Chapter 21:
Soil, Geology and Hydrogeology

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

A TETRA TECH COMPANY

PARK WIND
JERA GROUP

Energy for generations

ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report
Chapter 21: Soil, Geology and Hydrogeology

MDR1520B
EIAR – Chapter 21
A1 C01
March 2024

Contents

Tables

Figures

21 CHAPTER 21 – SOIL, GEOLOGY AND HYDROGEOLOGY

21.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) provides an assessment of the potential impacts of the Oriel Wind Farm Project (hereafter referred to as "the Project") on the soil, geological and hydrogeological environment during the construction, operational and maintenance, and decommissioning phases of the Project. Specifically, this chapter considers the potential impacts of the onshore infrastructure of the Project above the High-Water Mark (HWM). This includes the onshore cable (and all associated infrastructure including the transition joint bay, joint bays and temporary passing bays), the onshore substation and the connections to the existing electricity Transmission System of the Project.

The assessment presented is informed by the following EIAR chapters:

- Chapter 22: Hydrology and Flood Risk - any impact to watercourses, either positive or negative will have a knock-on effect on the groundwater environment depending on the degree of interaction between surface water and groundwater; and

- Appendix 21-1: Technical Report – Coastal Erosion Assessment Report.

Article 3 of Directive 2014/52/EU lists soil and water as factors for consideration within EIA and these are further clarified in the Environmental Protection Agency (EPA) Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022).

Soils relate to the biologically active, porous medium that has developed in the uppermost layer of the earth's crust. While land and soils are sometimes grouped together in an assessment, in this EIAR land is addressed separately in chapter 20: Land and Agriculture. This chapter provides an assessment of the potential impacts on soil from the Project from activities that may result in contamination, erosion, compaction and sealing. Geology is defined by the EPA as the science of the earth, including the composition, structure and origin of its rocks and generally relates to the layers beneath the soil strata.

The 2022 EPA Guidelines define water as surface water, wastewater and groundwater. Surface water and wastewater (during construction) are addressed in chapter 22: Hydrology and Flood Risk, while groundwater (hydrogeology) is addressed within this chapter. The EPA define groundwater as the water which flows underground through naturally porous parts of the soil or rock. There is no requirement for the Project to connect to or interfere with wastewater infrastructure as outlined in chapter 29: Material Assets. Chapter 7: Marine Processes (volume 2B) presents an assessment of the potential impact to soils, geology and seawater from infrastructure below the HWM.

The details and competencies of the specialist who prepared this chapter can be found in volume 2A, chapter 1: Introduction.

21.2 Purpose of this chapter

The primary purpose of the EIAR chapter is to provide an assessment of the likely direct and indirect significant effects of the Project on soils, geology and hydrogeology. In particular, this EIAR chapter:

- Presents the existing environmental baseline established from desk studies and the basic conceptual hydrogeological model developed for the Soils, Geology and Hydrogeology Study Area along the onshore cable route, the onshore substation site and their environs (section 21.7);

- Identifies any assumptions and limitations encountered in compiling the environmental information (section 21.7.15);

- Presents an assessment of the potential likely significant effects on soils, geology and hydrogeology arising from the Project, based on the information gathered and the analysis and assessments undertaken (section 21.10). An assessment of potential cumulative impacts is provided in section 21.11 and an assessment of transboundary effects is outlined in section 21.12; and

- Highlights any necessary monitoring (section 21.10.9) and/or measures (see sections 21.8.2 and 21.10.8) to prevent, minimise, reduce, or offset the likely significant environmental effects identified in the assessment.

21.3 Study area

The Soils, Geology and Hydrogeology Study Area (see Figure 21-1) includes an area within 1 km of the planning application boundary for the onshore infrastructure. This is the area where the Project has the potential to impact on soils and geology. A 1 km buffer is considered as conservative buffer for assessments on soils and geology for the potential impacts from the proposed onshore infrastructure.

A wider area which includes the relevant groundwater environment that underlies the proposed onshore infrastructure is also examined to understand the hydrogeological regime and to define the hydrogeological setting. This includes the Louth Groundwater Body (EPA Catchment Id: 06) and the bedrock aquifers that underlie the onshore infrastructure of the Project as shown on Figure 21-1.

21.4 Policy context

Planning policy on renewable energy infrastructure is presented in volume 2A, chapter 2: Policy and Legislation. Planning policy, specifically in relation to soil, geology and hydrogeology is contained in Louth County Development Plan and is summarised in Table 21-1.

Table 21-1: Summary of policy framework provisions relevant to soils, geology and hydrogeology.

Summary of relevant policy framework	How and where considered in the EIAR
BG 17 - In consultation with the Geological Survey of Ireland, protect from inappropriate development and maintain the character, integrity and conservation value of those features or areas of geological interest listed in Table 8.4 of the Plan.	Table 8.4 (of the plan) includes Dunany Point County Geological Site (CGS). Information on consultation with the GSI is presented in section 21.5. An assessment of impacts on the CGS is provided in section 21.10. The consultation has also been considered as part of the coastal erosion assessment completed at the proposed landfall (see appendix 21-1: Coastal Erosion Report).

The Water Framework Directive (2000/60/EC) and the Groundwater Directives (80/68/EEC and 2006/118/EC) have also informed the assessment on hydrogeology (see section 21.10).

The EU Water Framework Directive (WFD) 2000/60/EC came into force on 22 December 2000 and its primary objective is for all waters to achieve at least ‘good’ ecological status and no deterioration of status. The WFD also promotes the sustainable use of water resources, defines a management and reporting system based on River Basin Districts (RBDs) and sets environmental objectives which take account of the full range of pressures on the aquatic environment (including pollution, abstraction, flow regulation, habitat impact etc).

The first Groundwater Directive (80/68/EEC) aimed to protect groundwater from pollution by controlling discharges and disposal of certain dangerous substances to groundwater. The Directive was repealed in 2013 and replaced by the second Groundwater Directive (2006/118/EC) on the protection of groundwater against pollution and deterioration and is complementary to the WFD. This Directive is commonly referred to as the “Groundwater Daughter Directive”. In Ireland, the key water-related Directives are primarily transposed into national legislation through the following:

- European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003), as amended;
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009), as amended;
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010), as amended;

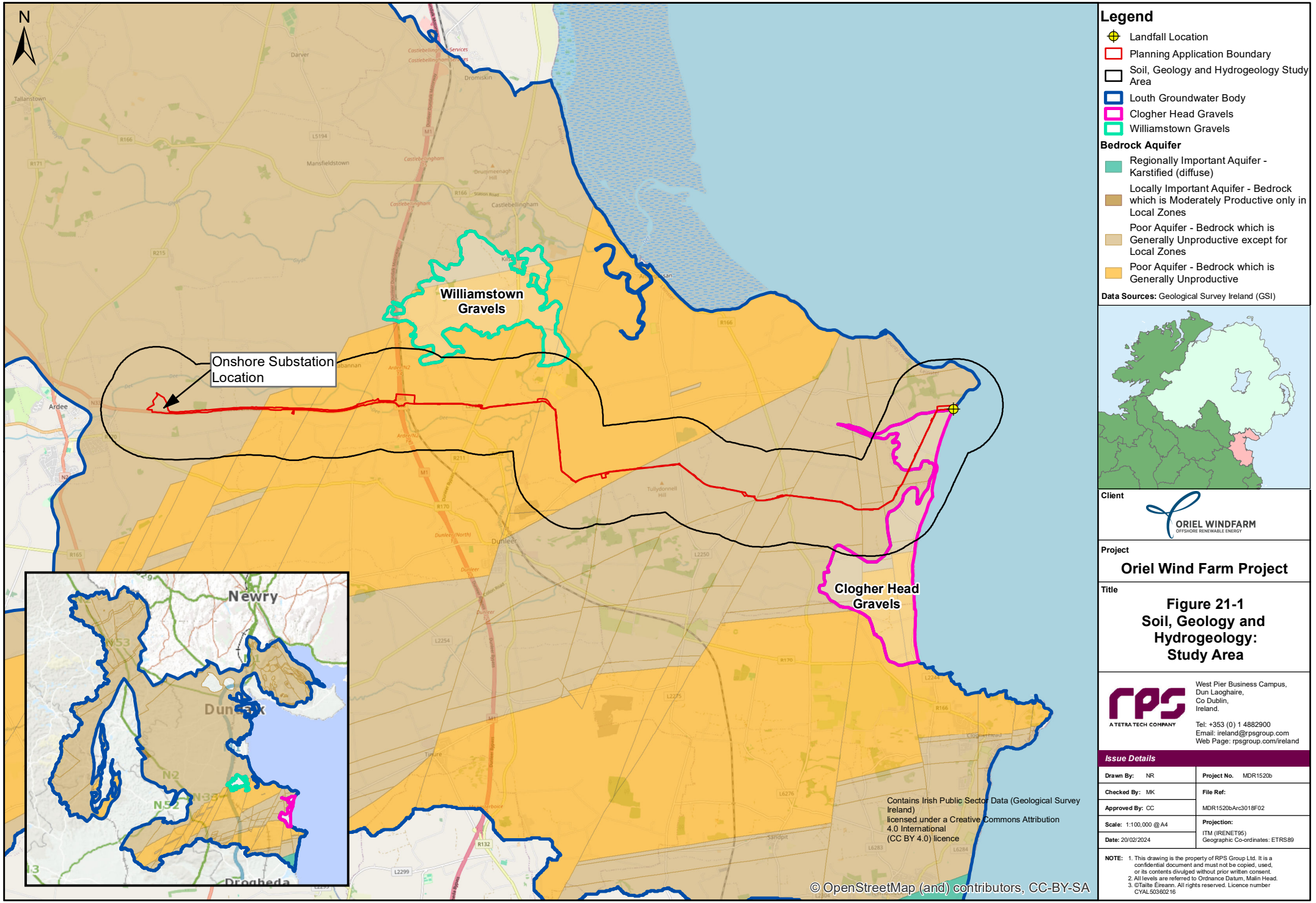
- European Communities (Drinking Water) Regulations 2014 (S.I. 122 of 2014), as amended;
- European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2010 (S.I. No. 610 of 2010), as amended; and
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011).

