gravel aquifers in Sections 1, 2 and 3 (i.e. not significant) and an indirect, negative, permanent, **Small Adverse Impact** of **Imperceptible Significance** on the PI aquifers in Section 1 (i.e. not significant) (NRA, 2008).

Overall, this impact is considered to be an indirect, negative, permanent, **Negligible Impact** of **Imperceptible Significance** (i.e. not significant)**.**

Table 10.64: Loss in Recharge Area Due to Proposed Development – Section 1

Aquifer	Area (km^2)	Road Length (km)	Area of Paved Surface (km^2)	Annual Recharge Rate (mm)	% Loss in Recharge Area
Lough Esker Psammite & Killeter Quartzite Formation	178	12.8	0.36	100	0.2%
Aghyaran & Killygordon Limestone Formation **Bedrock Aquifer**	170	3.09	0.09	200	0.05%

Table 10.65: Loss in Recharge Area Due to Proposed Development – Section 2

Aquifer	Area (km^2)	Road Length (km)	Area of Paved Surface (km^2)	Annual Recharge Rate (mm)	% Loss in Recharge Area
Termon Formation & Killeter Quartzite Formation	750	3.68	0.195	100	0.026%
Aghyaran & Killygordon Limestone Formation **Bedrock Aquifer**	170	1.3	0.16	200	0.09%
River Swilly Sand and Gravel Deposits– Overburden Aquifer	4.9	1.2	0.05	270	1.02

Table 10.66: Loss in Recharge Area Due to Proposed Development – Section 3

Aquifer	Area (km^2)	Road Length (km)	Area of Paved Surface (km^2)	Annual Recharge Rate (mm)	% Loss in Recharge Area
Aghyaran & Killygordon Limestone Formation **Bedrock Aquifer**	170	14.4	0.288	200	0.17%
Lough Foyle Succession **Bedrock Aquifer**	9	3.20	0.064	100	0.71%
Foyle Gravels **Bedrock Aquifer**	19	1.5	0.03	317	0.16%

Aquifer Storage

The excavation of bedrock in the cuttings has the potential to reduce the storage volume within the aquifer. However, the volume that will be excavated will be very small in comparison the to the overall aquifer.

Overall, this impact is considered to be an indirect, negative, permanent, **Negligible Impact** of **Imperceptible Significance** (i.e. not significant).

Groundwater Quality (Runoff)

A range of potential pollutants may be released on the impermeable areas of the Proposed Development. These will be carried away in the runoff after rainfall events. The concentration in the runoff will vary depending on:

- Volume of traffic
- Time since the last rainfall event
- Intensity of the rainfall event
- Area being drained

Groundwater Quality (Accidental Spillages)

During the operational phase, there is a risk of accidental spillage which could potentially cause groundwater contamination.

As per Section 10.4.4, the importance of the Locally Important (LI) and Poor (PI) aquifers are medium and low respectively. The predicted potential impact on groundwater quality in the underlying aquifers as a result of accidental spillage considered to be direct, negative, short-term, **Negligible Impact** of **Imperceptible Significance,** i.e. not significant (NRA, 2008).

As per Section 10.4.4, the importance of the River Finn SAC, which is supported by groundwater, is extremely high. The impact of pollutants entering the River Finn, with the groundwater as the pathway, is considered to be an indirect, negative, short-term, **Negligible Impact** of **Imperceptible Significance**, i.e. not significant (NRA, 2008).

GWB WFD Status

The potential impact on groundwater quality has been assessed as negligible (NRA, 2008), consequently the potential impact on the WFD status of the GWB underlying the Proposed Development is considered to be indirect, neutral, short-term, **Negligible Impact** of **Imperceptible Significance** (i.e. not significant) (NRA, 2008).

Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC) temperature increase has already caused a sea level rise of 0.2 m between 1901 and 2018 and it is very likely to virtually certain that sea levels will continue to rise throughout the 21st century (IPCC, 2021). Ireland will experience significant changes in rainfall characteristics and increased sea levels around the coast. Increased sea levels will increase the risk of coastal flooding and higher water levels upstream in river estuaries.

Implications for hydrogeology include a reduction in the thickness of the unsaturated ground below filter drains as the sea level and water table rises. The result will be less opportunity for breakdown of the effluent before it reaches the water table. Higher recharge rates have the potential to reflood upper saturated zones that have been depleted along road cuttings, affecting the capacity of the SuDS system and causing flooding.

