12 Land, Soils, Geology and Hydrogeology

12.1 Introduction

This Chapter of the EIAR considers and assesses the likely significant effects with regard to land, soils, geology and hydrogeology associated with both the construction phase and operational phase of the proposed development. Measures to mitigate any likely significant adverse effects of the proposed development on the land, soils, geology and hydrogeology near the proposed development are proposed within this chapter.

The proposed development consists of the following permanent and temporary elements:

The proposed development (encompassing the onshore elements in Ireland only) will comprise:

- **Landfall Compound** – a temporary landfall compound at Baginbun, where the high voltage direct current (HVDC) cable will be installed underground, below the beach and cliff at Baginbun Beach, by horizontal directional drilling (HDD);
- **HVDC Cables** – two HVDC electricity cables with a nominal capacity of 500 megawatts (MW), installed underground from the landfall at Baginbun to the converter station, including jointing bays and ground level marker posts at intervals along the route;
- **Converter Station** – a converter station situated close to the existing Eirgrid 220kV Great Island substation in Wexford;
- **Tail Station-** A 220kV Loughtown substation located beside the converter station. The tail station connects the HVAC 220kV cable into the 220kV grid via the existing Eirgrid Great Island substation.
- **Converter Station Construction Compound:** temporary compound for the construction of the converter station and tail station at Great Island.
- **Cable Contractor Compounds** – three temporary cable contractor compounds will be required (i) at the landfall site close to Baginbun Beach (ii) at the proposed converter station and (iii) one along the onshore route in the townland of Lewistown;
- **HDD Compounds** – temporary HDD contractor compounds are required. One will be located close to the cable contractor compound at Baginbun Beach with another HDD compound located at either side of the Campile River Estuary crossing;
- **High Voltage Alternating Current (HVAC) Cables** – one 220 kV HVAC electricity cable circuit consisting of three cables, installed underground connecting the converter station via the Loughtown tail station to the existing EirGrid substation;
- **Fibre Optic Cables** – fibre optic cables for operation and control purposes, laid underground with the HVDC and HVAC cables;

- **Community Gain Roadside Car Parking near Baginbun Beach** – in consultation with Wexford County Council, circa 54 roadside car parking spaces will be constructed; and
- **Community Gain in Ramsgrange Village** – in consultation with Wexford County Council, extension to existing footpaths, four new street lights and a speed activated sign at Ramsgrange.

A detailed description of the proposed development, including design, operation and decommissioning of the proposed development are described in **Chapter 3** whilst **Chapter 4** provides an outline of the general activities associated with the construction of the proposed development.

An assessment is made of the likely significant effects associated with the construction, operation and decommissioning of the proposed development on these resources. Potential effects on water and hydrology are documented in **Chapter 13** of this EIAR.

This chapter was prepared by Greg Balding, Gerry Baker and Marie Fleming. Greg is an experienced chartered engineering geologist, with an MSc in Engineering Geology. Gerry is a specialist hydrogeologist, with 18 years' experience. He has an MSc in Sustainable Management of the Water Environment. Marie is an experienced chartered geologist with an MSc and a DIC in Engineering Geology. **Appendix 1.1** provides further details of the authors' qualifications and experience.

12.2 Assessment Methodology

12.2.1 General

The following section outlines the land, soils, geology and hydrogeology assessment, the legislation and guidelines considered, and the adopted methodology for preparing this chapter.

The potential effects of the proposed development on land, soils, geology and hydrogeology has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any effect on these attributes.

12.2.2 Guidelines and Legislation

This chapter has been prepared using the following guidelines:

- Environmental Protection Agency (EPA, 2017). *Guidelines on the Information to be contained in Environmental Impact Assessment Reports*. Draft;
- European Communities (Water Policy) Regulations 2014 (S.I. No. 350 of 2014);
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended by the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2011 (S.I. No. 389 of 2011), the European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2012 (S.I. No. 149 of 2012) and the European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016);
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009) as amended by the European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2012 (S.I. No. 327 of 2012);
- European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2015 (SI No. 386 of 2015);
- European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (SI No. 77/2019);
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003) as amended by the European Communities (Water Policy) (Amendment) Regulations, 2005 (S.I. No. 413 of 2005);
- European Communities (Water Policy) (Amendment) Regulations, 2008 (S.I. No. 219 of 2008);
- European Communities (Water Policy) (Amendment) Regulations, 2010 (S.I. No. 93 of 2010);
- European Communities (Drinking Water) Regulations 2014 (S.I. No 122 of 2014), as amended by the European Union (Drinking Water) (Amendment) Regulations 2017 (S.I. No. 464 of 2017);

- European Communities (Quality of Salmonid Waters) Regulations 1988 (SI no. 293 of 1988); and
- Institute of Geologists of Ireland (IGI, 2013). *Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements*;
- National Roads Authority (NRA, 2008). *Environmental Impact Assessment of National Road Schemes – A Practical Guide*;
- National Roads Authority (NRA, 2008). *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.
- The EU Water Framework Directive (WFD), 2000/60/EC;
- The Groundwater Directive, 2006/118/EC;
- Water Services Acts (2007 – 2017).

12.2.3 Impact Assessment Methodology

The likely significant effects have been assessed by classifying the importance of the relevant attributes and quantifying the magnitude of any likely significant effects on these attributes. This has been undertaken in accordance with the IGI guidance which outlines a 13-step methodology that is divided across four distinct elements:

- Initial Assessment;
- Direct and Indirect Site Investigation;
- Mitigation Measures, Residual Effects and Final Impact Appraisal; and
- Completion of the Land, Soils, Geological and Hydrogeological Sections of the EIAR.

Initial Assessment

The 'Initial Assessment' presents a description of the past and present uses of the land across the relevant sites and route which may have a bearing on the proposed development. This includes a detailed description of the nature of the ground conditions beneath the relevant sites and route based on existing literature as well as site specific and neighbouring site investigation data.

Direct and Indirect Site investigation

Section 12.2.5.1 provides a summary of on the data available from the site-specific investigations carried out between December 2018 and March 2019. The information gathered on the baseline environment during ground investigations corresponds to the second element of the methodology, 'Direct and Indirect Site Investigation and Studies'.

Mitigation Measures, residual effects and Final Impact Assessment

The outcome from examining this available data is a Conceptual Site Model (CSM). The CSM is a summary of geological conditions beneath the proposed development that considers the likely significant effects of the proposed development.

A 'Feature Importance Ranking' is then assigned to each feature (likely to be affected by the proposed development based on guidance from the NRA and IGI). This facilitates the assessment of likely significant effects which has been undertaken in accordance with the guidance outlined in **Section 12.2.2.**

Section 12.8 outlines the "Mitigation Measures" associated with the works in accordance with the above methodology.

12.2.4 Study Area

The land, soils, geology and hydrogeology study area for the proposed development extends two kilometres either side of the proposed route and site, covering the HVAC cable, the converter station and tail station site, the sites of the construction compounds, the HVDC cable route and the landfall site.

12.2.5 Categorisation of the Baseline Environment

In order to identify and quantify the potential impact of the construction phase and operational phase (including decommissioning) of the proposed development, it is first necessary to undertake a detailed study of the (baseline) geological and hydrogeological environment of the study area. The existing land, soils, geology and hydrogeology conditions in the area have been interpreted from both desk study information and from project specific site investigations.

Site walkovers were carried out at various stages of the works along with site monitoring during the site-specific ground investigation works.

While there was an extensive list of Statutory Consultees, the following bodies were contacted in relation to the preparation of this Chapter:

State/Semi-State Organisations:

- Geological Survey of Ireland.

12.2.5.1Desk Study Information

As part of the desk study that was undertaken to establish the baseline conditions the following sources of information were reviewed:

- OSI, current and historical Ordnance Survey (OS) maps available for the study area [online], OSI website, Available at: http://map.geohive.ie/mapviewer.html , accessed 02/08/19;
- OSI, Aerial photography [online], OSI website, Available at: http://map.geohive.ie/mapviewer.html , accessed 02/08/19;
- Google, Aerial photography (2018) [online], Google maps, accessed 02/08/19;
- Bing, Aerial photography (2018) [online], Bing maps, accessed 02/08/19;

- GSI, geological maps of the site area produced by the Geological Survey of Ireland [online], GSI Geohive, available at: http://map.geohive.ie/mapviewer.html, accessed 02/08/19, including;
  - Quaternary Maps (GSI);
  - Bedrock Mapping;
  - Groundwater Mapping;
  - National Landslide Database (GSI);
  - Karst Database (GSI);
  - Historic Mine Sites - Inventory and Risk Classification;
- County Geological Sites (CGS) & Geological Heritage Areas (GHAs) (GSI);
- Geological Survey of Ireland, Memoirs;
- INFOMAR Seabed Mapping;
- British Geological Survey (BGS) 1:250,000 Offshore Bedrock Map;
- Teagasc and the Environmental Protection Agency Irish Soil Information System [online], available at: http://gis.teagasc.ie/soils/index.php, accessed 02/08/19;
- EPA, Corine Land Cover 2012 datasets, [online], available at: https://gis.epa.ie/EPAMaps, accessed 02/08/19;
- GSI (2001), Directory of Active Quarries, Pits and Mines in Ireland (GSI, 3rd Edition), GSI;
- Department of Communications, Energy and Natural Resources, (2011), State Mining and Prospecting Facilities, [online] Available at: http://www.mineralsireland.ie/files/Competition_Booklet_May2011_web.pdf, Accessed 02/08/19;
- EPA, Historic Mine Sites - Inventory and Risk Classification, [online], Available at: https://gis.epa.ie/EPAMaps accessed 02/08/19;
- National Parks and Wildlife Service, Proposed / Designated NHA, SPA, SAC Sites, [online], Available at: http://webgis.npws.ie/npwsviewer/, accessed 02/08/19; and
- EPA, Office of Licencing and Guidance, [online], Available at: https://gis.epa.ie/EPAMaps accessed 02/08/19.

12.2.5.2Project Specific Information

The following project specific ground investigations were completed:

- MMT Sweden AB – Greenlink Interconnector, Geotechnical Report, 102953-GRL-MMT-SUR-REP-GEOTECRE, Revision 3, September 2019.
- IGSL Ltd, Greenlink Interconnector, Onshore Ireland Intrusive Ground Investigation, Project No. 21475, April 2019;
- Apex Geoservices, Report on the Geophysical Investigation for the Greenlink Interconnector, Co. Wexford for Greenlink Interconnector Ltd. AGP18019_03, April 2019; and

- Terradat, Geophysical Survey Report, Seismic refraction to characterise superficial and bedrock geology Baginbun Beach for MMT Ltd, 19th November 2018

These reports are included in **Appendix 12.1**.

12.2.5.3 Nearshore Ground Investigation

A marine geophysical and geotechnical subsea and nearshore survey with laboratory analysis of the subsea cable route was carried out by MMT Sweden AB in April 2019.

The ground investigation comprised two boreholes in Baginbun Bay, which were drilled from a jack-up barge. The boreholes were constructed using light cable percussion boring till refusal was met. After this point rotary drilling was used.

12.2.5.4 Onshore Ground Investigation

An intrusive ground investigation was carried out by IGSL Ltd between January and March 2019.

The ground investigation consisted of:

- 14 No. of boreholes. The boreholes were constructed using light cable percussion boring till refusal was met. After this point Geobor-S rotary drilling was used. All boreholes were completed to the scheduled depth.
- 6 No. standpipes within the rotary core boreholes;
- 6 No. trial pits which were excavated to a maximum depth of 3.0m; and
- 12 No. Slit trenches were excavated along the cable route to identify shallow ground deposits and potential services.