21.5 Consultation

Table 21-2 summarises the issues raised relevant to soils, geology and hydrogeology, which have been identified during consultation activities undertaken to date, together with how these issues have been considered in the production of this EIAR chapter. Chapter 6: Consultation provides details on the types of consultation activities undertaken for the Project between 2019 and 2024 and the consultees that were contacted.

Table 21-2: Summary of key consultation issues relevant to soils, geology and hydrogeology.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
8 October 2019	Department of Agriculture, Environment and Rural Affairs (DAERA) - EIA scoping response	The topography, geology, soils and water environment of the site and surrounding area should be described.	Description included within this chapter under the baseline section (section 21.7).
23 September 2019	Inland Fisheries Ireland - EIA scoping response	Ensure that mitigation measures are put in place at all locations and phases of the Project to ensure the protection and conservation of the aquatic environment.	Measures are set out within this chapter in relation to management of soils to prevent sedimentation of watercourses (section 21.8.2 and 21.10.8). See also measures listed in chapter 19: Onshore Biodiversity and chapter 22: Hydrology & Flood Risk.
27 September 2019	Louth County Council - EIA scoping response	It will be important to ensure that measures to offset coastal erosion are provided in the Plan to protect this important resource.	The methodology for the installation of the TJB and the offshore cable at Dunany Point has been selected to minimise impact from coastal erosion (see appendix 22-1: Coastal Erosion Assessment Report)
08 February 2023	Geological Survey Ireland (GSI) – response to correspondence setting out works at the Dunany Point County Geological Site (CGS).	The potential impacts on the Dunany Point CGS from the construction and burial of the proposed transition joint bay require assessment. The GSI have provided a list of datasets and geological mapping sources that are available to be utilised within an EIAR. The Project needs to consider any potential impact on specific groundwater abstractions and on groundwater resources in general. Geo-hazards are to be taken into consideration for the Project. Geochemistry of soil and sediment data is provided as part of the Tellus programme; this is to be considered as part of the EIA process.	The impact assessment for the CGS is set out in section 21.10.3. Measures are included in the Project in relation to management of the CGS (see section 21.10.8). A Coastal Erosion Assessment Report (appendix 21-1) has also been prepared in response to the GSI correspondence. Datasets provided by the GSI have been reviewed and documented in section 21.7. Groundwater impacts are assessed in section 21.10.5, 21.10.6 and 21.10.7. Mitigation measures are set out in section 21.10.8. A geo-hazard baseline is considered in section 21.7.5. Geo-hazard risks are assessed further in the Coastal Erosion Assessment Report (appendix 21-1). Tellus data was reviewed as part of the baseline environment (section 21.7).



Legend

- Landfall Location
- Planning Application Boundary
- Soil, Geology and Hydrogeology Study Area
- Louth Groundwater Body
- Clogher Head Gravels
- Williamstown Gravels

Bedrock Aquifer

- Regionally Important Aquifer - Karstified (diffuse)
- Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive

Data Sources: Geological Survey Ireland (GSI)

Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-1 Soil, Geology and Hydrogeology: Study Area

RPS
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3018F02
Approved By: CC	
Scale: 1:100,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 20/02/2024	

21.6 Methodology to inform the baseline

21.6.1 Desktop study

The key sources (i.e. data and reports) used to inform the baseline characterisation of the Soils, Geology and Hydrogeology Study Area are summarised in Table 21-3 below. These sources provide the most up to date data for this assessment.

Table 21-3: Summary of key desktop sources.

Sources	Study	Data type	Format
GSI: https://www.gsi.ie/	Teagasc Soils and subsoils	National spatial dataset layers	Webmap
GSI: https://www.gsi.ie/	Bedrock Geology		Webmap
GSI: https://www.gsi.ie/; EPA: http://gis.epa.ie/Envision	Aquifer Classification		Webmap
GSI: https://www.gsi.ie/	Groundwater Vulnerability		Webmap
GSI: https://www.gsi.ie/	Groundwater Well information		Webmap
GSI: https://www.gsi.ie/	Geotechnical Investigations		Webmap
EPA: https://gis.epa.ie/EPAMaps/	Geological Heritage Sites		Webmap
EPA: http://gis.epa.ie/Envision; EPA: www.catchments.ie	Water Framework Directive (WFD) data	National spatial dataset layers Catchment data	Webmap PDF Documents
EPA: http://gis.epa.ie/EPAMaps/; http://dahg.maps.arcgis.com; National Parks and Wildlife Services (NPWS): https://www.npws.ie/	International, National and Locally Important Designated Sites	National spatial dataset layers Heritage locations in Ireland	Webmap

Note: All sources accessed in November 2023.

21.6.2 Site specific surveys

In addition to the desktop study data, the site-specific surveys and investigations outlined in Table 21-4 were also undertaken to inform this assessment.

Table 21-4: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Coastal Erosion Assessment	Landfall at Dunany	Inspection comprised visual examination of the exposed ground conditions, particularly at the cliff face at the location of the landfall. The inspection recorded ground conditions and salient geomorphological conditions within the area.	RPS	Sept. 2023	Appendix 21-1
Causeway Geotech Limited, June 2021	Oriel Windfarm Onshore 220kV Cable Route – Ground Investigation	Factual Ground Investigation Report	Causeway Geotech Limited	June 2021	Oriel Windfarm Onshore 220kV Cable Route – Ground Investigation
Apex Geophysics, October 2021	Report on the Geophysical Investigation for	Tabulated geophysical data	Apex Geophysics	October 2021	Report on the Geophysical Investigation for the

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
	the Oriel Windfarm 220kV Cable Route				Oriel Windfarm 220kV Cable Route
Causeway Geotech Limited, October 2021	Oriel Windfarm Onshore 220kV Cable Route – Additional Ground Investigation.	Photographs and drilling logs	Causeway Geotech Limited	October 2021	Oriel Windfarm Onshore 220kV Cable Route – Additional Ground Investigation.

21.6.3 Identification of designated sites

All designated sites within the Soils, Geology and Hydrogeology Study Area that could be affected by the construction, operational and maintenance, and decommissioning phases of the Project were identified using the three-step process described below:

- Step 1: All designated sites of international, European, national and local importance within the Soils, Geology and Hydrogeology Study Area were identified using a number of sources, including the GSI map viewer – geological heritage, NPWS – map viewer and EPA map viewer;
- Step 2: Information was compiled on the relevant geological heritage for each site; and
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Project; and,
  - Sites and associated features were located within the Soil, Geology and Hydrogeology Study Area (see section 21.7.4).