The predicted potential impact of climate change is to be an indirect, negative, permanent, **Small Adverse Impact** of **Slight Significance** on LI Aquifer and **Imperceptible Significance** on PI aquifer (i.e. not significant) (NRA, 2008).

10.7.4.1 Summary of Project Wide Operational Phase Potential Impacts

Table 10.67: Predicted Operational Phase Impacts on Soils, Geology and Hydrogeology (Sections 1, 2 and 3)

Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect
Soil Pollution	Low	Small Adverse	Imperceptible
Aquifer Recharge	Low (PI Aquifer) Medium (LI Aquifer)	Negligible Negligible	Imperceptible Imperceptible
Aquifer Storage	Low (PI Aquifer) Medium (LI Aquifer)	Negligible Negligible	Imperceptible Imperceptible
Groundwater Quality	Low (PI Aquifer) Medium (LI Aquifer) River Finn SAC	Negligible Negligible Negligible	Imperceptible Imperceptible Imperceptible
GWB WFD Status	High	Negligible	Imperceptible
Climate Change	Low (PI Aquifer) Medium (LI Aquifer)	Small Adverse Small Adverse	Imperceptible Slight

10.8 Mitigation Measures

The proposed Mitigation Measures for Sections 1, 2 and 3 of the Proposed Development are presented in the following sections and summarised in Table 10.68 (Construction Phase Mitigation Measures) and Table 10.69 (Operational Phase Mitigation Measures).

10.8.1 Construction Phase Mitigation Measures - Section 1, 2 & 3

The recommended mitigation measures are based on the Ground Investigation (GI) carried out to date and are used to inform the geotechnical design for the route. The results of the GI are considered sufficient to make a reasonable assessment on the extent of re-use of earthworks materials and the overall earthworks balance for the route. Some adjustments to this balance may occur during detailed design stage.

10.8.1.1 Geology

Importation of Road Construction Materials

No mitigation measures required for Sections 1 and 2. Vertical alignments have been optimised to achieve a balance in the earthworks quantities required to minimise the import of material. It is anticipated that there will be no requirement to import materials for Sections 1 and 2. A nominal amount of imported material has been included in the earthworks volumes for S1 and S2 considering the case where the excavated rock is determined to be unsuitable for processing during detailed design and/or construction. Where possible, all excavated materials generated during the works will be reused within the project area.

Approximately 170,000m^3 of Class 6 material will require importation to Section 3. All material imported and material reused on site will be subject to testing to ensure it is suitable for its proposed end use. It must comply with material properties and constituents as outlined in the TII Series 600 Earthworks Specification. In general, these criteria relate to moisture content, plasticity, density, California Bearing Ratio (CBR), strength and grading. Of the material that will not be suitable for reuse, some may require treatment, and some will be deemed unsuitable and will be deposited in material extraction and deposition areas or used as landscape fill.

Materials required to be imported will be sourced from reputable quarries which are listed on the register maintained by DCC and last updated in 2021. EIAR Drawing 10.14 identifies the location of quarries within the greater area which may be used to source road construction materials.

Subsoil & Bedrock Removal

The removal of soil and bedrock during excavation works is a direct and permanent impact. Subsoils and bedrock removal is an unavoidable consequence of the construction works. The earthworks balance has been designed to maximise the reusability of excavated materials within the site.

Mitigation for where surplus material cannot be reused is the placement of excess subsoil and rock in deposition areas. All requirements to win and dispose of material can be met within the Proposed Development Boundary by the utilisation of MED areas that have been identified within the site: there is no requirement to import earthworks materials. The Waste Management Plan will address the analysis of waste arisings, methods proposed for the prevention, reuse and recycling of wastes and material handling procedures.

In areas of soft soils and peat, excavate and replace options will achieve acceptable settlement limits. Organic peat/soils will be removed.