Three boreholes and two trial pits were located in the vicinity of the HDD compound at the landfall site near Baginbun Beach. Two boreholes and one trial pit were located at both the HDD entry point and the exit point for the crossing of the Campile River Estuary, outside the boundary of the River Barrow and River Nore SAC. Three boreholes and one inspection pit were located at the point where the cable route passes under the railway bridge, immediately to the east of the converter station site. Four boreholes and two trial pits were located in the converter station and tail station site.

12.2.5.5 Geophysical Surveys

Geophysical surveys were undertaken by both Terradat and Apex Geophysics.

Terradat's geophysical investigation focused on the intertidal zone and onshore area of the proposed landfall and HDD drilling location at Baginbun Beach.

Terradat's geophysical investigation was carried out between the 21st and 25th October 2018. The geophysical survey consisted of a seismic refraction survey to investigate the shallow geology at the proposed landfall HDD site for the Greenlink Interconnector project.

Apex Geophysics carried out at a geophysical investigation at a number of locations including the Great Island converter station site, selected areas along the onshore cable route and the landfall site. The Apex geophysical investigation was carried out over two periods in December 2018 and January 2019 to support the results of the intrusive investigation, investigate the presence of any anomalies and investigate the nature of the subsoils within the converter station site boundary.

The geophysical investigation comprised:

- Thermal Resistivity;
- Electromagnetic Survey (EM);
- Seismic Refraction (p-wave); and
- Electrical Resistivity Tomography (ERT).

The objectives of the geophysical ground investigation were to map the type and the thickness of the sediment layers, determine sediment stiffness, map the depth to bedrock, map variation in bedrock type and rock quality and determine engineering parameters.

12.2.6 Technical Limitations

The baseline data described and considered in this assessment includes existing data from desk study information available at the time in the region as well as dedicated field surveys commissioned specifically for the proposed development. The data collected provides comprehensive information on land, soils, geology and hydrogeology within the study area.

The baseline data from the intrusive investigation provides valuable information on the existing soils, geology and hydrogeological environment at point locations within the study area. Between each point the baseline data from the intrusive investigation has been assessed by conservative interpretation. While land, soils, geology and hydrogeology can vary, the exploratory locations have been selected following the completion of the comprehensive review of all existing information available at the time.

This review was completed by studying local geological maps, aerial photography, historic ground investigation and completing site walkovers to provide an understanding of the study area. The locations and the spacing of the exploratory locations used as part of the intrusive investigation were chosen in order to gain an understanding of the soils, geology and hydrogeology. The findings from the investigations for most cases compared favourably with the desk study of existing information on the baseline conditions.

As is common in most construction projects, ground models for proposed developments are based upon numerous information sources such as, but not limited to geological maps, historic investigations in the area and overburden mapping. By examining the existing landforms and understanding the geological history and geomorphology of a site, these can all be used to assist in constructing a robust ground model. This ground model should then be assessed and confirmed through the project specific ground investigation.

However, there were some limitations in gaining a full ground interpretation at the Campile River Estuary Crossing within the boundary of the River Barrow and River Nore SAC prohibiting the movement of machinery within this area. No intrusive ground investigation was carried out within the boundaries of the SAC to determine the depth of soft ground deposits and to confirm the depth to bedrock.

The interpretation at this location has been based on an understanding and appreciation of the ground conditions underlying the SAC from all available sources including the findings of the intrusive investigations outside the boundary of the SAC. The interpretation should be updated if any further information becomes available.

Based on the comparability of the results from the investigations commissioned specifically for the proposed development and the desk study of existing information on the baseline conditions, the information on the baseline conditions (as described in **Section 12.2.5**) is deemed sufficient.

12.3 Baseline Environment

12.3.1 Introduction

This section describes the existing land, soils, geology and hydrogeology within the study area. A regional overview is provided in terms of the geomorphology, topography, soils, solid geology and hydrogeology of the local area followed by sub sections identifying the feature importance ranking, in accordance with the IGI guidelines, of the agricultural soils, superficial deposits, bedrock geology, soft and unstable ground, contaminated land, karst solution features, mineral and aggregate resources and geological heritage sites within the study area.

Chapter 3 *Proposed Development* of the EIAR outlines the proposed development.

When examining the receiving environment of the study area, the proposed development has been divided into sub-sections based on the main elements for ease of presentation and due to the volume of information available.

The subsections of the proposed development are as follows:

- Converter Station, near Great Island (including the HVAC connection to the existing substation and tail station, and temporary contractors' compounds)
- Onshore Cable Route – Converter Station to Baginbun landfall (including the temporary contractor's compound in Lewistown)
- Landfall, Baginbun Beach (including temporary contractors' compounds).

The CSM is tabulated in **Section 12.3.4**.

12.3.2 Regional Overview

The onshore routing in Ireland will connect from the Irish landfall site near Baginbun Beach to a converter station site adjacent to the Great Island power station and from the converter station via the tail station to the Great Island 220kv substation.

The cable route from the Great Island converter station to the 220kV substation will be approximately 23km in length.

12.3.2.1Regional Geomorphology and Topography

The northern area of the proposed development displays a gently undulating topography with an average elevation of approximately 35m OD with localised topographic highs generally synonymous with outcropping rock or near surface bedrock. The topographical lows are associated with remnants of glacial meltwater channels and the existing estuarine channel of the Campile River.

The landscape of the region principally reflects the erosional and depositional environment of the last glaciation. The area is dominated by bedrock plains surrounded by flat to gently undulating glacial sediments.

The post-glacial landscape reflects the effects of fluvial (river) processes that have altered the topography, albeit only to a small extent in this area.

The proposed cable route intercepts a number of rivers and associated tributaries as outlined in **Chapter 13** *Water and Hydrology*.

Great Island Power Station is situated adjacent to the confluence of the Rivers Suir and Barrow extending to the Barrow Estuary which enters the Celtic Sea.

In general, the coastline in the vicinity of the proposed development is characterised by a rocky coastline with generally low and rocky cliffs interspersed with sandy beaches.

12.3.2.2Regional Soils and Subsoils

According to the Teagasc mapping, the underlying soils in the study area are generally described as deep well drained mineral soil from acidic parent material, encountering acidic mineral poorly drained soils, with areas of bedrock at the surface, shallow poorly drained mineral soils and alluvium (**Figure 12.1**).

Made ground will be encountered in built up areas and along existing roads (generally comprising road pavement).

The regional subsoil geology of the study area is dominated by a cover of glacial till intersected by alluvial sediments associated with rivers and streams (**Figure 12.2**).

Alluvial deposits with marine estuarine sediments are encountered adjacent to the Campile River Estuary near Great Island and are likely to be encountered adjacent to any existing waterbodies. These are likely to be highly variable comprising clays and silts or sands and gravels.

While no peat is identified from regional mapping within the study area, to the east of the peninsula, there are deposits noted, recorded as fen peat.

According to the Geological Survey of Ireland (GSI) quaternary maps the glacial tills along the route are comprised mainly of glacial till from lower Palaeozoic shales. Where till is absent, or subsoil cover is very thin, rock is likely to be present close to the surface or outcropping. Beach sediments are located along coastal areas.

12.3.2.3Regional Bedrock Geology

The GSI online 1:100,000 bedrock geology mapping indicates that the survey area is underlain by Cambrian, Ordovician and Devonian bedrock (**Figure 12.3**).

The Devonian rocks are the youngest rocks in the study area and are only encountered in the southern sections of the proposed development. The Devonian Bedrock succession consists of the Templetown Formation which comprises red conglomerates and sandstones.

Ordovician bedrock dominates the Northern part of the study area in the area around Great Island, Campile, Ramsgrange and Duncannon with the older Cambrian bedrock dominating the southern part of the study area to the landfall at Baginbun Bay.

The Ordovician Bedrock is comprised of the Campile Formation which comprises a number of members. The Great Island and Campile area is underlain by a highly complex heavily faulted geological succession consisting of primarily felsic and rhyolitic volcanics.

In the study area around Ramsgrange, the geology transitions into the Ballyhack Member consisting of grey slates with thin siltstones and the Arthurstown Member consisting of red, purple and green slates and siltstones. These geological units also form part of the Campile formation.

The Cambrian Bedrock is comprised of the Booley Bay Formation which is composed of meta-sediments in the form of greywacke, slate and quartzite. These are also described by the GSI as grey to black mudstones with siltstones.

The Great Island area is a heavily faulted and folded region. Generally, the structural regime in the area is north south trending and is most evident between the contact of the Ordovician and Cambrian bedrock units.

The geological constraints for the region are shown on **Figure 12.4**. The geological constraints map identifies the mineral deposits, active quarries and geological heritage zones for the study area.

12.3.2.4Regional Hydrogeology

Aquifer Type and Classification

The GSI has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource. The aquifer classes and sub-classes are shown in the National Draft Bedrock Aquifer Map.

There are three principal types of aquifer, corresponding to whether they are major, minor or unproductive resources. These are further subdivided into 10 aquifer categories in **Table 12.1**.

Table 12.1: Aquifer Types

Aquifer Type	Description	Code
Regionally Important (R)	Karstified Bedrock dominated by diffuse flow	(Rkd)
	Karstified Bedrock dominated by conduit flow	(Rkc)
	Fissured bedrock	(Rf)
	Extensive sand & gravel	(Rg)
Locally Important (L)	Sand & gravel	(Lg)
	Bedrock which is Generally Moderately Productive	(Lm)
	Bedrock which is karstified to a limited degree or limited area	(Lk)
	Bedrock which is Moderately Productive only in Local zones	(Ll)
Poor (P)	Bedrock which is Generally Unproductive except for Local zones	(Pl)
	Bedrock which is Generally Unproductive	(Pu)

The GSI Bedrock Aquifer mapping for the study area indicates that there are two main aquifer types within the study area (**Figure 12.5**). A Regionally Important Aquifer, Rf – classified due to the presence of fissured bedrock, the regionally important aquifer is in the northern part of the study area around Great Island and Campile within the volcanics of the Campile Formation.

The remainder of the study area is underlain by a Poor Aquifer, Pl which is described by the GSI as bedrock which is generally unproductive except for local zones.

Under the Water Framework Directive, the GSI have delineated a number of groundwater bodies (GWB) in Ireland. In the study area the following two GWB have been identified (**Figure 12.6**):

- Adamstown GWB
- Fethard GWB

Aquifer Vulnerability

Aquifer vulnerability of a groundwater body is the term used to describe the intrinsic geological and hydrogeological characteristics which determine the ease with which a groundwater body may be contaminated by human activities.

The vulnerability is determined by the travel time and quantity of contaminants and the attenuation capacity of the overlying deposits. The groundwater vulnerability is determined mainly by the permeability and thickness of the subsoils that underlies the topsoil. The type of recharge is also considered in karstic areas in the area (point or diffuse). For example, bedrock with a thick, low permeability overburden is less vulnerable than bedrock with a thin high permeability, gravel overburden.

Aquifer vulnerability classification guidelines, as published by the GSI, are given in **Table 12.2** which demonstrates that the aquifers are most at risk in areas where subsoils are thin or absent and where karst features such as swallow holes are present. This is due to the ability of potential contaminants to reach the aquifer in a relatively short period and with little or no contaminant attenuation due to the thin or absent overburden.

Table 12.2: Aquifer Vulnerability

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	Sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0-10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable
(2) Precise permeability values cannot be given at present.