Dunany Point and Port Raised Beach CGSs are located within the Soil, Geology and Hydrogeology Study Area. There are no protected sites with groundwater dependent habitats within the Soils, Geology and Hydrogeology Study Area (see chapter 19: Onshore Biodiversity for further details on habitats).

21.7 Baseline environment

A description of the baseline environment is provided below.

21.7.1 Topography

The site of the Project (onshore infrastructure) is situated between Dunany Point (Dunany Bay Beach), and the townland of Stickillin, located 3 km east of Ardee in Co. Louth where the onshore substation is located. The topography of the Project within the Soils, Geology and Hydrogeology Study Area is gently undulating ranging in height from approximately +45 to 0 m above ordnance datum (mAOD), gently decreasing and sloping towards Dunany Point and the east coast.

21.7.2 Soils and subsoils

Figure 21-2 presents the six types of soils predominantly covering the Soils, Geology and Hydrogeology Study Area.

The landfall location lies approximately 700 m south of Dunany Point and at this location the underlying soils largely consist of marine sands as well as mineral poorly drained (mainly acidic) soils, derived mainly from non-calcareous parent materials (AminPD, GSI/Teagasc, 2018).

Similarly, mineral poorly drained (mainly acidic) soils, derived mainly from non-calcareous parent materials AminPD/fine loamy cover the majority of the easternmost 10 km from the onshore cable route. The presence

of small sections of marine sand and gravel (Marsands), as well as glaciofluvial sands and gravels (AminSW) are also present in the eastern section of the onshore cable route.

The presence of deep well drained mineral soils (AminDW) cover the route from Mullincross and surrounding area towards the M1 Motorway. From the M1 motorway to Stickillin and the surrounding areas, the soils are defined as deep well drained mineral (mainly basic), derived from mainly calcareous materials (BminDW) that are occasionally interrupted with relatively small inclusions of alluvium (AluvMIN). Types of soils identified for the Soils, Geology and Hydrogeology Study Area are described in Table 21-5 below.

The onshore substation site is located in an agricultural field in the townland of Stickillin. The field has existing access from the N33 national road which services the field and agricultural buildings. The onshore substation site is underlain by deep well drained mineral (mainly basic) soils (BminDW) derived from mainly calcareous material. The Quaternary sediment underlying the site is described as till derived from limestones (TLs). The calcareous material is likely to be associated with the Clontail Formation calcareous red-mica greywacke bedrock that underlies the site.

Table 21-5: Types of soils identified for the Soils, Geology and Hydrogeology Study Area.

Legend (soil type)	Soil group	Parent material name	Parent material description
AminPD	Surface water Gleys, Groundwater Gleys	Irish Sea till	Sandstone and shale till (Lower Palaeozoic) with matrix of Irish Sea Basin origin
AminDW	Acid Brown Earths, Brown Podzolics	Till derived chiefly from Lower Palaeozoic rocks	Sandstone and shale till (Lower Palaeozoic)
BminDW	Grey Brown Podzolics, Brown Earths (medium-high base status)	Till derived chiefly from limestone	Limestone till (Carboniferous)
AluvMIN	Mineral alluvium	Alluvium	Alluvium undifferentiated
AminSW	Lithosolos, Regosolos	Glaciofluvial sands and gravels	Sandstone and shale sands and gravels
MarSands	-	Beach sands and gravels	-

https://www.gsi.ie/ Accessed: November 2023.

The geophysical investigation undertaken by Apex interpreted that the onshore substation site was generally underlain by various CLAY horizons (often sandy gravelly CLAY) with beds of SAND and GRAVEL within the CLAY horizons up to 35 meters above ground level (mbgl). The geophysical survey by Apex geophysics drew the following interpretations:

- A thin layer (0.5 to 1.1 m, average 0.9 m) of predominantly soft to firm slightly sandy slightly gravelly CLAY with localised pockets of loose to medium dense silty clayey sand and/or gravel;
- Over a thin layer (0.2 to 3.3 m, average 1.5 m) of firm to stiff slightly sandy slightly gravelly CLAY with localised medium dense to dense silty clayey sand and/or gravel;
- over a thick layer (average 35.9 m thick) of stiff to very stiff soils. The soils are interpreted as comprising of slightly sandy slightly gravelly CLAY with a lens of low resistivity (25 – 50 Ohm-m) possible Irish Sea till on the seaward side of the profile to a depth c. 0 mOD; and
- Over slightly weathered to fresh rock.

The underlying subsoil or Quaternary sediments comprise primarily of till derived from Lower Palaeozoic sandstones and shales (IrSTLPSsS), as shown in Figure 21-3. For approximately 8 km of the onshore cable route (from the landfall westwards) the subsoils comprise glaciomarine sediments, described as clayey texture soils, composed of sandstone and shale till with matrix of Irish Sea Basin origin and Beach sands and

gravels. The western section of the onshore cable route, (approximately 5 km from Stickillin eastwards), subsoils are comprised of limestone till, with occasional occurrence of alluvium.

The GSI online database (https://dcenr.maps.arcgis.com/) states that the onshore cable route is characterised by moderate permeability subsoil overlain by well-drained soil in the western section from Stickillin to the M1 and underlain with low permeability subsoils along the eastern section of the onshore cable route, from the M1 towards the landfall location.

The GSI Geotechnical map viewer indicates numerous geotechnical boreholes as part of the Dunleer-Dundalk Motorway Project M1 (Report no.2527), along the M1. The western section of onshore cable route, including the N33 road, has a dense borehole occurrence. This section, equally, includes four boreholes drilled to the bedrock (no. 8865, no. 88706, no. 88707 and no. 88709) and describes the subsoils as mostly stiff, grey to brown, silty gravely clay. Depth to bedrock in these boreholes, is in the range of between 1.65-5.5 mbgl) respectively and representing low to medium permeability subsoils.

The south section of the M1 Motorway, southwards of the M1 junction and Ardee/N2 road, includes seven boreholes that are drilled to the bedrock (no. 88412, no. 88414, no. 88415, no. 88416, no. 88417, no. 88418 and no. 88419), describing subsoils as mostly stiff (firm-hard) silty clays, with depth to bedrock ranging between 3.7-11.2 mbgl respectively and representing a low permeability subsoil.