Soil Erosion Prevention

Erosion and sediment control controls include:

- Temporary fencing will be erected on site indicating the route to be taken by vehicles in order to minimise compaction of soils outside of areas proposed for excavation.
- Slopes considered to be at risk from erosion are to be topsoiled and seeded as soon as possible to prevent deterioration due to weathering effects.
- Where stockpiling of topsoil is required, stockpiles shall be limited to heights not exceeding two metres, shall be battered back to a stable slope, and shall not be unnecessarily trafficked.
- Where stockpiling of overburden is required, stockpiles shall be limited to heights not exceeding four metres, shall be battered back to a stable slope, and shall not be unnecessarily trafficked.
- When the design cut level has been achieved, the slopes shall be battered back to a safe angle of repose and the underlying material shall be protected by immediate covering with construction materials or topsoil, as required.
- Adequate drainage shall be provided to limit and control surface water runoff. There shall be no direct discharge of runoff to watercourse.
- On completion of construction, reinstatement will take place, stockpiled soils will be backfilled and landscaped in accordance with good engineering practice.
- Use of sediment ponds, silt traps and bunds.

Sealing of Overburden Material

Minimising areas and time for exposure of soils – topsoil stripping and subsoil removal will not be carried out over large areas in advance resulting in these areas being exposed for long periods of time. Topsoil and subsoil shall be used immediately following stripping, wherever practicable and shall not be unnecessarily trafficked.

Soil Pollution

The following mitigation measures will be implemented during the construction phase to manage accidental emissions and release of potential hazardous substances:

- The storage and handling of oils, fuel, chemicals and hydraulic fluids will be in secure areas within the site compounds and will not occur within a minimum of 50 m of watercourses.
- All hydrocarbons used during the construction phase shall be appropriately handled, stored and disposed of in accordance with the TII/NRA document "Guidelines for the crossing of watercourses during the construction of National Road Schemes" (NRA, 2008).
- All chemical and fuel filling locations shall be protected from potential spillages through the provision of appropriate protection measures including but not limited to bunded areas and double skinned bowser units with spill kits.

- Storage tanks shall have secondary containment provided by means of an above ground bund to capture any oil leakage. Storage tanks and associated provision, including bunds, shall conform to the current best practice for oil storage and will be undertaken in accordance with Best Practice Guide BPGCS005 – Oil Storage Guidelines (Enterprise Ireland, 2017).
- The pouring of concrete, sealing of joints, application of water-proofing paint or protective systems and curing agents will be completed in the dry weather conditions and allowed to cure for 48 hours in order to avoid pollution of watercourses.
- An Emergency Response Plan (ERP) detailing the procedures to be undertaken in the event of a spillage of chemical, fuel or other hazardous wastes (e.g. concrete) shall be in place prior to commencement of the proposed Scheme. These procedures to be undertaken shall at a minimum include the following:
  - Carry out an investigation to identify the nature, source and cause of the incident and any emission arising therefrom;
  - Isolate the source of any such emission;
  - Evaluate the environmental pollution, if any, caused by the incident;
  - Identify and execute the measures to minimise the emissions/malfunction and the effects thereof;
  - Identify the date, time and place of the incident;
  - Notify the Environmental Protection Agency and other relevant authorities; and
  - DCC and the appointed contractor during the construction phase shall provide a proposal to the Environmental Protection Agency for its agreement within one month of the incident occurring or as otherwise agreed by the Agency to identify and put in place measures to avoid reoccurrence of the incident and identify and put in place any other appropriate remedial action.
- Relevant staff, including cover staff shall be trained in the implementation of the ERP and the use of spill kit / control equipment.
- Plant and equipment shall be maintained in place and in working order for the duration of the works.

10.8.1.2 Hydrogeology

Where predicted impacts have been identified, they can be mitigated as follows:

Groundwater Quality – Accidental Spillages

A specific Environmental Operating Plan (EOP) has been prepared as part of the implementation of these works and will be submitted as part of the planning documents. An Emergency Response Plan (ERP) detailing the procedures to be undertaken in the event of a spillage of chemical, fuel or other hazardous wastes (e.g., concrete) shall be in place prior to commencement of the proposed Scheme.

Construction activities will be undertaken in strict compliance with measures set out in CIRIA's (2006) Control of water pollution from linear construction projects, including:

- Drainage will be provided to collect seepage water and slope angles will be engineered suitable for materials on side slopes.
- Oil interceptors will be provided in order to prevent runoff of pollutants to surface water, which could potentially filter to groundwater. A suitably qualified contractor will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis and including decommissioning at the end of the construction phase.
- Closed drains will be used in areas where there is potential interaction between the drainage waters.
- All potentially harmful substances (e.g. oils, diesel, herbicides, pesticides, concrete etc.) will be stored in accordance with the manufacturer's guidelines regarding safe and secure buildings/compounds and hardstanding areas. Adequate means to absorb or contain any spillages of these chemicals are available at all times.