Regional Groundwater Vulnerability varies significantly throughout the region (**Figure 12.7**). The GSI database shows the northern section of the study area to have high to extreme groundwater vulnerability with rock at or near the surface in some areas. Moving southwards towards Ramsgrange and Duncannon the groundwater vulnerability is classified as low to moderate. The southern section of the study area is classified as having high to extreme groundwater vulnerability with extreme areas having some rock at or near the surface.

Groundwater abstractions

Groundwater resources describe any large spring, well or boreholes which are used as a groundwater abstraction source by domestic, agricultural, commercial, industrial, local authority or group water scheme users.

Source Protection Zones (SPZ) reports have been produced by the GSI and the EPA. The reports aim to guide development planning and regulation to provide protection to groundwater sources. To date no SPZ reports have been produced for any location within the study area.

Hydro-ecology

The NPWS online database has been consulted to establish whether areas with national or international important ecological sites are located within the vicinity of the study area and are highlighted in **Table 12.3**.

Groundwater dependant habitats may be impacted by any potential option through accidental contamination, localised flooding or the alteration of base-flow supplies to wetlands causing the area to dry out.

Ecological features or habitats which need to be protected have designations based on Irish, European or international law. These designations include: Special Protection Area (SPA), Special Area of Conservation (SAC), National Heritage Area (NHA) and proposed National Heritage Area (pNHA).

Table 12.3: Summary of Hydro-Ecology

Site	Code	Description
Special Area of Conservation (SAC)		
River Barrow & River Nore	002162	0m. The crossing point of the Campile Estuary, downstream of Campile is located within this SAC. All onshore cable route options considered cross the SAC (described in Chapter 2 of this EIAR).
Hook Head	000764	10m. Baginbun Beach landfall site is close to this SAC.
Bannow Bay	000697	300m north of onshore cable route near Fethard.
Lower River Suir	002137	1.2km west of the proposed Great Island converter station.
Ballyteige Burrow	000696	8.7km east of Baginbun beach in Coolcull townland.
Saltee Islands	000707	9.7km south east of Baginbun Beach landfall site.
Tramore Dunes and Backstrand	000671	11.6km west of the onshore cable route.
Special Protection Area (SPA		
Bannow Bay SPA	004033	1km north of onshore cable route near Fethard.
Keeragh Islands	004118	6.2km east of Baginbun Beach landfall site.
Ballyteige Burrow SPA	004020	9.2km east of Baginbun Beach in Coolcull townland.
Tramore Back Strand	004027	11.7km west of the onshore cable route.

The Hydrogeological constraints are shown on **Figure 12.8**. The drawing shows the Natura 2000 and other designated sites within the study area. It also highlights wells and their location accuracy along with groundwater recharge for the proposed site and routes.

12.3.3 Site Specific Environment

12.3.3.1 Geomorphology and Topography

Converter station, tail station, temporary construction compounds and HVAC cable

The site area is circa 9.3 ha (23 acres). The converter station and tail station footprint is 1.96ha. The topography of the entire site varies from 0.00mOD to 30mOD. The topography of the footprint has a much narrower range approx. 21.5 to 26 mOD. The site area is currently agricultural land. The site has a varied topography generally sloping to the north, east and south. The lower ground surrounding the converter station is tidal marsh and lake alluvium and the historic maps indicate this area as being an area of reclamation.

The geomorphology of the site is dominated by bedrock plains and the topographic lows around Great Island are associated with remnants of glacial meltwater channels.

Cable Route and temporary construction compound in Lewistown

The proposed onshore underground cable route from the converter station and tail station to the landfall is approximately 23km long across a gently undulating landscape comprised mainly of agricultural land, rivers and interspersed residential and mixed-use buildings. The topography varies significantly along the route with topographic highs of 70 mOD noted around Ramsgrange.

The proposed HDD crossing of the Campile River Estuary is located near Dunbrody Abbey. The fields to the north and south of the crossing are both agricultural land. The topography of the site varies between 0m OD and 20m OD.

The geomorphology of the cable route is dominated by bedrock plains with flat undulating sediments identified around Ramsgrange. The topographical lows are associated with remnants of glacial meltwater channels and the existing estuarine channel of the Campile River.

Landfall and temporary construction compounds near Baginbun Beach

The topography of the site is for the most part flat, dipping towards the sea from 15mOD in the west to 10.75mOD in the eastern part of the site. The proposed HDD site is currently used as agricultural land. Rocky Cliffs with a thin covering of Irish Sea Till are located to the east of the site adjacent to Baginbun Beach. The beach is generally sandy with outcropping rock interspersed along the shoreline.

12.3.3.2Soils and Subsoils

Subsoil deposits were established based on the Irish National Soil Map 1:250,000, the Teagasc Subsoil Map and relevant ground investigation information along the proposed road development.

A summary of the soil and subsoil deposits is presented in **Table 12.4**.

Converter station and tail station site, temporary construction compounds and HVAC cable

The Teagasc soil mapping identifies the soils underlying the converter station site as shallow, well drained, fine loamy drift soils with siliceous stones. The mapping shows the lower ground to be tidal marsh. (**Figure 12.11**).

The GSI online database for the converter station site indicates that the north and western parts of the site is underlain by shallow bedrock, at or close to the surface. In turn, the southern and eastern parts of the site are indicated as underlain by estuarine silts and clays. Glacial Till derived from Lower Palaeozoic shales is present to the north of the site outside the site perimeter (**Figure 12.10**).

The intrusive investigation indicated the topsoil across the site had an average thickness of 0.30m and was generally described as dark brown slightly sandy clay/silt with rootlets.

Glacial till deposits were encountered during the project specific ground investigation and have been interpreted as firm to stiff silt/clay and sandy gravelly silt/clay in the north part of the site and medium dense clayey sand/gravel to moderately weathered rock through the centre of the site with an average thickness of 3.7m. The thickness of the glacial till varies from 0.10m to 5.60 m (approximately 26 m OD to -1 m OD).

The geophysical investigation was carried out on the lower lands at Great Island either side of the railway track. The geophysical investigation identified very soft to firm soils with an average thickness of 3m south of the track. The geophysical investigation on the northern side of the track identified thick saturated estuarine silt deposits to depths of up to 15m bgl.

Cable Route and temporary construction compound in Lewistown

The Teagasc soils map for the cable route identifies well drained fine-grained loamy drift soils with siliceous stones throughout the proposed development particularly in the northern sections around Great Island and Ramsgrange (**Figure 12.11**). Tidal marshes and mudflats have been identified at Great Island and the Campile River Estuary.

Alluvial deposits are generally located at or close to water bodies in particular rivers and streams. The southern section of the route has identified as including fine loamy drift soils with siliceous stones.

The subsoils map for the area has identified rock at or near the surface and acid volcanic tills in the northern parts of the cable route (**Figure 12.12**). South of Ramsgrange the subsoils are predominantly identified as shale tills with occasional outcrops of rock at or near the surface.

The project specific ground investigation identified a shallow cover of made ground (road pavement and subbase) overlying glacial till. The base of the glacial till was not confirmed in the ground investigation. The till has been described as firm to stiff grey and light brown sandy gravelly silt with cobbles.

A geophysical investigation was carried out along the cable route at the proposed joint bay locations for the onshore cable route. The upper soils have been interpreted as soft silt/clay and/or loose clayey sand/gravel. They have an average thickness of approximately 0.9m. The subsoils have been interpreted as firm to stiff sandy gravelly silt/clay and/ or medium dense clayey sand/gravel with an average thickness between 2.1 and 7.2m. The soils and subsoils have been interpreted as diggable by an excavator.

A detailed ground investigation was carried out at the location of the HDD crossing at the Campile River Estuary. The Teagasc soils map indicates the soils at the crossing point to be a well-drained fine loamy drift soils with siliceous stones. The map also identifies this area to be dominated by tidal marshes and mudflats.

The proposed HDD route is underlain by varying subsoils. The GSI quaternary sediments map **(Figure 12.10)** for the area indicates bedrock outcrop or sub crop either side of the river and till derived from Lower Palaeozoic shales. The lower ground at the river crossing is underlain by estuarine silts and clays.

The glacial till deposits encountered in the intrusive investigation are described as firm to stiff brown sandy gravelly clay and firm light brown sandy gravelly silt. The thickness of the glacial till varies from 0.10m to 21.10 m (approx. 19 mOD -14 mOD). Estuarine muds were not identified in the ground investigation. However as noted above, neither boreholes nor trial pits were excavated within the boundary of the SAC.

The geophysical investigation carried out at the Campile River Estuary has identified soft estuarine silts and clays and clayey sands and gravel. They have an average thickness of 1.2m and will be diggable.

The geophysical investigation also interpreted the subsoils as firm to stiff silts and clays with an average thickness of 7.3m.

Landfall and temporary construction compounds near Baginbun Beach

The soils underlying the landfall site at Baginbun Beach are deep, well drained, mineral (mainly acidic) soils which are classified as acid brown earths and brown podzolics derived from mainly non-calcareous parent materials (**Figure 12.13**).

The GSI quaternary sediments map show Baginbun to be underlain by a glacial till which is derived from Lower Palaeozoic shales (**Figure 12.14**).

The intrusive investigation indicated that topsoil across the site had an average thickness of 0.30m and was generally described as brown slightly sandy clay/silt with rare gravel.

The glacial till deposits encountered are described as firm to stiff brown sandy gravelly clay and firm light brown sandy clay with mottled light grey sandy silt with occasional gravel. The thickness of the glacial till varies from 0.20m to 3.40 m (approximately 14m OD to 10m OD).

The onshore geophysical investigation indicates the upper soils as soft sandy gravelly silt/clay with an average thickness of 1.0m. The subsoils have been interpreted as a firm to stiff sandy gravelly silt/clay with an average thickness of 3.7m. The soils and subsoils were determined to be diggable by an excavator.

The nearshore geophysical investigation carried out by TerraDat indicates a shallow covering of soils and subsoils at approximately 1m depth.

The offshore seabed investigation indicates the marine sediments consist of medium dense dark grey slightly silty fine and medium sand overlying stiff slightly sandy gravelly clay. The clay extends to approximately 3.30m below seabed level (bsl)where it overlies very dense brownish grey slightly clayey very sandy gravel to depths of up to 4.40m bsl.

Table 12.4: Soils and subsoil deposits within Proposed Development

Strata[1]	General Extent/Location	Depth to Top of Strata (mBGL)	Thickness Range (m)	Notes/Description
Topsoil	Widespread	0.0	0.5	Occasionally sandy/peaty
Made Ground	Onshore Cable Route	0	0.1	Road pavement
Alluvial/ Estuarine Deposits	Great Island / Campile River Estuary crossing	1.20	1.20 - 10.5	Soft grey slightly gravelly sandy SILT
Marine Sediments	HDD Exit point	0	4.40	Medium dense dark grey slightly silty fine & medium SAND and
				Stiff slightly sandy gravelly CLAY
				Very dense orangish greyish brown slightly clayey very sandy GRAVEL
Glacial Till	Widespread	0.20	0.2 - 21.10	Firm to stiff brown sandy gravelly clay

[1] Strata indicated may not be present at all locations along the proposed development.

12.3.3.3Bedrock Geology

Great Island Converter Station and tail station, temporary construction compounds and HVAC cable

The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock map of the Great Island area indicates that the proposed development is underlain by the Campile Formation of Ordovician age, comprising a variety of acidic volcanic rocks and shales. The formation is characterised by a variable internal stratigraphy, with rapid facies changes laterally and vertically within the formation (**Figure 12.15**).