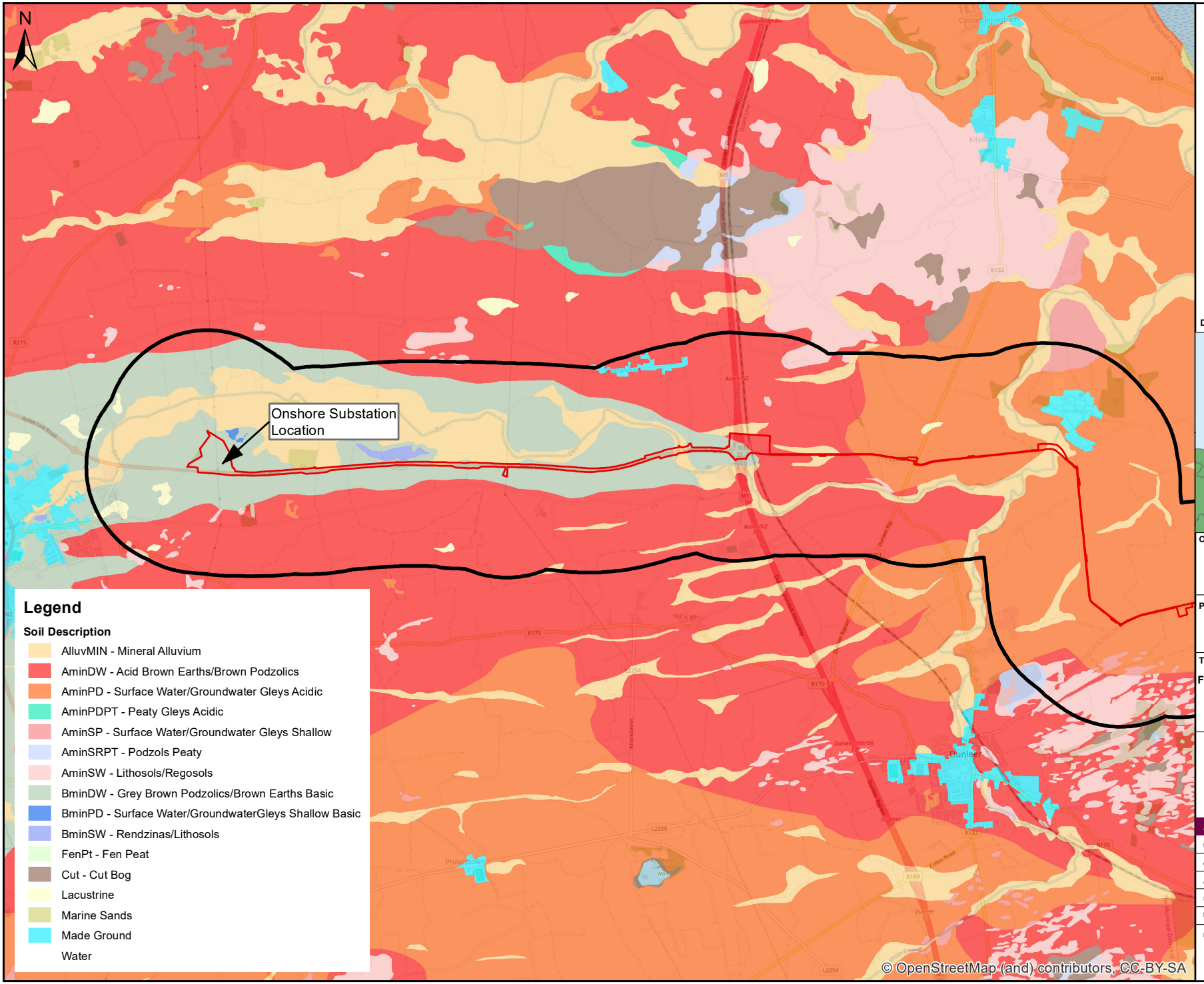
The Ground Investigation undertaken by Causeway Geotech Limited (2021) in the east of the Project included one borehole (BHLP-07). The borehole found the sub-surface conditions consisted of firm to stiff brown sandy gravelly CLAY up to 3.80 mbgl and stiff to very stiff brown slightly sandy slightly gravelly silty CLAY to 8.30 mbgl. This horizon is underlain by very stiff brown slightly sandy slightly gravelly silty CLAY with low cobble content to 12.00 mbgl, medium dense brown sandy silty subangular to subrounded fine to coarse GRAVEL to 14.50 mbgl, very stiff brown slightly sandy gravelly silty CLAY with low cobble content to 17.60mbgl, grey gravelly silty SAND to 19.40 mbgl, very stiff grey slightly sandy gravelly CLAY with low cobble content to 24.80 mbgl and very stiff grey slightly sandy slightly gravelly silty CLAY up to 35.50 mbgl. No noticeable groundwater strikes during the borehole drilling.

21.7.3 Bedrock geology

Based on GSI map viewer, there are three different Lower Palaeozoic bedrock units underlining the Soils, Geology, and Hydrogeology Study Area, as outlined in Figure 21-4:

- *Glaspistol Formation* – underlaying a section west of the landfall location, for approximately 4.5 km of the onshore cable route and consists of black mudstones, grey to buff coloured quartzose greywackes and occasional green bentonites;
- *Little Harbour Formation* – underlaying a section to the east of Togher and a short section around the Coast Road and L2244 junction, for approximately 4 km of the onshore cable route. Formation consists of calcareous greywacke and mudstone;
- *Salterstown Formation* – underlaying the mid-section and majority of the onshore cable route (approximately 10 km). Formation consists of calcareous greywacke and banded mudstone; and,
- *Clontail Formation* – underlaying the western section of the onshore cable route from Stickillin towards the east (approximately 2 km). Formation is consisted of green-grey greywackes with quartzose fine sandstone to siltstone units.

The GSI database (refer also to Figure 21-4) does show structural faults along the onshore cable route, mainly intersecting the Salterstown Formation and Little Harbour Formation periodically in a north to south direction.

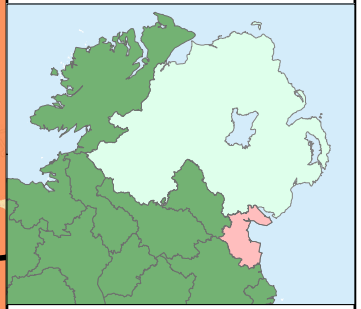


Legend

Onshore Cable Route - planning application boundary

Soil, Geology and Hydrogeology Study Area

Data Sources: EPA



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-2: Soils identified within the Soils, Geology and Hydrogeology Study Area

Map 1 of 2

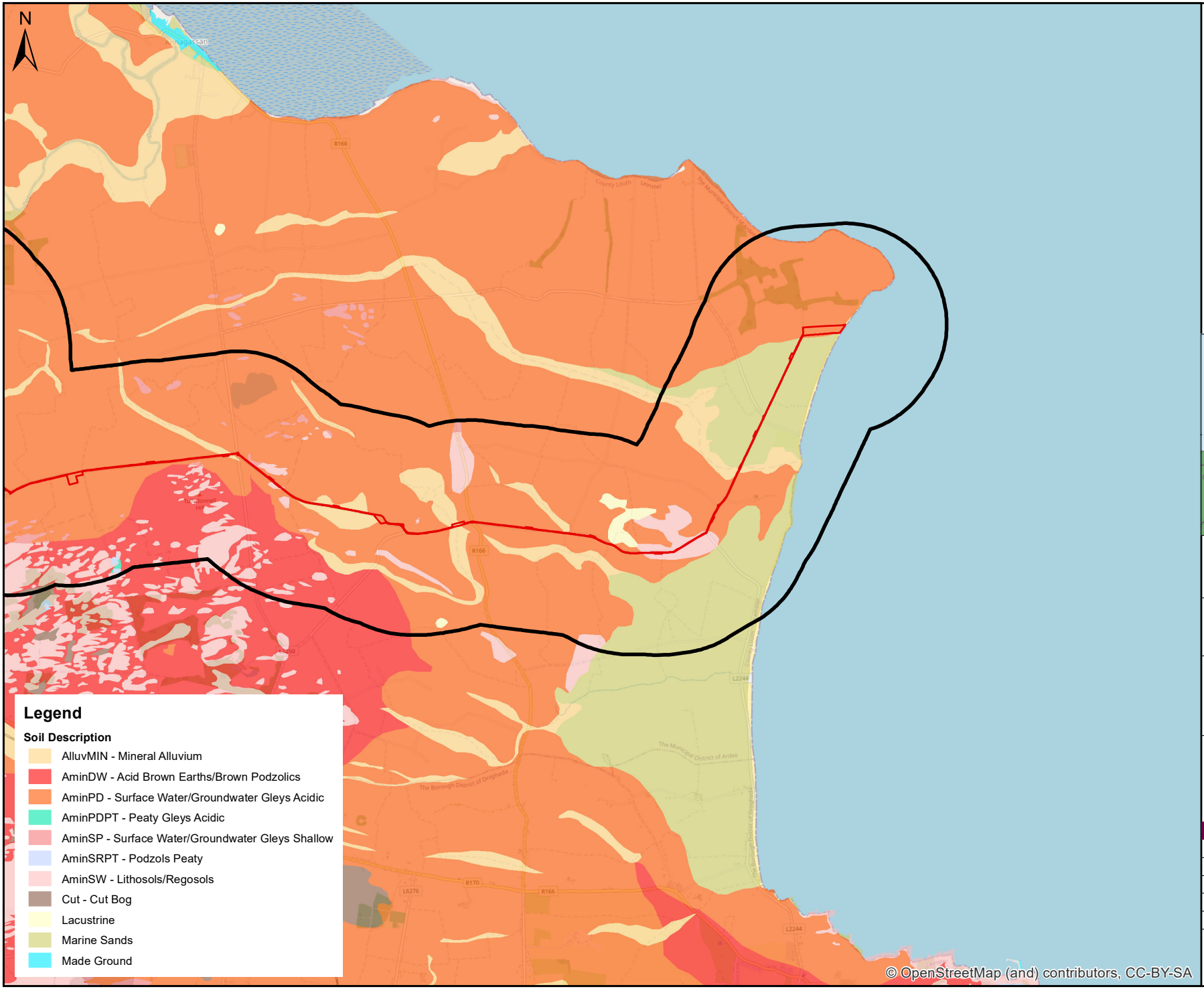
rps
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3006F01
Approved By: CW	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	