These measures will ensure groundwater will remain free from pollution.

Domestic Water Wells

The well impact assessment carried out based on the available data, indicates no significant hydraulic impact at any of the wells (with the exception of Holywell). Any well lying within the land take will be replaced by the provision of a new well or by providing a connection to an existing public or group water scheme.

An additional well audit will be carried out at detailed design stage to confirm which, if any of these are impacted, which wells are in use and to confirm there are no other operational wells undetected to date (this is unlikely given the low aquifer yields and the municipal water supply in the area being a surface water source). Those identified will be replaced by the provision of a new well or by providing a connection to an existing public or group water scheme.

The mitigation measures outlined above to protect the groundwater quality will also benefit the domestic wells in the area

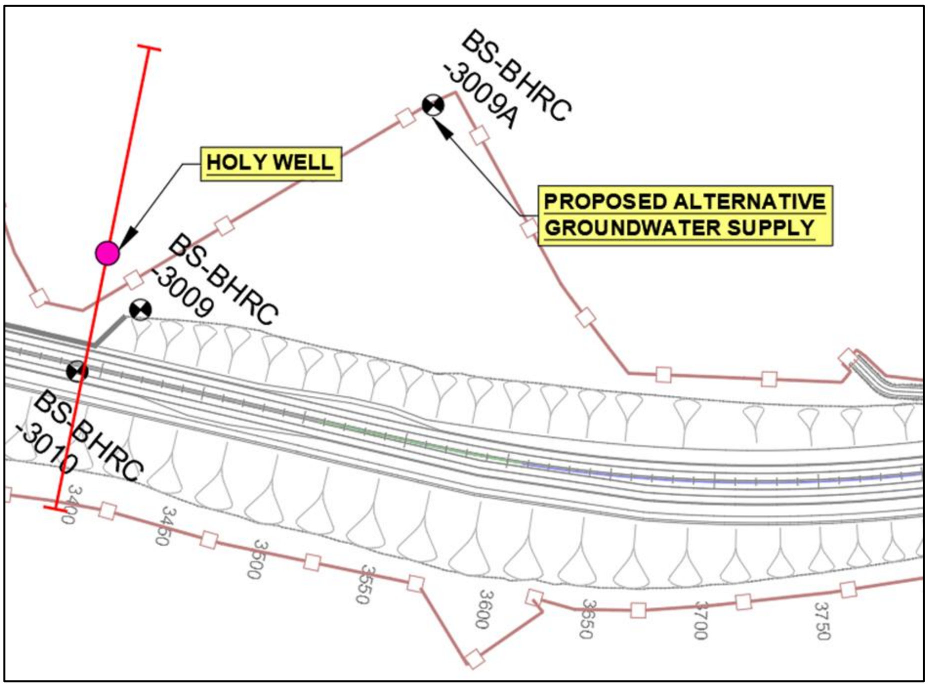
Holywell

The cutting at Holywell is 9m deep and has a 700 m total length. The centre of the cut is located 41 m from Holywell. The average groundwater depth is 4.16 m bgl. Although groundwater flow paths are typically short in this lithology, the obvious scenario is that the groundwater supply to Holywell will be intercepted, therefore the mitigation set out below is based on the worst case scenario; that the groundwater flow path to Holywell will be affected.

It is proposed post-planning to conduct further hydrogeological investigations to ensure that either the current water source can be retained, or an alternative and suitable groundwater source for Holywell from the same aquifer can be identified and provided. The results of focussed field investigations and permeability testing around the Holywell area (refer Section 10.5.1.2) have been used to inform this solution. Post-planning, further hydrogeological investigations are required to further clarify the groundwater yields in the area of Holy Well and to provide site specific validation for aquifer transmissivity

It has been ascertained (in Section 10.7.3.1) that the zone of influence of the cutting is in the order of 3.9 to 13.7 m from the cutting. Outside this zone, it is anticipated that the groundwater flow paths will be unaffected, although this is uncertain as testing was carried out at different times of the year and transmissivity values are derived from published broad datasets. Results will be clarified following further permeability and pump testing post planning.