During the project specific GI, weathered rock was encountered in RC02-3, RC03-3, RC04-3, RC05-3, RC06-3. RC02-3 and RC05-3 are located on the upper ground adjacent to the Great Island power station, RC04-3 is located to the south of both of these locations on the lower ground. RC03-3 and RC06-3 are located either side of the railway bridge (Drawing GIL-Arup-ZZ-XX-DR-C-0014-01 shows the rotary core borehole locations). Weathered rock was not encountered in RC01-3. It was encountered from depths of 0.90 m bgl to 5.40 m bgl. This was described as probably highly weathered rock recovered as clayey sandy cobbly gravel.

Bedrock was described as very strong, medium to thinly (flow) banded dark greenish grey, fine to medium grained rhyolite. (volcanics with high quartz content.). Bedrock was encountered to depths of up to 25m. The thickness of the stratigraphy was not proven.

The geophysical investigation interpreted the bedrock at shallow depths throughout the site as slightly weathered fresh slate and volcanics which will require mechanical breaking or blasting.

The geophysical investigation carried out where the cable route passes under the railway bridge identified rock at 2.5 to 3.0m bgl on the south side of the railway bridge and at depths of up to 15m on the north side of the track.

The structural geology at Great Island is highly complex and heavily faulted with a series of NW-SE trending faults.

Cable Route and temporary construction compound in Lewistown

The Geological Survey of Ireland (GSI) 1:100,000 bedrock map for the proposed development encounters the Devonian Templetown Formation in the southern section (**Figure 12.3**).

The younger Ordovician rocks dominate the Northern part of the proposed development around Great Island, Campile, Ramsgrange and Duncannon with the older Cambrian bedrock dominating the southern part of the study area to the landfall at Baginbun Bay. The Ordovician Bedrock is comprised of the Campile Formation which comprises a number of members which include the Arthurstown and Ballyhack Members along with felsic and Rhyolitic volcanics. The Cambrian Bedrock is comprised of the Booley Bay Formation. **Figures 12.3** and **12.17** illustrate the bedrock geology.

The area is a highly complex heavily faulted geological zone.

A detailed project specific ground investigation was carried out at the Campile River Estuary. The Geological Survey of Ireland (GSI) 1:100,000 bedrock map for the HDD Campile River Estuary crossing indicates that the area to be underlain by the Ordovician Campile Formation, comprising a variety of variable felsic volcanics and shales. The formation is characterised by a variable internal stratigraphy, with rapid facies changes laterally and vertically within the formation.

During the project specific GI, weathered rock was encountered in RC01-2, RC03-2 & RC04-2. RC01-2 and RC03-2 are located to the North of the Campile River and RC04-2 is located to the south of the Campile River. Drawing GIL-Arup-ZZ-XX-DR-C-0014-02 illustrates the locations of the rotary core boreholes. It was encountered from depth ranging from 2.00 m bgl to 10.00 m bgl. This was described as probably highly weathered rock recovered as dense brown gravelly sand with occasional cobbles.

Bedrock was described as medium strong to strong, medium to thinly (flow banded dark blueish grey, fine to medium grained rhyolite (volcanics with occasional weak ash layer and beds of mudstone/siltstone). Bedrock was encountered from depths ranging from 4.40 m bgl to 20.00 m bgl (approx. 14 mOD to -12 mOD).

The onshore geophysical investigation interpreted two layers of bedrock across the site at the Campile River Estuary crossing, the upper layer has been interpreted as highly to moderately weathered bedrock with a poor rock quality and it is expected this material will be rippable to marginally rippable.

The second layer has been interpreted as slightly weathered fresh slate with good rock quality and it is expected that this layer would require breaking or blasting. The depth of this layer was not determined.

Landfall and temporary construction compounds near Baginbun Beach

The GSI Bedrock map 1:100,00 scale shows Baginbun beach to be underlain by the Booley Bay Formation. This formation comprises Cambrian rocks described as Cambrian meta-sediments in the form of greywacke, slate and quartzite. They are also described as grey to black mudstone with siltstone by the GSI. The GSI database also indicates there is a north-east south-west trending fault running through the site (**Figure 12.17**).

During the project specific GI, weathered rock was encountered in all the boreholes. The top of the weathered rock ranged from 2.00 m bgl to 3.40 m bgl. This was described as probably highly weathered rock with clay infill recovered as stiff light brown sandy slightly gravelly clay with occasional cobbles.

Bedrock was described as medium strong to weak, thickly to thinly bedded, pale greenish grey, fine grained mudstone with interbeds/interlaminations of siltstone and very occasional sandstone. The top of bedrock was encountered from depths of 2.50 m bgl to 60.00 m bgl (approx.11m OD to -46m OD).

The onshore geophysical investigation interpreted the bedrock at the Landfall site as slightly weathered to fresh mudstone with siltstone which will require breaking and or blasting. The top of slightly weathered to fresh bedrock lies at an average depth of 4.7m bgl.

The nearshore geophysical investigation carried out on Baginbun Beach indicates hard rock close to the surface.

The offshore seabed investigation indicated bedrock was encountered at approximately 4.40m depth. The bedrock encountered consisted of relatively uniform silty mudstone with some siltstone bands. The rock was described as weak to moderately weak with some medium strong layers increasing with depth and fractures are closely spaced.

Table 12.5: Rock Formations within Study Area

Geological Period	Formation	Member	Description	General Extent/ Location
Devonian	Templetown	-	Red conglomerates with sandstones	Southern part of the cable route
Ordovician	Campile	Arthurstown	Red, purple & green slates & siltstones	Ramsgrange
		Ballyhack	Grey slates with thin siltstones	Ramsgrange
		Volcanics	Felsic volcanics	Great Island Campile River Estuary crossing
		Campile	Rhyolitic volcanics, grey & brown slates	Great Island Campile River Estuary crossing
Cambrian	Booley Bay	-	Grey to black mudstones with siltstones	Baginbun Beach

12.3.3.4Karst

Karst is a type of geological feature characterised by caves, caverns and other types of underground drainage resulting from the dissolution of the underlying bedrock. This typically occurs in areas of high rainfall with soluble rock.

The GSI Karst database was consulted. A locally important karstified aquifer was identified near Hook Head but this is located outside the study area. The geophysical surveys and site investigation information for the proposed development do not indicate the presence or potential presence of karst across the proposed development area.

Consequently, the risk of karst is deemed negligible and will not be further assessed.

12.3.3.5Soft and/or Unstable Ground

Soft deposits consist of peat, alluvium or very soft cohesive material. Various sources of information were consulted in establishing these areas along the study area namely:

- Teagasc Subsoil map, produced by Teagasc, EPA and GSI;
- GSI database of historical landslides;
- EPA subsoil mapping;
- Ground Investigation data; and
- Site Walkover

The Teagasc Subsoil map outlined locations of soft soil within the study area. The GSI database shows no recorded landslide events within the study area.

The following text outlines where soft and / or unstable ground such as alluvial deposits are expected to be encountered across the cable route. A 'feature importance ranking' has been assigned a Feature Importance ranking based on Table C2 (Criteria for Rating Site Importance of Geological Features (NRA 2008)) from the Institute of Geologists of Ireland (IGI, 2013), Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements.

Table 12.6 summarises the geological feature importance for soft soils within the study area.

Converter Station and tail station temporary contractors' compounds and HVAC cable

The GSI database indicates soft ground deposits within the study area. These have been identified as tidal marshes and lake alluvium.

Soft deposits of silt were identified during the project specific ground investigation in BH03-3 and BH06-3 which are located in the lower ground either side of the railway bridge (Drawing GIL-Arup-ZZ-XX-DR-C-0014-01 illustrates the locations of the boreholes). These were described as soft grey gravelly sandy SILT. They encountered from depths of 1.20m bgl to 11.50 m bgl.

Onshore Cable Route including temporary contractor's compound in Lewistown

The GSI database indicates numerous soft ground deposits within the study area. These are generally associated with remnants of post glacial events and river washout.

According to the GSI database the Campile River Estuary crossing is dominated by mudflats and is potentially an infilled channel of mud and soft ground. These were confirmed during a site walkover.

Landfall including temporary contractors' compounds near Baginbun Beach

There is no indication from the publicly available data or from the ground investigation that soft ground is present at the landfall site.

Several site walkovers were completed as part of the geotechnical study and assessment, during these walkovers cliff instability and minor landslides, mainly in the thin overburden, were noted on the cliffs at Baginbun Beach.

Table 12.6: Geological Feature of Importance for soft soils within Study Area

Feature	Description	Feature Importance Ranking	Criteria
Great Island	Tidal Marshes	Low	Volume of soft soil underlying the cable route is small on a local scale. No soft ground under the footprint of the converter station, tail station, HVAC cable route or contractors' compounds.
Campile River Estuary crossing	Alluvial/Estuarine Deposits	Low	Volume of soft soil underlying the cable route is small of a local scale.
Landfall	Cliff Instability	Low	Small on a local scale.

12.3.3.6Contaminated Land

Various sources of information were consulted in assessing the study area for locations of potential contaminated land:

- CORINE land cover mapping;

- Teagasc Soil map;
- EPA;
- Ground investigation data; and
- Wexford County Council

There was no evidence of contaminated land found during the intrusive ground investigation.

Converter Station and tails station, temporary contractors' compounds and HVAC cable

No features associated with contaminated land were identified at the Great Island converter station site.

Based on the samples recovered during the project specific ground investigation, there was no evidence of elevated contaminants within the shallow sediments.

Onshore Cable Route including temporary contractor's compound in Lewistown

The cable route runs along the road in numerous places and there will be some made ground expected along the route.

Based on the samples recovered during the project specific ground investigation, there was no evidence of elevated contaminants within the shallow sediments.

Landfall including temporary contractors' compounds in Lewistown

No features associated with contaminated land were identified at the proposed development.

Based on the samples recovered during the project specific ground investigation, there was no evidence of elevated contaminants within the shallow sediments.

12.3.3.7Mineral/Aggregate Resources

Various datasets were consulted in establishing the economic geology of the study area including:

- GSI: aggregate potential mapping;
- GSI: mineral localities; and
- EPA: active mine sites.

The GSI aggregate potential mapping database indicates the northern section of the proposed development around Great Island generally has high crushed rock aggregate potential. The areas around Ramsgrange and Duncannon have very low to low crush rock aggregate potential with the southern section of the route and around the landfall having a low to moderate crushed rock aggregate potential.

The GSI database indicates that the Hook Head peninsula is noted for having very low granular aggregate potential.

The GSI database also indicates numerous mid-20th century historic pits and quarries in the northern section of the route around Great Island and also Ramsgrange. There are no active mines or quarries within the study area.

The GSI mineral localities database show no active metallic mines exist today in the study area. There is no record of underground mining in the area therefore there would be a low risk of underground structure collapse due to underground excavations, consequently, this assessment does not consider this feature any further.

12.3.3.8Geological Heritage Areas

Geological Heritage Areas are designated as part of the Irish Geological Heritage Programme; a partnership with the (GSI) and the Department of Environment, Heritage and Local Government. A review of the Geological Heritage Areas in the area has indicated that the potential geological heritage interest in the area of the proposed development is as follows:

Converter Station and tail station, temporary contractors' compounds and HVAC cable

There are no Geological Heritage Areas (GHA) or County Geological Sites (CGS) within this area.