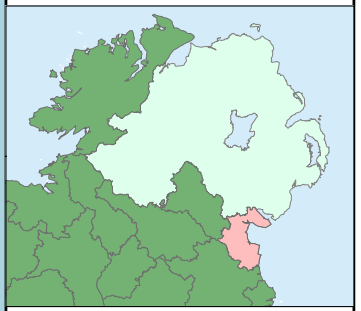


Legend

Onshore Cable Route - planning application boundary

Soil, Geology and Hydrogeology Study Area

Data Sources: EPA



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-2: Soils identified within the Soils, Geology and Hydrogeology Study Area

Map 2 of 2

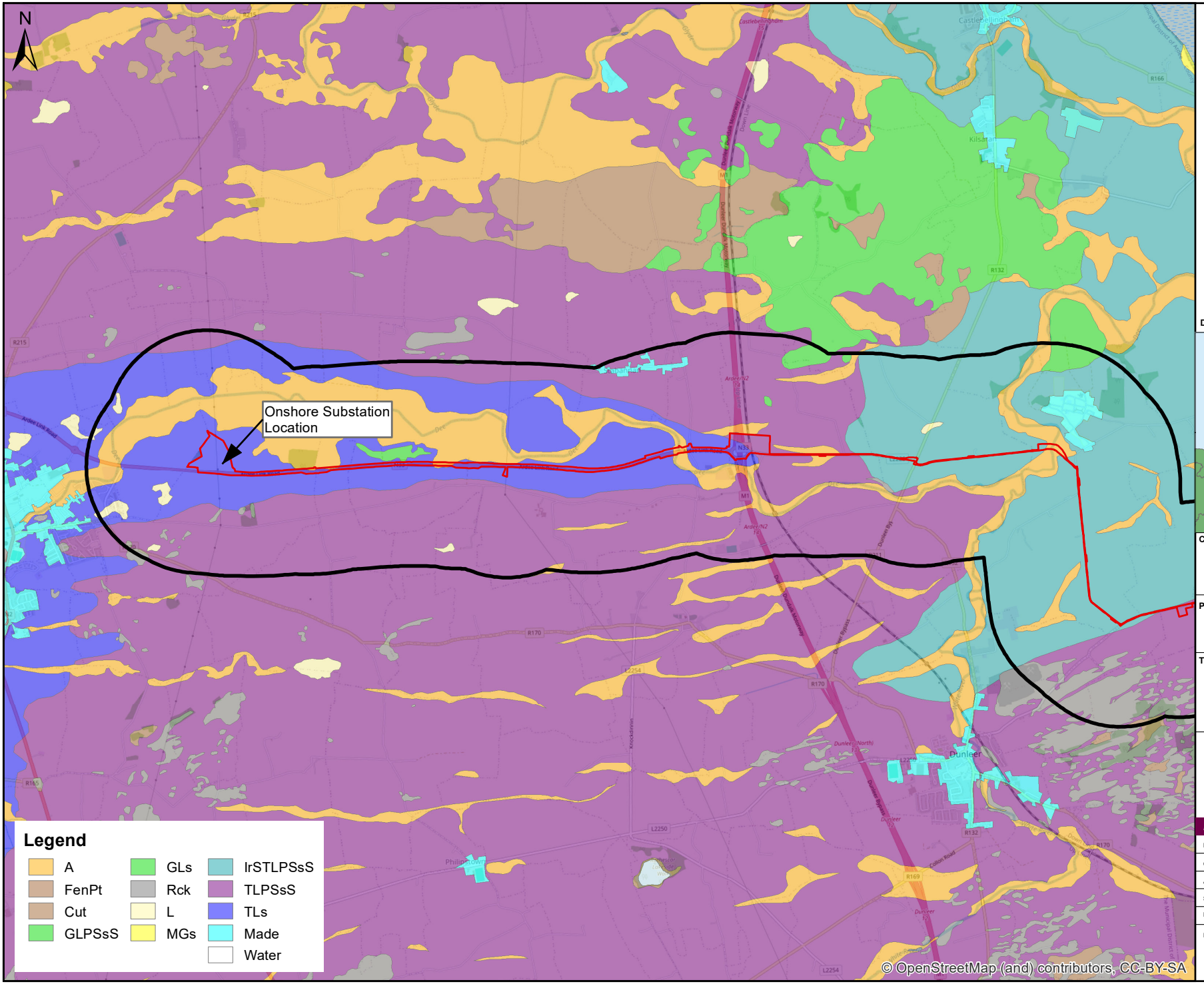
RPS
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

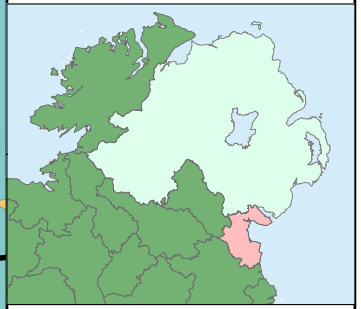
Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3006F01
Approved By: CW	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	



Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area

Data Sources: EPA



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-3
Subsoils identified within the Soils, Geology and Hydrogeology Study Area

Map 1 of 2

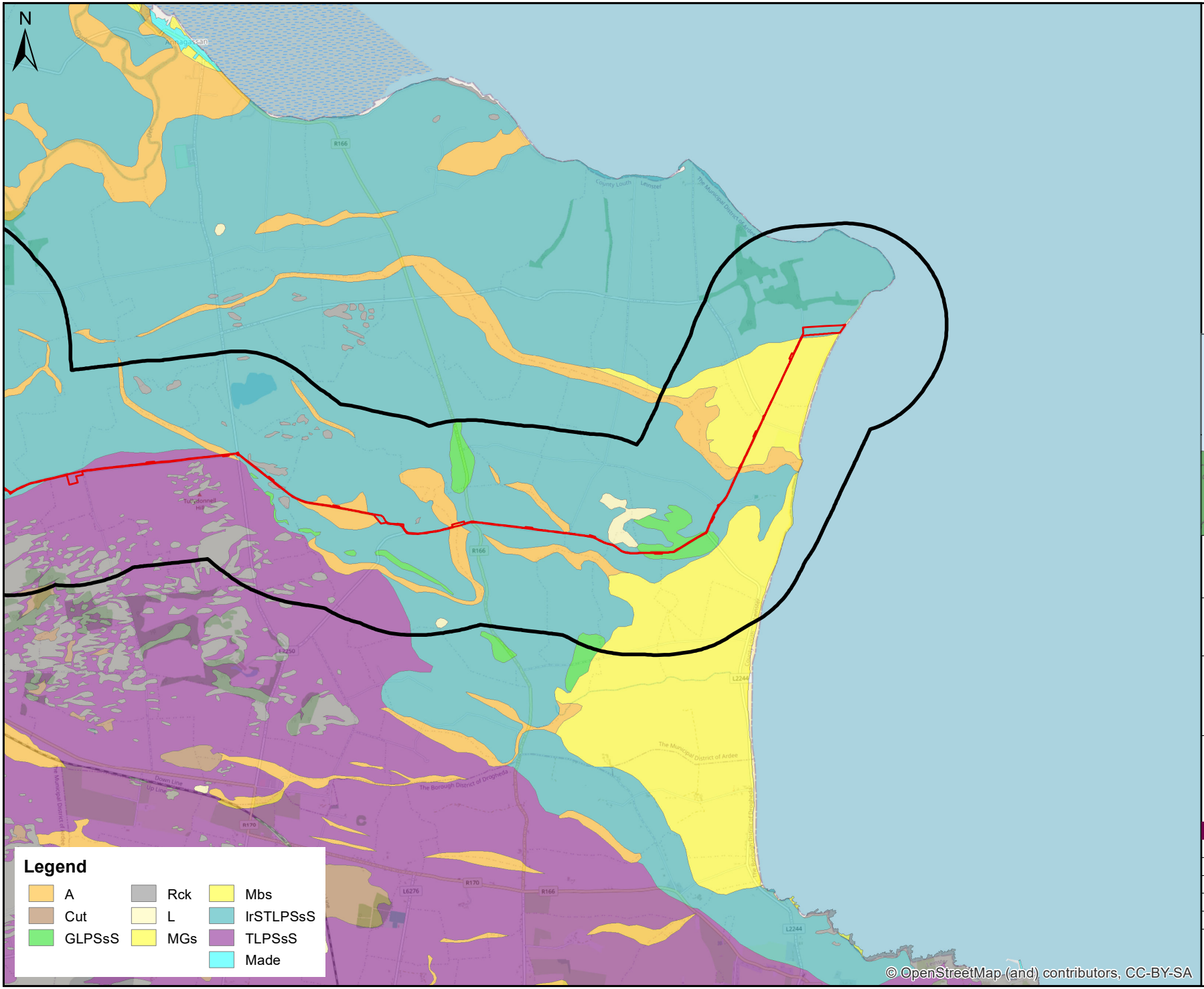
RPS
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