BSBHRC3009A has been sited outside this apparent zone of influence (refer Figure 10-4) and within the existing land take, with the view to providing an alternative well site and groundwater source. Preliminary pump testing was carried out at this borehole to determine well yield and revealed a yield of 16.34 m^3/day (Low Yield). Based on the average and maximum measured flow rate at Holywell being 1.98 m^3/day and 8.38 m^3/day respectively, in the current situation, there is an adequate groundwater supply at BSBHRC3009A to replicate the ephemeral supply to Holywell in the vicinity of BSBHRC3009A.



*Not to scale. Borehole marker size has been exaggerated for illustrative purposes. Proposed alternative groundwater supply is subject to further testing and commissioning at detailed design stage

Figure 10-4: Location of proposed alternative groundwater source for Holywell (BSBHRC3009A)

The dewatering plan for the construction phase will need to be informed by further focussed hydrogeological monitoring and pump tests around Holywell to determine well yield and to refine the zone of influence of the cutting and potential impact on the proposed supply at BSBHRC3009A. Hydrogeological investigations to date have focused on the impact to Holywell for EIA purposes and investigations to inform dewatering plans will take place post planning.

It is noted however, that although the feed to Holywell is groundwater, it is from a Poor Aquifer with a low yield. Any replacement well site and supply in the locality will also have low yields, even if outside the zone of influence of the cutting.

Arrangements for ensuring this groundwater supply at Holywell is maintained will be developed at detailed design stage and will follow the steps set out below. This arrangement will be designed in conjunction with the development of the proposed woodland amenity area of Dromboe Woods.

Step 1: Conduct further hydrogeological investigations to confirm with certainty that the current water source can/cannot be retained. These investigations will comprise focussed field investigations and permeability testing to better quantify the initial field investigations i.e. pump testing to determine the original source feeding Holywell and to obtain site-specific transmissivity values and aquifer thickness for use in the calculation of Ro.

Step 2: If it is determined that the current source cannot be retained, an alternative groundwater source has been identified to replace current flow at Holywell. As stated above, initial investigations have identified BSBHRC3009A as a potential for providing an alternative groundwater source while retaining the original well site.

Step 3: Determine if yield and flow characteristics of groundwater from the upgradient borehole BSBHRC3009A matches Holywell through pump testing to supplement preliminary pump testing previously carried out at BSBHRC3009A.

Step 4: If BSBHRC3009A is deemed suitable as an alternative source, determine capture method e.g. pipe by gravity, buried pipe, or pump borehole to feed Holywell. The optimum method will be determined by the aforementioned hydrogeological investigations.

10.8.1.3 Summary of Project Wide Construction Phase Mitigation Measures

Table 10.68: Summary of Construction Phase Mitigation Measures- Section 1, 2 and 3

Impact	Mitigation Measure	Summary of Effectiveness	Residual Impact
Importation of Road Construction Materials	Testing of imported and reused material Treatment of unsuitable material Unsuitable material deposited in deposition areas	Ensures suitability for end use Avoids use of landfill for disposal	Imperceptible
Overburden & Bedrock Removal	Utilisation of MED areas for all winning and disposal of earthwork materials	Provides proper treatment to prevent on site leaching of contaminants Avoids use of landfill for disposal	Imperceptible
Erosion, Storage & Stockpiles	Sediment and erosion control techniques such as use of sediment ponds, silt traps and fencing, controlled stockpiling and adequate drainage	Minimises the disturbing of soil, prevents the mobilisation of fines	Imperceptible
Sealing of Overburden Material	Covering of exposed overburden with construction materials or topsoil, as required	Prevents compaction of soil maintain soil integrity and structure	Imperceptible
Soil Pollution	Proper storage and handling of oils, fuels and chemicals, spill protection measures, ERP	Preserves soil quality and integrity	Imperceptible
Removal of Waste	None required. Positive Impact	n/a	n/a
Geological Heritage	None required. Positive Impact	n/a	n/a
Groundwater Quality	Proper storage and handling of oils, fuels and chemicals, proper drainage to prevent runoff of pollutants, spill protection measures, ERP	Preserves groundwater quality	Imperceptible
Domestic Wells	Replacement of impacted wells or connection to an existing public or group water scheme	Ensures security of supply	Imperceptible
Holywell Spring	Replacement supply to replicate the ephemeral supply	Maintains Holywell as a site of cultural importance	Imperceptible

10.8.2 Operational Phase Mitigation Measures - Section 1, 2, & 3

10.8.2.1 Geology

Soil Pollution

Mitigation measures proposed for soil pollution are consistent with the design mitigation measures outlined below for the protection of groundwater, as potential contaminants will travel through soil before entering the groundwater system. As such, measures to protect the groundwater from contamination will also protect the soils i.e. embedded pollution control measures in drainage design to reduce the risk of accidental spillage and protect soil quality.