Onshore Cable Route including Campile River Estuary crossing and temporary contractor's compound in Lewistown

The onshore cable route passes by Booley Bay. Booley Bay is located approximately 300m from the route. This is classified as IGH 2-2: Occurrence of Ediacaran biota. IGH 4-40: Turbidite structures and Ediacaran-type faunas in the Upper Cambrian Booley Bay Formation of the Ribband Group (CGS recommended for Geological National Heritage Area) (**Figure 12.4**).

Landfall including temporary contractors' compounds

Baginbun Head is noted for Cambrian Stratigraphy and is classified as County Geological Site (CGS) (**Figure 12.20**).

A summary of the geological heritage areas is outlined in **Table 12.7**.

Table 12.7: Geological Heritage Areas

Feature	Description	Potential Effect	Criteria
Great Island	N/A	N/A	N/A
Booley Bay	IGH 2-2: Occurrence of Ediacaran biota.	Negligible	No measurable changes anticipated during the cable route, as the HDD will be a minimum of 10m

Feature	Description	Potential Effect	Criteria
			below the river bed.
	IGH 4-40: Turbidite structures and Ediacaran-type faunas in the Upper Cambrian Booley Bay Formation of the Ribband Group	Negligible	No measurable changes anticipated during the cable route, as direct effects will be avoided.
Landfall	Cambrian Stratigraphy	Moderate adverse	HDD will drill under a site which is Classified as a County Geological Site

12.3.3.9Hydrogeology

The hydrogeology for the proposed development is discussed in following subsections.

Groundwater monitoring was carried out during the ground investigation and on a weekly basis for a duration of 3 weeks post fieldworks. The groundwater monitoring data is outlined in **Table 12.8**. This table presents the groundwater levels identified within the borehole on the date recorded and water strikes encountered during the ground investigation outlined in **Table 12.9**.

Table 12.8: Groundwater monitoring data

Site	Borehole No.	Strata	29/03/2019	12/04/2019	18/04/2019	26/04/2019
			m bgl			
Great Island	BH01-1	Rock	1.1	1.25	0.63	0.85
	BH04-1	Rock	6.1	6.9	5.2	6.15
Campile River Estuary Crossing	BH04-2	Rock	9.6	9.4	8.9	9.0
	BH01-2	Rock	9.8	10.9	10.1	10.1
Landfall	BH01-3	Rock	13.7	15.6	14.0	13.5

Site	Borehole No.	Strata	29/03/2019	12/04/2019	18/04/2019	26/04/2019
			m bgl			
	BH06A-3	Rock	0.6	0.85	0.1	0.3

Table 12.9: Groundwater strikes

Site	Hole type	Depth (m bgl)	Flow
Great Island	BH01-3	17.00	Seepage
	BH02-3	n/a	
	BH03-3	1.70	Moderate
	BH04-3	n/a	
	BH05-3	n/a	
	BH06-3	3.50	Moderate
	TP01-3	n/a	
	TP02-3	n/a	
Campile crossing	BH01-2	n/a	
	BH03-2	n/a	
	BH04-2	n/a	
	BH05-2	5.50	Moderate
	BH06-2	4.50	Rapid
	TP01-2	n/a	
	TP02-2	1.70	Seepage
Landfall	BH01-1	3.30	
	BH02-1	n/a	
	BH04-1	n/a	
	TP01-1	n/a	
	TP02-1	n.a	

12.3.3.10 Aquifer Type and Classification

Converter Station and tail station including temporary contractors' compounds and HVAC cable

The GSI online database indicates the Great Island converter station site is underlain by a regionally important aquifer (Rf). A regionally important aquifer has the ability for yields of more than 400m^3/day (**Figure 12.21**).

Onshore Cable Route including temporary contractor's compound in Lewistown

The GSI online database indicates the proposed development is underlain by a regionally important aquifer (Rf) in the northern section of the route around Great Island and Campile. The rest of the cable route is underlain by a poor aquifer.

Landfall including temporary contractors' compounds near Baginbun Beach

The aquifer at Baginbun Beach is classified as a poorly productive aquifer (Pl). It is only productive in local zones. A poorly productive aquifer has the ability to produce "moderate to low" well yields of less than 100m^3/day (**Figure 12.23**).

12.3.3.11 Aquifer Vulnerability

Converter Station and tail station including temporary contractors' compounds and HVAC cable

Groundwater vulnerability within the proposed development ranges from "Rock at or near the surface" underlying the site to high, to moderate (**Figure 12.24**).

Onshore Cable Route including temporary contractor's compound in Lewistown

The online database also indicates the proposed development passes through an area of high to extreme groundwater vulnerability (**Figure 12.7**).

Landfall including temporary contractors' compounds near Baginbun Beach

According to the data from the GSI, the proposed development lies in an area of extreme groundwater vulnerability (**Figure 12.26).**

12.3.3.12 Groundwater Resources

Converter Station and tail station including temporary contractors' compounds and HVAC cable

Based on GSI records, there are 10 no. industrial use boreholes identified. Three are located on the power station site, and seven are in the field adjacent to the converter station and tail station site, east of the power station.

The source that the groundwater is abstracted from is not stated but it is likely that it abstracts from the bedrock beneath (**Figure 12.27**).

Onshore Cable Route including temporary contractor's compound in Lewistown

Based on GSI records, two domestic and agricultural wells are located within 2km of the proposed development around Ramsgrange. The abstractions identified include 2 boreholes drilled to depths of 11m bgl and 45.7m bgl with yields of 54.5m^3 and 109.1m^3 per day (**Figure 12.8**) and are located approximately 750m from the cable route.

The source that the groundwater is abstracted from is not stated but it is likely that it abstracts from the bedrock beneath.

Landfall including temporary contractors' compounds near Baginbun Beach

Based on GSI records, there are no groundwater resources located within the vicinity of the Landfall site.

12.3.3.13 Hydro-ecology

Groundwater dependant habitats may be impacted by any potential option through accidental contamination, localised flooding or the alteration of base-flow supplies to wetlands causing the area to dry out.

Ecological features or habitats which need to be protected have designations based on Irish, European or international law. These designations include: Special Protection Area (SPA), Special Area of Conservation (SAC), National Heritage Area (NHA) and proposed National Heritage Area (pNHA).

Groundwater dependant habitats are listed in **Table 12.10**. **Chapter 9** presents a description of the habitats and species for which the sites have been designated.

Table 12.10: Groundwater dependant habitats

Site	Feature		Importance Ranking	Justification
Great Island	SAC	River Barrow & River Nore	High	Located adjacent to the Great Island power station.
		Lower River Suir	Medium	Located 1.25km west of the Great Island power station.
	pNHA	Barrow River Estuary	High	Located adjacent to the Great Island power station.
Onshore Cable route	SAC	River Barrow & River Nore	High	All onshore cable route options cross the SAC.

Site	Feature		Importance Ranking	Justification
		Bannow Bay	High	Baginbun Beach cable route crosses the SAC just South of Fethard town.
	pNHA	Barrow River Estuary	High	All onshore cable route options cross the NHA.
Landfall	SAC	Hook Head	High	Baginbun Beach Landfall site is within this SAC.
	SPA and IBA	Bannow Bay SPA and IBA	High	Baginbun Beach cable route crosses the SPA just South of Fethard Town

12.3.3.14 Summary of Features of Land, Soils, Geological & Hydrogeological Importance

A summary of the features found within the study area, are presented below in **Table 12.11**. A feature importance ranking based on Table C2 (Criteria for rating site importance of geological features (NRA 2008) from the Institute of Geologists of Ireland *Guidelines for the preparation of soil, geology and hydrogeology chapters of the environmental impact statements* (IGI, 2013) has been assigned to each feature.

Table 12.11: Summary of features of Land, Soils, Geological and Hydrogeological Importance

Feature		Importance ranking	Justification
Agricultural Soils	Topsoil and upper soils across the whole cable route	High	Well drained and/or high fertility soils
Soft Ground	Soft ground, poorly drained estuarine silts and clays at Great Island and Campile	Low	Volume of soft soils underlying the route is small on a local scale
Bedrock/Aggregate Resources	Excavation of bedrock for Great Island converter station	Moderate	Uneconomically extractable resource
Aquifer	Regionally important aquifer	High	This is a high-quality attribute and is important both on a local and regional scale.
Marine sediments	Proposed landfall	Low	Volume of soft soils underlying the landfall is low on a local scale.

12.3.4 Conceptual Site Model

A CSM was developed based on the ground investigation data. The model includes the factual data within the study area that was gathered during the GIs. See **Appendix 12.1** for all ground investigation data.

The proposed development is predominantly underlain by glacial till overlying bedrock at depth. Typically, the trench will be excavated to a depth of 1.3m bgl.

Table 12.12 describes the CSM of the site area.

Table 12.12: Conceptual site model

Feature/Location	Ground Level (mOD)		Construction Method	Ground Conditions
	Max	Min		
Converter Station and tail station including temporary contractors' compounds and HVAC cable	32	1	See Section 4.4 and 4.5	Glacial tills over felsic and rhyolitic volcanics.
HVDC cable route including temporary contractor's compound in Lewistown	70	1	See Section 4.4 and 4.5	Glacial tills to 1.20m bgl. Bedrock not encountered along cable route during the ground investigation.
Cable Route (Campile Estuary)	17	1	See Section 4.4 and 4.5	Estuarine Deposits and Glacial till over bedrock.
Landfall including temporary contractors' compounds near Baginbun Beach	15	0	See Section 4.4 and 4.5	Glacial tills over interbedded mudstones and siltstones.

12.3.4.1Importance of Features

According to the NPWS website there are six proposed Natural Heritage Areas (pNHA), Special Areas of Conservation (SAC) or Special Protected Areas (SPA) along the proposed cable route which are listed in **Table 12.10**.

12.3.4.2Environment

The environment along the cable route is varied and falls into a number of different categories in accordance with the Environment types outlined in the IGI Guidelines. The follow areas of note were identified:

Type A environment – Passive geological/hydrogeological environments – areas of thick low permeability subsoils

Type B Environment – Naturally dynamic hydrogeological environments – areas underlain by regionally important aquifers.

Type D Environment – Sensitive geological environments – areas underlain by county geological sites.

Type E Environment – Groundwater dependant eco systems – areas which have wetlands or are protected areas.

Based on the derived CSM the area across the proposed development is classified as generally a Type A environment (passive geological environments – areas of thick low permeability subsoils and underlain by poor aquifers) and Type B Naturally dynamic hydrogeological environments – areas underlain by regional important aquifers. Some certain sections of the route are classified as Type D – Sensitive geological environments and Type E (groundwater dependent ecosystem – wetlands and nearshore area) based on the criteria outlined in the guidelines.

12.4 Characteristics of Proposed Development

A full description of the proposed development and construction activities is provided in **Chapter 3** *Proposed Development* and **Chapter 4** *Construction strategy*, respectively.

The potential effects related to such construction activities are described in **Section 12.5**.

12.4.1.1Activities/Environment Matrix

The IGI guidelines recommend that an Activities/Environment Matrix be prepared to identify the type of investigations required, which depend on the nature of the baseline environment and the construction and operation activities proposed.

Table 12.13 presents the Activities/Environment Matrix, and outlines the works required, in accordance with the IGL guidelines, and the works undertaken on site.

Table 12.13: Details of works required under the IGI guidelines and how they were undertaken on the site.