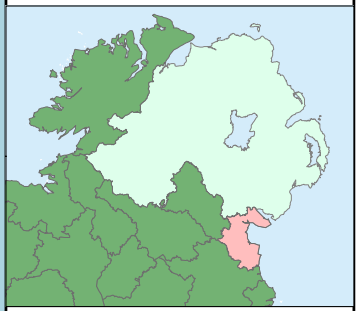
Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3007F01
Approved By: CC	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	



Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area

Data Sources: EPA



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-3
Subsoils identified within the Soils, Geology and Hydrogeology Study Area

Map 2 of 2

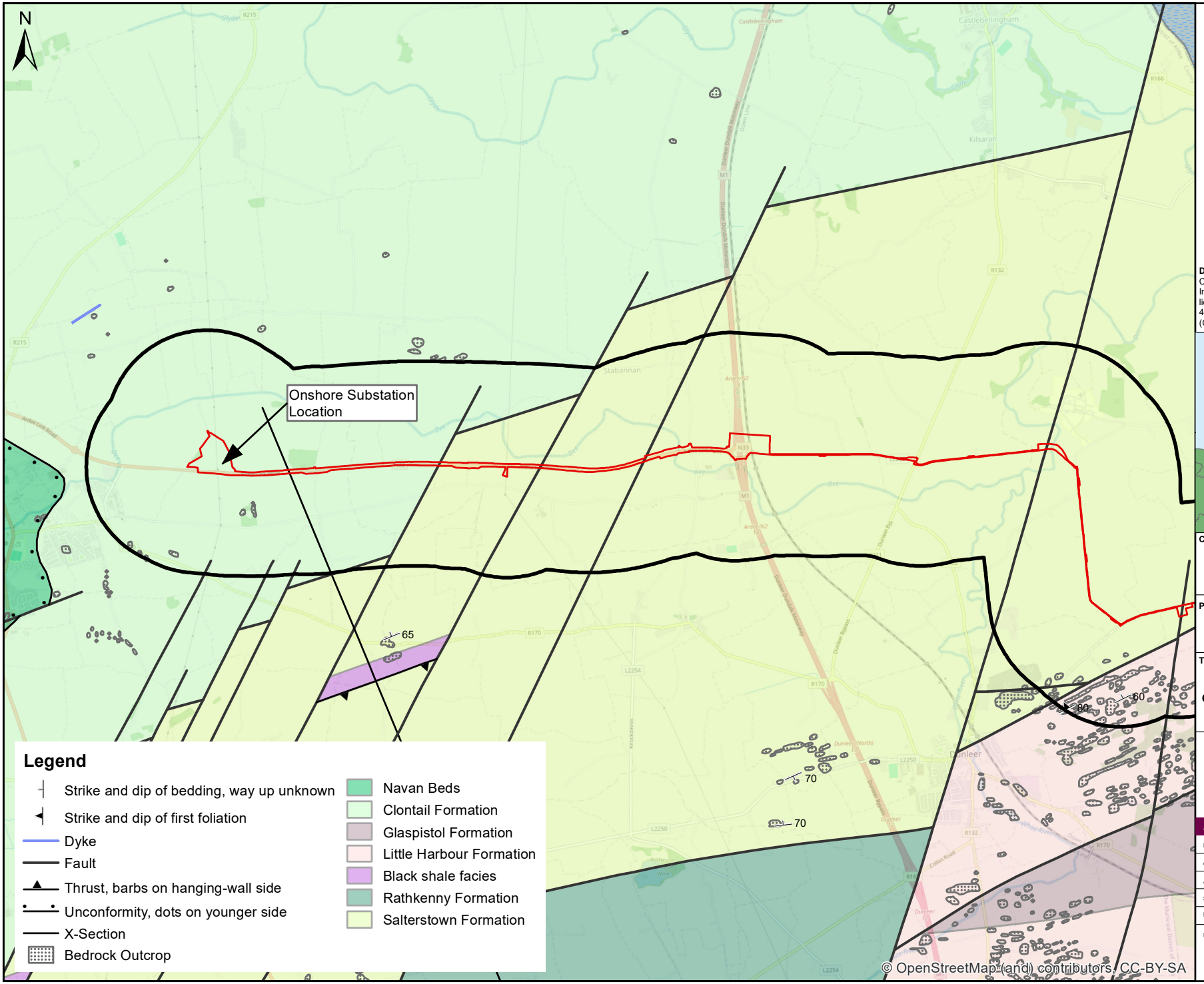
rps
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

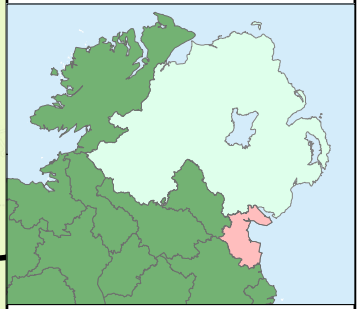
Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3007F01
Approved By: CC	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	



Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

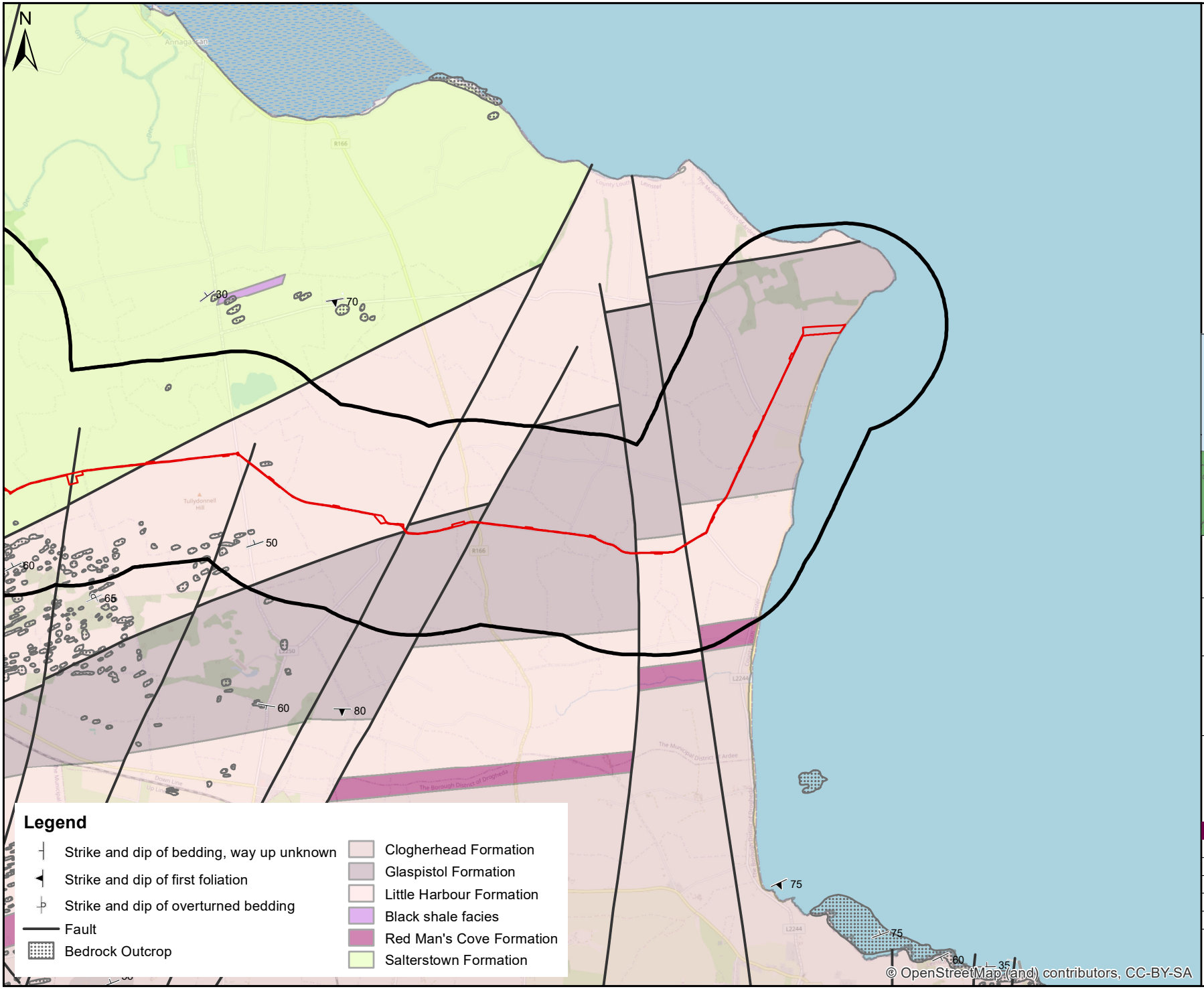
Project
Oriel Wind Farm Project

Title
Figure 21-4
Bedrock identified within the Soils, Geology and Hydrogeology Study Area
Map 1 of 2