10.8.2.2 Hydrogeology

Groundwater Quality

The drainage design, consisting of a primary mainline conveyance system and secondary attenuation is outlined in Section 4.7.10 Drainage Infrastructure of Chapter 4: Project Description.

Embedded mitigation is incorporated into the drainage design. The assessment in terms of the groundwater response matrix has indicated that a drainage system designed in accordance with TII Design Manual for Roads and Bridge (DMRB) (included in DN-DNG-03065, Road Drainage and the Water Environment) is acceptable for routine runoff.

The system includes a number of SuDS treatment and Pollution Control components. Sealed drainage will be implemented where deemed acceptable by the groundwater response matrix as per Section 10.5.4 above.

There is 1 no. infiltration pond at the Ballybofey Link Road Ch 0+795 to 1+964, where rock is >3m from the surface).

The drainage system has been specifically designed to reduce the risk of accidental spillage and restrict the pathway to the underlying groundwater environment.

Aquifer Recharge & Storage

As the operational impacts on aquifer recharge volumes has been assessed as Negligible no mitigation is proposed.

Holywell

Once a suitable alternative well site and groundwater supply (BSBHRC3009A or another) has been tested and commissioned, no further mitigation measures will be required during operation.

Climate Change

The Greater Dublin Strategic Drainage Study and the UK Highways Agency publication 'Road Drainage and the water environment' (TII, 2015) (HA216/06) recommend that the sensitivity of the drainage design to a factored increase on present day rainfall depths for all durations and return periods is established and that, where necessary, make provisions for this in drainage design. The NRA (now TII) guidelines state that 'Assessment of return periods of both serious accidents and resulting pollution incidents should take account of anticipated increases in rainfall intensity as a result of future climate change'.

The proposed surface water drainage network is designed to allow for an increase of 20% in flow rates in attenuation ponds with an additional 300 mm freeboard to cater for the effects of climate change, in line with OPW and TII requirements. There is therefore no impact predicted in terms of climate change as a result of the Proposed Development.

10.8.2.3 Summary of Project Wide Operational Phase Mitigation Measures

Table 10.69: Summary of Operational Phase Mitigation Measures- Section 1, 2 and 3

Impact	Mitigation Measure	Summary of Effectiveness	Residual Impact
Soil Pollution	Drainage design, consisting of a primary mainline conveyance system and secondary attenuation	Collection and control of runoff preventing leaching of contaminated runoff to underlying soil and subsoils	Imperceptible
Aquifer Recharge and Storage	As the operational impacts on aquifer recharge volumes has been assessed as negligible no mitigation is proposed	n/a	Imperceptible
Groundwater Contamination	Drainage design, consisting of a primary mainline conveyance system and secondary attenuation	Collection and control of runoff preventing contaminated runoff reaching surface and/or groundwater bodies	Imperceptible
Climate Change	Compliance with OPW and TII drainage design requirements	Allows for an increase in flow rates to attenuation ponds	Imperceptible

10.9 Predicted Residual Impacts

This section of the report assesses the predicted residual impacts of the project as a whole; Section 1, Section 2 and Section 3. It is planned that all three Sections of the Proposed Development will be progressed as one project. However, there may be a phased approach taken to the procurement and award of the contracts for the different Sections.

It is anticipated that the construction of all three Sections of the Proposed Development will be carried out in a number of stages. Each stage will include a Section, which may be further divided into smaller sub-sections of road typically depending on local constraints. The associated typical construction period will vary between Sections.

The different stages of the construction for each Section will include further ground investigations and survey works, utilities and services diversions, fencing and site clearance and the main construction works. These are all outlined in further detail in Chapter 4: Project Description.

An overall analysis of the impacts concludes that all of the potential impacts (both during construction and operational phase) are predicted to be reduced to **Imperceptible** (see Table 10.68 and Table 10.69, above) with the successful implementation of the mitigation measures outlined in Section 10.8.