Work required under Activity and Type Class (based on IGI guidelines)	Details of works completed to date
Earthworks	
Invasive site works to characterise nature, thickness, permeability and stratification of soils, subsoils.	Project specific ground investigation carried out across the proposed converter station and tail station site, onshore cable route and landfall site.
Excavation of materials above the water table	
Site works to fully characterise nature, thickness, permeability and stratification of soils, subsoils, bedrock geology and in order to define the resource volume/weight according to the PERC Reporting Standard	Project specific ground investigation carried out across the proposed converter station and tail station site, onshore cable route and landfall site.
Excavation of materials below the water table	
Site works to fully characterise nature, thickness, permeability and stratification of soils, subsoils, bedrock geology and in	Project specific ground investigation carried out across the proposed

Work required under Activity and Type Class (based on IGI guidelines)	Details of works completed to date
order to define the resource volume/weight according to the PERC Reporting Standard	converter station and tail station site, onshore cable route and landfall site.
Lowering of groundwater levels by pumping or discharge	
Invasive site works to characterise nature, thickness, permeability and stratification of soils, subsoils.	Project specific ground investigation carried out across the proposed converter station and tail station site, onshore cable route and landfall site.

12.5 Potential Effects – Construction Phase

The potential land, soils, geology and hydrogeology effects during the construction phase are presented in this section.

Construction methodologies for the various elements of the proposed development is presented in **Chapter 4** *Construction Strategy*.

12.5.1 Converter Station and tail station, Temporary Contractors' Compounds and HVAC Cable

The proposed construction methodologies at this location are outlined in **Section 4.4 and 4.5** of **Chapter 4** *Construction Strategy*.

The potential construction effects on the geological attributes identified are listed below:

- Compression of Substrata
- Loss of Agricultural Land and Overburden;
- Loss of Solid Geology;
- Effect on the surrounding ground;
- Impact on bedrock Aquifer;
- Impact on Ground Water Quality and Dependent Ecosystems.

Compression of Substrata

Construction may result in increased loading on underlying soils which could affect the current characteristics of the ground. However, given the general nature of these soils (over-consolidated glacial tills), the significance of this potential effect is deemed to be imperceptible.

Loss of Agricultural Land and Overburden

It is expected that much of the topsoil and overburden at the proposed Great Island converter station and tail station site will be excavated to allow for construction to take place.

Topsoil will not be replaced over the 2.5 hectares of the footprint of the converter station, tail station, storm water pond and access road, and areas of cut.

Topsoil will be replaced in all other areas following completion of construction. Surplus topsoil will be reused in landscaping. The significance of this potential effect is imperceptible.

Loss of solid Geology

Excavation of rock will be required to construct the proposed Great Island converter station and tail station site. The excavated material will be reused elsewhere in the proposed development if it can be shown to fulfil an appropriate engineering specification. If the excavated rock does not meet an appropriate engineering specification, it will be used in landscaping.

Given the quantity of rock approximately 23,000m^3, which will be removed, it is considered a moderate adverse impact. However, while the bedrock in the area is of moderate importance, it is uneconomic to extract it and there are readily available alternative sources of similar bedrock available.

Therefore, this has been assigned a slight/moderate effect upon the local environment.

Effects on the surrounding ground

Soil and rock excavation along with the installation of precast piles has the potential to induce movement and settlement of surrounding ground. The removal of the bedrock may be carried out using a variety of techniques including mechanical excavation, chemical blasting or conventional blasting techniques. This could result in ground vibrations and destabilisation of existing soil slopes, existing rock slopes, with effects felt in the immediate vicinity of the works.

These works may also give rise to noise and vibration effects and may result in the generation of dust.

The significance of the potential effect is slight.

Impact on Bedrock Aquifer productivity

The bedrock will be excavated to form the platform for the converter station and tail station. Precast piles will be used for the foundations of the converter station and tail station. The precast piles will only penetrate as far as the weathered top of the bedrock, not into the intact rock. The installation of the precast piles does not have the potential to impact the bedrock aquifer. This bedrock is classified as a Regionally Important Aquifer and has been assigned a High importance. However, due to the shallow depth of the excavation, the magnitude of the effect would be small[2] adverse.

The significance of the potential effect is moderate/slight.

Impact on Ground Water Quality and groundwater-dependent ecosystems

The activities which may impact upon the groundwater quality beneath the proposed scheme during the construction phase are:

- Accidental spillages of polluting materials onsite;

[2] NRA (2008) defines a Small Adverse impact as one that 'results in minor impact on integrity of attribute or loss of small part of attribute'.

- Accidental release of fines into the groundwater and surface water; and
- The potential for contaminated runoff to enter the groundwater and surface water.

If any of these occur, they may potentially contaminate the surface water, and groundwater beneath the proposed development and have a negative effect on dependent ecosystems. These are potential short-term effects due to the construction phase been short-term, however a pollution incident during the construction phase could have a long term effect.

Even in the absence of mitigation measures, potential pollutants will not be stored on site in large quantities, so the volume which could spill will not be great. Only a small part of the aquifer could be affected which results in a small adverse effect.

The magnitude and significance of these potential effects on the receptors are summarised below:

- The magnitude of this potential effect on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of slight;
- The magnitude of this potential effect on the Regionally Important aquifer could potentially be small adverse leading to a significance rating of moderate/slight.

Summary of Great Island Converter Station Potential Construction Effects

Table 12.14 summarises the potential effects during the construction stage of the works.

Table 12.14: Summary of Potential Effects on Geological Attributes at the proposed Great Island Converter Station and tail station, HVAC cable route and contractors' compounds

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Compression of substrata	Low	Boulder clays	Small adverse	Removal of soils and replacement with structure will not impact on the clay	Imperceptible
Loss of agricultural land and overburden	High	Well drained fine loamy soils	Small adverse	Loss of a small proportion of local high fertility soils	Moderate/Slight
Loss of solid geology	Moderate	Attribute has a low value on a local scale	Moderate adverse	Excavation of ~ 23,000m³ of rock	Slight
Effect on surrounding ground	Low	Soils are generally glacial tills	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Impact on Bedrock Aquifer productivity	High	Regionally important aquifer	Small adverse	Excavation of small portion of regionally important aquifer.	Moderate/Slight
Impact on Groundwater Quality and groundwater dependent ecosystems	Low	Groundwater flow may be affected on a small scale only.	Small adverse	Due to the depth of the excavation, small volumes of potential pollutants stored on site and the low number of abstraction boreholes in the immediate vicinity, minimal impact is anticipated on groundwater quality	Imperceptible

12.5.2 Cable Route and Temporary Contractor's Compound in Lewistown

The proposed construction methodologies for the proposed cable route are outlined in **Section 4.5** of **Chapter 4** *Construction Strategy*.

The proposed construction effects of the proposed cable and temporary contractor's compound in Lewistown on the geological attributes identified in the areas are listed below:

- Loss of Agricultural Land and Overburden;
- Loss of Solid Geology;
- Effect on the surrounding ground;
- Excavation of soft mineral soils beneath the route;
- Mobilisation of contaminated sediments during HDD drilling;
- Impact on Bedrock Aquifer;
- Impact on Groundwater quality and groundwater dependent ecosystems.

Loss of Agricultural Land and Overburden

It is anticipated that the temporary removal of fertile soil in the northern section of the cable route and at the temporary contractor's compounds will have a small adverse impact to the quality, drainage characteristics and uses of agricultural land during the construction.

Topsoil will be removed for excavation of the cable trench, in those parts of the route which are off-road. This are listed in Chapter 4, section 4.5.7. Topsoil will be removed from the footprint of the Lewistown contractor's compound and the HDD compounds at the Campile River Estuary crossing. Once construction and installation of the cable is completed, the topsoil will be reinstated. The topsoil in the Lewistown compound and the HDD compounds will also be replaced, once construction is complete.

The significance of this potential effect is **imperceptible**.

Loss of Solid Geology

Excavation of rock will be required to construct the proposed cable route in some locations. It is intended that the excavated material will be reused elsewhere on the proposed development if it can be shown to fulfil an appropriate engineering specification. It will be reused in the landscaping on the converter station and tail station site, if it does not meet engineering specification.

It is not intended to excavate significant quantities of rock at any one location along the cable route, and it is therefore considered a small adverse effect that does not have an effect of any regional significance.

The significance of the potential impact is **slight**.

Effect on the surrounding ground

The soil and rock excavation during the HDD drilling at Campile River Estuary crossing has the potential to induce movement and settlement of surrounding ground. The removal of the bedrock could result in minor ground vibrations.

These works may also give rise to noise and vibration effects and may result in the generation of dust. These effects are discussed in further detail in **Chapter 8** *Noise and Vibration* and **Chapter 7** *Air Quality and Climate*.

The significance of the potential effect is imperceptible.

Excavation of soft mineral soils beneath the route

Limited soft soils will require excavation and replacement when encountered at the base of excavations for the proposed cable route. These are expected to be localised and minor in extent.

Given the relatively small quantity of soils which will be removed it is considered a small adverse effect that does not have an effect of any regional significance.

The significance of the potential effect is **imperceptible**.

Mobilisation of contaminated sediments during HDD Drilling

HDD drilling is planned to take place at the Campile River Estuary crossing which could result in the mobilisation of contaminated sediments.

Mobilisation of contaminated sediment is considered as having a high importance due to the SAC in the area. Given the nature of the ground conditions and the proposed construction methods, the potential for breakouts of drilling fluid or other materials related to the HDD under the Campile may occur. The launch and reception pits for the HDD activity will be located at sites which are significantly elevated over the estuary level, and so potential effects associated with flood conditions are not predicted.

Based upon the ground conditions, the fact that no evidence of contamination was uncovered in the ground investigation at the site, and the method of construction proposed, the risk of an effect is deemed to be negligible and thus the likely significant effect is imperceptible during construction.

Impact on Bedrock Aquifer productivity

Approximately 8km of the cable route, at the northern end, is underlain by bedrock which is classified as a regionally important aquifer. This has been assigned High Importance.

The HDD drill bore for the Campile Estuary River crossing is expected to have a 200mm to 250mm outer diameter. It will be a closed system, with drilling fluid recirculated, the drill cuttings recovered, and drilling fluid reused. The cable trench excavation will, typically, be less than two metres deep. Consequently, the magnitude of the effect is expected to be small adverse.

The significance of the potential effect is **moderate/slight**.

Impact on Groundwater Quality and groundwater dependent ecosystems

Potential pollutants will not be stored along the cable route and will only be stored at the Lewistown compound, so the volume which could spill will not be significant. No potential pollutants will be stored at the Campile River Estuary HDD compound. Only a localised part of the aquifer could be affected by a spill.

The HDD may require a drilling fluid to cool and lubricate the drill head. Typically, bentonite is used, which comprises 95% water and 5% bentonite clay which is a non-toxic, natural substance. The bentonite effectively seals the bore maintaining a closed system throughout the drill. The bentonite drilling fluid is circulated down through the drill rods and back up the outside the rods in the annulus of the borehole. As it is non-toxic, the bentonite would not have a significant effect on ground water quality. **Chapter 4**, Section 4.5.2 provides more information on the HDD construction method.

If any of these occur, they may potentially contaminate the groundwater beneath the proposed development and also impact the groundwater quality at receptors such as the Campile River Estuary. The risk of potential effect is short term for the duration of the construction phase but the contamination could have long term effects. The magnitude and significance of these potential effects on the receptors are summarised below:

- The magnitude of this potential effect on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of **slight**;
- The magnitude of this potential effect on the Campile River Estuary could potentially be small adverse leading to a significance rating of **slight**.
- The magnitude of this potential effect on the Regionally Important aquifer could potentially be small adverse leading to a significance rating of **slight**.