RPS
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	Project No. MDR1520b
Checked By: MK	File Ref: MDR1520bArc3008F01
Approved By: CC	
Scale: 1:50,000 @ A4	Projection: ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	

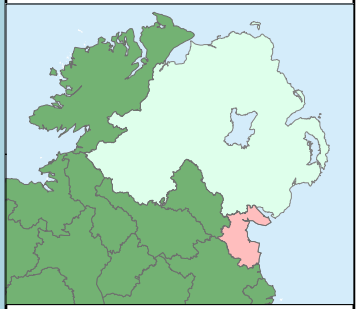


Legend

Onshore Cable Route - planning application boundary

Soil, Geology and Hydrogeology Study Area

Data Sources: Geological Survey Ireland (GSI)
Contains Irish Public Sector Data (Geological Survey Ireland)
licensed under a Creative Commons Attribution 4.0 International
(CC BY 4.0) licence



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-4
Bedrock identified within the Soils, Geology and Hydrogeology Study Area

Map 2 of 2

rps
A TETRA TECH COMPANY

West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3008F01
Approved By: CC	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95)
Date: 15/12/2023	Geographic Co-ordinates: ETRS89

21.7.4 Geological heritage

Geological heritage data and maps derive from County Geological Site (CGS) audits. The GSI Public Viewer online-mapping tool identifies sites of geological heritage for the Soils, Geology, and Hydrogeology Study Area and these are shown in Figure 21-5 and listed in Table 21-6.

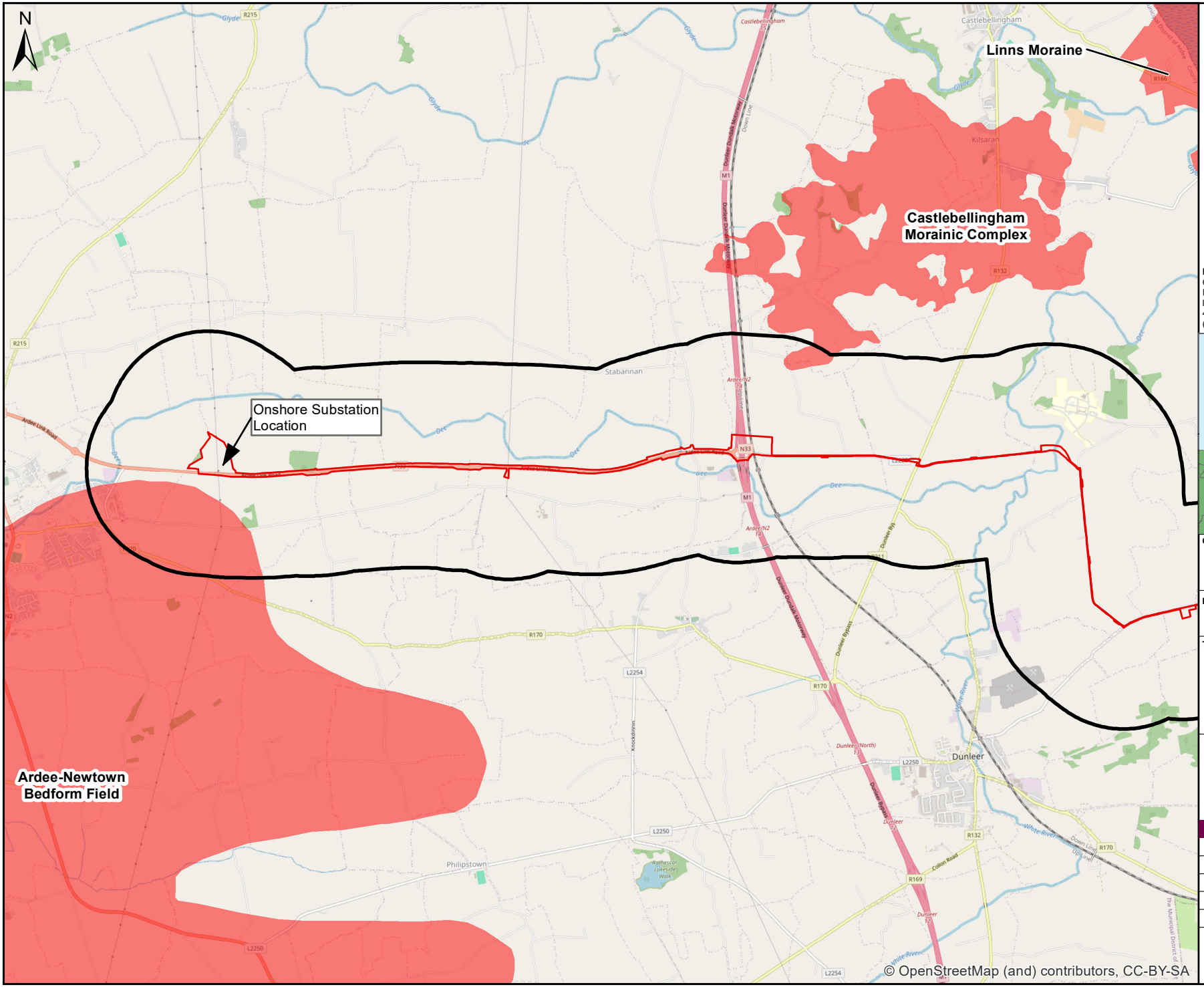
Table 21-6: Geological Heritage Areas in the Soils, Geology and Hydrogeology Study Area.

Site code	Site name	Description	Proximity to Project
LH017	Dunany Point	A low coastal cliff section several 100 m long, c. 6 m-8 m high for most of its extent.	CGS is intersected by the Project (TJB Option 1 overlap with coastal cliff, approx. 100 m^2 and, TJB Option 2 overlap approx. with costal cliff, 200 m^2).
LH025	Port Raised Beach	A wide, flat-topped feature adjacent to the shoreline between Clogherhead and Dunany Point.	The application boundary extent intersects with the CGS, however no works will occur within the site, with works confined to the existing road and the adjacent field.
LH10	Castlebellingham Moranic complex	The complex includes a large accumulation of sands and gravels deposited at the edge of the northward-retreating ice margin at the end of the last Ice Age.	The application boundary extent intersects a small section of the CGS, however no works will occur within the site.
LH018	Dundalk Bay	Dundalk Bay is a wide coastal embayment, incorporating wide expanses of coastal flats.	Approximately 4 km north of the landfall location and onshore cable route.
LH001	Ardee-Newtown Bedform Field	This is a field of subglacial bedforms and includes drumlins, crag-and-tails and ribbed moraines.	Approximately 200 m south of the onshore substation site (on the far side of the N33).

Dunany Point includes a coastal cliff section that extends for several hundred metres and is approximately 8 m—10 m high over most of its extent, comprised of Quaternary Age glacial sediments, deposited during deglaciation at the end of the last Ice Age. The cliff section exposes sediments important to an understanding of relative sea levels in this part of Ireland during the end of the last Ice Age. The sediments in the ridge consist mainly of muddy sediments that contrast starkly with the stratified deposits exposed along the north side of Dundalk Bay at Rathcor and Cooley Point (GSI, 2013a).

Port Raised Beach was formed at the end of the last Quaternary glaciation and is therefore as such, a textbook locality for the recognition of coastal emergence, and a fall in relative sea level. The site primarily needs protection from potential intensive erosion. The beach is exceptionally flat-topped and has no real relief, except occasional low swales which are themselves probably individual beach features. The beach has been cut into till which was deposited earlier in glaciation. The feature is probably the widest raised beach in Ireland (GSI, 2013b).