10.10 Transboundary Effects

Section 3 of the Proposed Development includes the N14/N15 to A5 Link south of Lifford to the border with Northern Ireland on the River Finn where it will connect to a proposed Trunk Road T3 (A5 Western Transport Corridor to Land Frontier), which in-turn will connect to the proposed A5 Western Transport Corridor (WTC). The Finn Valley is a broad valley predominantly overlooked by residential development on rising slopes west of the N15 at Coneyburrow / Curraghalane. The N14/N15 to A5 Link is located to the south of Lifford and the south east of Strabane and is approximately 306 m in length to the border with Northern Ireland. It is proposed to pile the structure and surcharge the embankment on both sides of the bridge. The earthworks proposed will have no transboundary effects.

10.11 Monitoring

Based on the conclusions of the impact assessment and residual effects, specific monitoring of land, soils, geology or hydrogeology is not considered necessary during the construction phase.

Post-construction phase monitoring of groundwater wells identified in the vicinity of cuts (refer to Table 10.50 (Section 1), Table 10.54 (Section 2), and Table 10.57 (Section 3) are to be carried out for a period of three months.

10.12 Summary and Conclusions

Table 10.70: Summary of Potential Environmental Effects, Mitigation and Monitoring Sections 1, 2, 3

Description of Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect	Mitigation Measures	Residual Effect
Construction Phase - Soils and Geology					
Importation of Road Construction Materials	Low	Negligible	Imperceptible	Testing of imported and reused material & treatment of unsuitable material Unsuitable material deposited in deposition areas	Imperceptible
Overburden Removal	Low	Small Adverse	Imperceptible	Removal off site for treatment, recycling or disposal Placement of excess material in deposition areas	Imperceptible
Bedrock Removal	Low	Minor to Moderate Beneficial	-	-	-
Erosion, Storage & Stockpiles	Low	Small Adverse	Imperceptible	Sediment and erosion control techniques such as use of sediment ponds, silt traps and fencing, controlled stockpiling and adequate drainage	Imperceptible
Sealing of Overburden Material	Low	Negligible	Imperceptible	Covering of exposed overburden with construction materials or topsoil, as required	Imperceptible
Soil Pollution	Low	Small Adverse	Imperceptible	Proper storage and handling of oils, fuels and chemicals, spill protection measures, ERP	Imperceptible
Removal of Waste	Low	Minor Beneficial	-	None required. Positive Impact	-
Geological Heritage	High	Moderate Beneficial	-	None required. Positive Impact	-
Construction Phase - Hydrogeology					
Groundwater Quality	Low (PI aquifer) Medium (LI aquifer) Extremely High (River Finn SAC)	Small Adverse Small Adverse Negligible	Imperceptible Slight Imperceptible	Proper storage and handling of oils, fuels and chemicals, proper drainage to prevent runoff of pollutants, spill protection measures, ERP	Imperceptible
Domestic Wells	Low	Small Adverse	Imperceptible	Replacement of impacted wells or connection to an existing public or group water scheme	Imperceptible
Holywell Spring	High	Moderate Adverse	Significant/Moderate	Replacement supply to replicate the ephemeral supply	Imperceptible

Description of Impact	Receptor Importance Rating	Magnitude of Impact	Significance of Effect	Mitigation Measures	Residual Effect
Operational Phase - Soils and Geology					
Soil Pollution	Low	Small Adverse	Imperceptible	Drainage design, consisting of a primary mainline conveyance system and secondary attenuation	Imperceptible
Operational Phase - Hydrogeology					
Aquifer Recharge	Low (PI Aquifer) Medium (LI Aquifer)	Negligible Negligible	Imperceptible Imperceptible	As the operational impacts on aquifer recharge volumes has been assessed as negligible no mitigation is proposed.	Imperceptible
Aquifer Storage	Low (PI Aquifer) Medium (LI Aquifer)	Negligible Negligible	Imperceptible Imperceptible	As the operational impacts on aquifer recharge volumes has been assessed as negligible no mitigation is proposed.	Imperceptible
Groundwater Quality	Low (PI Aquifer) Medium (LI Aquifer) Extremely High (River Finn SAC)	Negligible Negligible Negligible	Imperceptible Imperceptible Imperceptible	Drainage design, consisting of a primary mainline conveyance system, sealed drainage and secondary attenuation	Imperceptible
Climate Change	Low (PI Aquifer) Medium (LI Aquifer)	Small Adverse Small Adverse	Imperceptible Slight	Compliance with OPW and TII drainage design requirements	Imperceptible

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