Reinstatement

Following the excavation of the onshore cable route during construction, the route will be required to be reinstated to its original condition with the replacement of excavated materials where appropriate. If the excavated materials are not suitable for re-use, then equivalent materials may be imported for reinstatement. Acceptable materials for import may include materials classified as by products from excavations in natural soils under Article 27 of the European Communities (Waste Directive) Regulations 2011, S.I. No.126 of 2011.

Summary of Cable Route Construction Potential Effects

Table 12.15 summarises the potential effects during the construction stage of the works.

Table 12.15: Summary of effects on land, soils, geology and hydrogeology for the proposed onshore cable route and temporary contractor's compound in Lewistown

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Loss of agricultural land and overburden	Medium	The route is expected to transverse public road network where possible and will have minimal impact on agricultural land	Small adverse	Loss of topsoil will be temporary	slight
Loss of solid geology	Low	Attribute has a low value on a local scale	Small adverse	Proportion of any possible aggregate reserves lost is small	Imperceptible
Effect on surrounding ground	Low	Soils are generally glacial tills	Small adverse	Movements expected to be minimal due to underlying ground conditions	Imperceptible
Excavation of soft mineral soils beneath the route	Low	Volume of soft alluvial soil at the HDD crossing is small on a local scale.	Small adverse	Only a small proportion of soft mineral soils beneath the route will require excavation	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Mobilisation of contaminated sediments during HDD drilling	High	Sensitive nature of the environment	Negligible	Based on ground conditions and testing results which showed no evidence of contamination	Imperceptible
Impact on bedrock aquifer productivity	High	Regional Important Aquifer	Small adverse	HDD drilling through a regionally important aquifer	Slight
Impact on Groundwater Quality and groundwater dependent ecosystems	Low	Groundwater flow may be affected on a small scale only.	Negligible	Due to the depth of the the of the cable trench, and the HDD method proposed for Campile River Estuary crossing, minimal impact is anticipated on groundwater quality	Imperceptible

12.5.3 Landfall and Temporary Contractors' Compounds near Baginbun Beach

The proposed construction methodologies for the proposed landfall and contractors' compounds are outlined in **Section 4.4 and 4.5** of **Chapter 4** *Construction Strategy*.

The proposed construction effects of the proposed Landfall on the geological attributes identified in the areas are listed below:

- Loss of Agricultural Land and Overburden;
- Loss of Solid Geology;
- Effect on the surrounding ground;
- Mobilisation of contaminated sediments during the HDD drilling;
- Impact on bedrock aquifer;
- Impact on groundwater quality and groundwater dependent ecosystems.

Loss of Agricultural Land and Overburden

It is anticipated that the temporary removal of fertile soil at the landfall will have a small adverse impact on the quality, drainage characteristics and uses of important agricultural land during the construction. The construction compounds will be fully reinstated, and topsoil replaced on completion of construction.

Given the temporary disturbance to the site limited solely to the construction phase and the location of the construction compound, this is considered to have a temporary small adverse effect.

The significance of this potential effect is **imperceptible**.

Loss of Solid Geology

The HDD drilling is anticipated to travel through mudstone bedrock beneath the landfall site. The excavated material may be reused elsewhere on the proposed development if it can be shown to fulfil an appropriate engineering specification. It will be reused in landscaping at the converter station and tail station site, if unsuitable for use as engineering fill.

No significant quantities of rock will be removed at this location, and therefore it is considered to be a small adverse effect that will not have an effect of any regional significance.

The significance of the potential effect is **slight**.

Effects on the surrounding ground

Soil and rock excavation during the HDD drilling has the potential to induce movement and settlement of surrounding ground. The removal of the bedrock could result in minor ground vibrations.

These works may also give rise to noise and vibration effects and may result in the generation of dust. The magnitude of this effect is small adverse.

The significance of the potential effect is **imperceptible**.

Mobilisation of contaminated sediments during HDD Drilling

HDD drilling is planned to take place at the Landfall site which could result in the mobilisation of contaminated sediments.

This is considered as having a high importance due to the surrounding Hook Head SACs in the area. Given the nature of the ground conditions and the proposed construction methods, the potential to mobilise suspected contaminated sediment is deemed to be negligible and thus the likely significant effect is **imperceptible** and thus not significant during construction.

Impact on Bedrock Aquifer productivity

This bedrock is classified as a Poor Aquifer which is generally unproductive except for local zones, with a low importance. The HDD drill bore is expected to have a 350mm to 450mm outer diameter. It will be a closed system, with drilling fluid recirculated, the drill cuttings recovered, and drilling fluid reused. Due to the nature of the HDD drilling the magnitude of the impact would be small adverse.

The significance of the potential effect is **slight**.

Impact on Groundwater Quality and groundwater dependent ecosystems

Potential pollutants will be stored at the Baginbun cable contractor compound. No potential pollutants will be stored at Baginbun HDD compound. The HDD for the landfall may require a drilling fluid to cool and lubricate the drill head. Typically, bentonite is used, which comprises 95% water and 5% bentonite clay which is a non-toxic, natural substance. The bentonite effectively seals the bore maintaining a closed system throughout the drill. The bentonite drilling fluid is circulated down through the drill rods and back up the outside the rods in the annulus of the borehole.

As it is non-toxic, the bentonite would not have a significant effect on ground water quality. **Chapter 4**, Section 4.5.2 provides more information on the HDD construction method.

If any of these occur, they may potentially contaminate the groundwater beneath the proposed development and also impact the groundwater quality offshore. These are potential short-term effects. The magnitude and significance of these potential effects on the receptors are summarised below:

- The magnitude of this potential effect on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of **slight**;
- The magnitude of this potential effect offshore could potentially be small adverse leading to a significance rating of **slight**.
- The magnitude of this potential effect on the Poor aquifer could potentially be small adverse leading to a significance rating of **slight**.

Summary of Landfall Construction Potential Effects

Table 12.16 summarises the potential effects during the construction stage of the works.

Table 12.16: Summary of potential effects on land, soils geology and hydrogeology at the landfall and contractors' compounds near Baginbun Beach

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Loss of agricultural land and overburden	High	Well drained fine loamy soils	Small adverse	Loss of topsoil will be temporary	Slight
Loss of solid geology	Medium	Attribute has a low value on a local scale	Small adverse	Proportion of any possible aggregate reserves lost is small	Slight
Effects on surrounding ground	Low	Soils are generally glacial tills. HDD is through intact rock	Small adverse	Tunnelling through glacial tills or bedrock would not result in substantial ground movements.	Imperceptible
Mobilisation of contaminated sediments during HDD drilling	High	Sensitive nature of the environment	Negligible	Based on ground conditions and testing results. Testing showed no contamination. Nature of construction is such that risk that	Imperceptible

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
				sediments will be mobilised is negligible	
Impact on bedrock aquifer productivity	Low	Poor Aquifer	Small adverse	HDD drilling through a poorly productive aquifer	Slight
Impact on groundwater quality and groundwater dependent ecosystems	Low	Groundwater flow may be affected on a small scale only.	Negligible	Due to the nature of the HDD method proposed, minimal impact is anticipated on groundwater quality	Imperceptible

12.6 Potential Effects – Operational Phase

The operation and maintenance of the proposed development are described in **Chapter 3** *Proposed Development*, sections 3.4, 3.5 and 3.6. The potential effects from fire, and the likelihood of such an occurrence, are discussed in **Chapter 17** *Major Accidents and Disasters* in **Section 17.4.** Should contamination of soil occur, there would be localised effects of short duration, which could be remediated.

The potential effects of erosion on the safe operation of the proposed development were considered. At the landfall, the cables will be a minimum of ten metres below the beach, and there is no potential for coastal erosion to come close to the cables over the lifetime of the proposed development. The onshore cable is not routed through any location which is predicted to be subject to coastal erosion over the lifetime of the project, and the converter station and tail station are located a significant distance from the coast so again, there is no risk to the safe operation of the proposed development from erosion.

The significance rating on land, soils, geology and hydrogeology from the operational phase of the proposed development will be **Slight**.

The operational phase of the proposed development will have an overall **neutral long-term effect** on the soils and geology along the routes.

12.7 Potential Effects - Decommissioning

The decommissioning of the of the proposed development is described in **Chapter 3**, *Proposed Development*, sections 3.4, 3.5 and 3.6. Buildings and above ground structures will be removed, and the converter station and tail station site will be reinstated. Above ground structures along the cable route will be removed.

The only potential for an effect on land, soils, geology and hydrogeology will be due to the presence of machinery onsite to undertake demolition activities.

The proposed decommissioning effects of the proposed development on the geological attributes identified in the areas are listed below:

- Effect on the surrounding ground;
- Impact on groundwater quality and groundwater dependant ecosystems.

Effects on the surrounding ground

Removal of above ground structures and crushed stone, infilling of the attenuation pond, and reinstatement with topsoil has the potential to induce movement and settlement of surrounding ground. The demolition works could result in minor ground vibrations.

These works may also give rise to noise and vibration effects and may result in the generation of dust. The magnitude of this effect is small adverse.

The significance of the potential effect is **imperceptible**.

Impact on Groundwater Quality and groundwater dependant ecosystems

The activities which may impact upon the groundwater quality beneath the proposed scheme during the decommissioning phase are:

- Accidental spillages of polluting materials onsite;
- Release of fines into the groundwater and surface water; and
- The potential for contaminated runoff to enter the groundwater and surface water.

If any of these occur, they may potentially contaminate the groundwater beneath the proposed development and also effect the groundwater quality in the vicinity. The most significant activity will take place at the converter station site. The level of activity along the cable route as far as the landfall site will be very minor, as there are very few above ground structures at these locations.

The potential effects are short-term. The magnitude and significance of these potential effects on the receptors are summarised below:

- The magnitude of this potential effect on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of **slight**;
- The magnitude of this potential effect offshore could potentially be small adverse leading to a significance rating of **slight**.
- The magnitude of this potential effect on the water quality of the Regionally Important and Poor aquifer could potentially be small adverse leading to a significance rating of **slight**.

Table 12.17: Summary of effects of proposed development - operational phase on land, soils geology and hydrogeology

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Effects on surrounding ground	Low	The ground works are temporary and are only short term	Small adverse	Due to the nature of the works and short term works the impact is anticipated to low	Imperceptible
Impact on groundwater quality and groundwater dependent ecosystems	Low	Groundwater flow may be affected on a small scale only.	Negligible	Due to the nature of the works proposed minimal impact is anticipated on groundwater quality	Imperceptible

12.8 Mitigation Measures

12.8.1 Introduction

This section describes the mitigation measures to reduce or avoid potential effects where possible, for the construction, operational and decommissioning phases of the proposed development.

The mitigation strategy outlined in this section will be will be implemented during the construction phase of the proposed development. The strategy will be incorporated into the overall Construction Environmental Management Plan (CEMP).

12.8.2 Construction Phase

The mitigation measures for the potential construction effects are provided below:

12.8.2.1General

Regulatory Compliance: The adopted construction techniques will comply with the requirements of statutory bodies (Wexford County Council and EPA) and construction will be completed in accordance with the CEMP (**Appendix 4.1**).

Ground Contamination: Good housekeeping (daily site clean-ups, use of disposal bins, etc.) will be carried out on sites during construction, and the proper use, storage and disposal of all substances within bunds (110% capacity) and their containers will help prevent soil contamination. For all activities involving the use of potential pollutants or hazardous materials, there will be a requirement to ensure that the material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. Potential pollutants shall also be adequately secured against vandalism and will be provided with proper containment according to codes of best practice. Any spillages will be immediately contained, and contaminated soil removed from site and disposed of in a licenced waste facility.

Ground Contamination: Excavations in made ground will be monitored by an appropriately qualified person to ensure that any hotspots of contamination encountered are identified, segregated and disposed of appropriately. Any identified hotspots shall be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure that the hotspot does not cross-contaminate clean soils elsewhere throughout the sites.

Ground Contamination: Potential soil and water pollution will be minimised by the implementation of good construction practices. Such practices will include adequate bunding for oil containers, wheel washers and dust suppression on site roads, and regular plant maintenance.

The Construction Industry Research and Information Association (CIRIA) provides guidance on the control and management of water pollution from construction sites in their publication Control of Water Pollution from

Construction Sites, Guidance for Consultants and Contractors (Masters-Williams et al, 2001) and has been reflected in the CEMP. The controls and measures proposed also have regard to other CIRIA guidance relating to linear construction projects, as appropriate. A contingency plan for pollution emergencies will also be developed by the appointed contractor prior to the commencement of works and regularly updated, which would identify the actions to be taken in the event of a pollution incident. The contingency plan for pollution emergencies will address the following:

- Containment measures;
- Emergency discharge routes;
- List of appropriate equipment and clean-up materials;
- Maintenance schedule for equipment;
- Details of trained staff, location and provision for 24-hour cover;
- Details of staff responsibilities;
- Notification procedures to inform the relevant environmental protection authority;
- Audit and review schedule;
- Telephone numbers of statutory water undertakers and local water company; and
- List of specialist pollution clean-up companies and their telephone numbers.

12.8.2.2 Mitigation of potential effects

Compression of substrata

Excavation support: Excavations shall be kept to a minimum, using shoring or trench boxes where appropriate. For more extensive excavations, a temporary works designer shall be appointed to design excavation support measures in accordance with all relevant guidelines.

Loss of Agricultural Land and Solid Geology

Material Reuse: The ground level of the converter station platform has been chosen to balance the volume of excavated material with the volume of fill. Excavated material will be used in the screening berms, which will be located to the south and the east of the converter station platform. Thus, the export of spoil will be avoided. However, 20,500m^3 of structural fill will be imported. An earthworks balance table is included in **Section 4.9.1** of **Chapter 4** *Construction Strategy*.

Effects on the surrounding Ground

Movement Monitoring: Ground settlement, horizontal movement and vibration monitoring will be implemented during the construction activities where required to ensure that the construction does not exceed the design limitations and relevant vibration limits to protect property.

Ground Settlement Control: Ground settlements will be controlled through the selection of a foundation type and method of construction which are suitable for the particular ground conditions.

Effects of excavation of mineral soils beneath the cable route

Movement Monitoring: Ground settlement, horizontal movement and vibration monitoring in the immediate vicinity of roadside buildings will be established during the construction activities to ensure that the construction does not exceed the design limitations and relevant vibration limits to protect property.

Ground Settlement Control: Ground settlement will be controlled through the selection and method of construction which are suitable for the particular ground conditions.

12.8.3 Operational Phase

No potential effects on land, soils, geology and groundwater have been predicted for the operational phase.

12.8.4 Decommissioning Phase

The mitigation measures, described above for the construction phase which are relevant to decommissioning, updated to reflect best practice at the time, will be implemented for the decommissioning phase.

12.9 Monitoring

Any excavation shall be monitored during earthworks to ensure the stability of slopes and to ensure that the soils excavated for disposal are consistent with the descriptions and classifications according to the waste acceptance criteria testing carried out as part of the site investigations.

Movement monitoring shall be carried out during any activities which may result in ground movements or movements of any nearby structures.

Implementation of the CEMP will be monitored on an ongoing basis by Greenlink Interconnector Ltd’s site management team.

The relevant monitoring measures mentioned above will be implemented during the decommissioning phase of the proposed development.

12.10 Residual Effects

With the implementation of the proposed mitigation measures and monitoring, the no residual effects of significance on land, soils, geology and hydrogeology are predicted during construction, operation and decommissioning.

12.10.1 Summary of Residual Effects

Table 12.18 presents the residual effects following implementation of the mitigation measures identified within this chapter.

Table 12.18 Impact Assessment Summary

Feature	Importance		Magnitude of Impact		Significance of Impact	Mitigation Measures	Residual Impact	Residual Significance of Impact
	Ranking	Justification	Ranking	Justification				
Compression of Substrata	Low	Glacial tills are over-consolidated	Small adverse	Removal of soils and replacement with structures or placement on structure on the subsoils will not impact on the characteristics of the soils	Imperceptible	Movement monitoring, Implementation of CEMP	Negligible	Imperceptible
Loss of agricultural land overburden	High	Well drained and/or high fertility soils	Small adverse	Irreversible loss of a small proportion of local high fertility soils	Moderate / slight	Area in which soils will be removed permanently has been minimised in the design. Soils will be replaced in the cable trench and at the construction compounds on completion of construction	Negligible	Imperceptible
Loss of solid geology	Low	Attribute has a low value on a local scale	Large adverse	Loss of a small proportion of any possible aggregate reserves	Moderate / slight	Volume of bedrock removed permanently has been minimised in the design	Moderate adverse	Slight

Feature	Importance		Magnitude of Impact		Significance of Impact	Mitigation Measures	Residual Impact	Residual Significance of Impact
	Ranking	Justification	Ranking	Justification				
Effects of excavation on surrounding ground	Low	Soils are generally over-consolidated glacial tills. Soils have been surcharged therefore settlement is unlikely	Small adverse	Adequate design of temporary works limits movements to an acceptable limit	Imperceptible	Excavation support, Movement monitoring, Ground settlement control, Implementation of CEMP	Negligible	Imperceptible
Excavation of soft mineral soils	Low	Volume of soft alluvial soil to be excavated is small on a local scale	Small adverse	Requirements to excavate small proportion of soft mineral soils beneath the route	Imperceptible	Implementation of CEMP	Negligible	Imperceptible
Mobilisation of sediments	High	Due to the close proximity to sensitive environments	Small adverse	Based on ground conditions, there should be limited mobilisation of those sediments.	Moderate / Slight	Implementation of CEMP	Negligible	Imperceptible

12.11 Cumulative and Transboundary Effects

12.11.1 Cumulative Effects

The proposed development forms part of the Greenlink project, which also includes offshore elements, and works in the United Kingdom. The only potential for cumulative effects or interactive effects on land, soils, geology and hydrogeology with the wider project occur at the landfall site near Baginbun Beach, and the potential effects at this location have been fully addressed in this chapter.

It is a requirement to consider the cumulative effects of past, present and future developments. The past and present developments, which have the potential for cumulative effects, are the original and existing power stations at Great Island, and the roads, farms, dwellings and other buildings along the cable route.

Having reviewed other planned developments that could have cumulative effects, two have been identified, where there is the potential for cumulative effects. These are:

- Great Island – Kilkenny 110kV Line Uprate Project
- Great Island Energy Storage System

These developments are described in **Chapter 18** *Cumulative, Transboundary and Interactive Effects*, Section 18.4.4.

The existing and previous power stations and the existing roads and buildings on the cable route may have compressed the substrata. They have reduced the area of agricultural land and overburden. The power stations have reduced the volume of solid geology and may have impacted on the bedrock aquifer. Construction of the power line upgrade and energy storage system will involve potential effects similar to the construction phase of the proposed converter station and tail station.

The potential cumulative effects on the geological attributes identified in the study area are listed below:

- Compression of Substrata
- Loss of Agricultural Land and Overburden;
- Loss of Solid Geology;
- Effect on the surrounding ground;
- Impact on bedrock Aquifer;
- Impact on Ground Water Quality and Dependent Ecosystems.

Compression of Substrata

Construction of the energy storage system, the proposed development, and the existing developments in the area may result in cumulative increased loading on underlying soils which could have a cumulative affect the current characteristics of the ground.

However, given the general nature of these soils (over consolidated glacial tills), the significance of this potential effect is deemed to be imperceptible.

Loss of Agricultural Land and Overburden

Construction of the energy storage system, the proposed development, and the existing developments in the area will reduce the area of agricultural land and overburden. To construct the energy storage system, it is expected that much of the topsoil and overburden will be excavated. Some, but not all, of the topsoil will be replaced. The cumulative loss of agricultural land and overburden, when the existing developments are included, will be significant in the immediate local area, but slight in the wider study area.

Loss of solid Geology

Excavation of rock will be required to construct the energy storage system. There will be a cumulative loss of bedrock, when the existing and previous power stations are included. However, the bedrock in the area is of low importance and there are readily available alternative sources of similar bedrock available. Therefore, the magnitude has been assigned a rating of moderate cumulative effect upon the local environment and the significance is slight.

Effects on the surrounding ground

Soil and rock excavation to construct the energy storage system has the potential to induce movement and settlement of surrounding ground. The removal of the bedrock may be carried out using a variety of techniques including mechanical excavation, chemical blasting or conventional blasting techniques. This could result in ground vibrations and destabilisation of existing slopes, existing rock slopes, with effects felt in the immediate vicinity of the works.

These works may also give rise to noise and may result in the generation of dust. These would be construction effects. Construction of the energy storage system will take place in advance of the construction of the converter station and tail station. No cumulative effect is expected.

Impact on Bedrock Aquifer

Excavation of bedrock and piling is required to construct the energy storage station and the power line upgrade, as well as the proposed development, and were undertaken to construct the power stations. There are existing groundwater wells on the power station site and in the field to the southeast of the converter station and tail station site. The bedrock at Great Island is classified as a Regionally Important Aquifer and has been assigned a High importance. However, due to the volume of the total excavation, the magnitude of the cumulative effect would be moderate adverse. The significance of the potential effect is moderate/slight.

No groundwater abstraction is proposed for the energy storage system or the proposed development. No cumulative effect on groundwater abstraction is expected.

Impact on Ground Water Quality and Groundwater Dependent Ecosystems

The activities during the construction of the energy storage system, the power line upgrade and the proposed development and the operation of the existing developments, which may impact upon groundwater quality are:

- Accidental spillages of polluting materials onsite;
- Accidental release of fines into the groundwater and surface water; and
- The potential for contaminated runoff to enter the groundwater and surface water.

The existing power station operates under an industrial emissions licence from the EPA and has measures in place to prevent contamination of groundwater and surface water. The construction of the energy storage system will take place in advance of the proposed development. The construction of the power line upgrade and proposed development will overlap in time. The power upgrade will extend for 49km northwards from Great island and the intensity of construction activity at Great Island will be low. The magnitude and significance of the potential cumulative effects on the receptors are summarised below:

- The magnitude of the potential cumulative effect on the sand and gravel aquifer could potentially be small adverse leading to a significance rating of slight;
- The magnitude of the potential cumulative effect on the Regionally Important aquifer will be small adverse leading to a significance rating of moderate/slight.

12.11.2 Transboundary Effects

Considering the nature and location of the proposed development as described in **Chapter 3** *The Proposed Development* and **Chapter 4** *Construction Strategy* no transboundary effects on land, soils, geology and hydrogeology are predicted.

12.12 Conclusion

As is stated above, with the implementation of the proposed mitigation measures and monitoring, no residual effects of significance on land, soils, geology and hydrogeology are predicted during construction, operation or decommissioning.

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