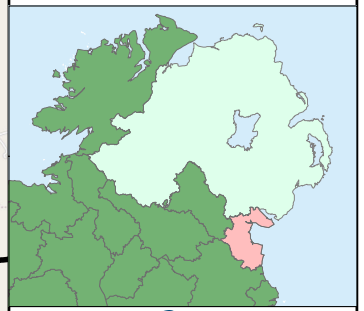
The Ardee-Newtown Bedform Field is a field of subglacial bedforms, which are features formed under the bed of an ice sheet and includes drumlins, crag-and-tails and ribbed moraines, and forms part of a small, discrete field of these features south and southwest of Ardee town. The field covers an area of 8 x 6 km and includes approximately 50 features. Some of the drumlins are superimposed on ribbed moraine features.



Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area
- Geological Heritage Site Boundaries

Data Sources: Geological Survey Ireland (GSI)
Contains Irish Public Sector Data (Geological Survey Ireland)
licensed under a Creative Commons Attribution 4.0 International
(CC BY 4.0) licence



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

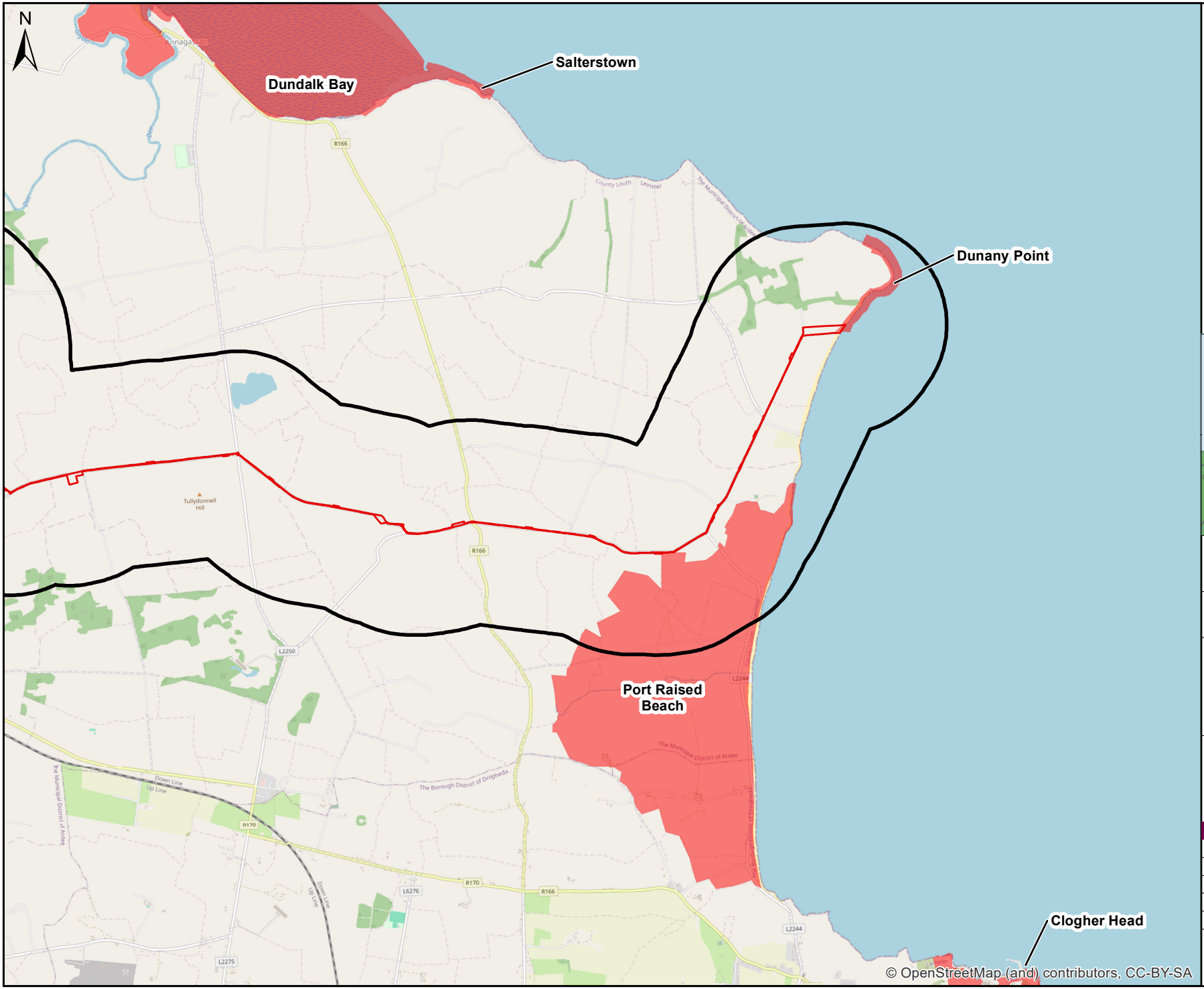
Project
Oriel Wind Farm Project

Title
Figure 21-5
Geological heritage identified within the Soils, Geology and Hydrogeology Study Area
Map 1 of 2

RPS
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

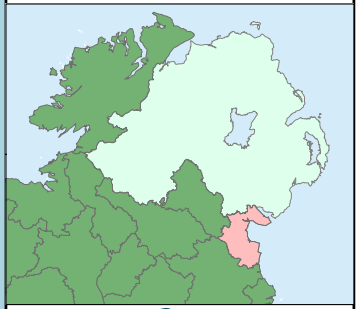
Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3009F01
Approved By: CC	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Scale: 1:50,000 @ A4	
Date: 15/12/2023	



Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area
- Geological Heritage Site Boundaries

Data Sources: Geological Survey Ireland (GSI)
Contains Irish Public Sector Data (Geological Survey Ireland)
licensed under a Creative Commons Attribution 4.0 International
(CC BY 4.0) licence



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project
Oriel Wind Farm Project

Title
Figure 21-5
Geological heritage identified within the Soils, Geology and Hydrogeology Study Area
Map 2 of 2

RPS
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3009F01
Approved By: CC	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95)
Date: 15/12/2023	Geographic Co-ordinates: ETRS89

21.7.5 Geo-hazards

According to the GSI online database, there are presently no records of geo-hazards such as landslides/landslips. The location for the proposed onshore infrastructure is recorded as low susceptibility for landslides. The nearest recorded landslide event is Mell (GSI_LS06-0302), located circa 14 km south of the onshore cable route.

21.7.6 Aquifer classification

The GSI provide a general hydrogeological classification based on the geological setting. The GSI aquifer categories are intended to describe both resource potential (Regionally or Locally Important, or Poor) and groundwater flow type and attenuation potential (through fissures, karst conduits or intergranular). The regional aquifer classification is displayed in Figure 21-6.

The GSI online database states that the Salterstown Formation found in the central region of the onshore cable (as described in Section 21.7.3) is classified as a Poor Bedrock Aquifer which is generally unproductive (Pu). A Pu bedrock aquifer generally has few and poorly connected fractures, fissures and joints. This low fissure permeability tends to decrease further with depth. A shallow zone of slightly higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may rarely occur along large fault zones.

The Clontail Formation and Little Harbour Formation (as described in section 21.7.3) in the western and eastern regions of the onshore cable route, respectively, are classified as Poor Bedrock Aquifers which are generally unproductive, except for in local zones (Pl). A Pl aquifer is described as aquifers with limited and relatively poorly connected network of fractures, fissures and joints and with relatively poor permeability and/or more limited zones of higher permeability which tends to decrease further with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may also occur along fault zones. These zones may be able to provide larger 'locally important' supplies of water. In general, the poor fissure network results in poor aquifer storage, short flow paths (tens of metres) and low 'recharge acceptance'. Groundwater discharge to streams ('baseflow') is very limited.

Poor bedrock aquifers are capable of supplying small abstractions (e.g. domestic supplies, small group schemes), or are characterised as 'moderate' to 'low' yields (<100 m^3/d) aquifers. Groundwater flow occurs predominantly through a limited and poorly connected network of fractures, fissures and joints.

Approximately 800 m north of the onshore cable route is underlain by gravels derived from Lower Palaeozoic sandstone (GLPSsS) Quaternary sediments which correspond with a 5 km^2 Locally Important Gravel Aquifer (Lg).

An Lg aquifer is a sand/gravel aquifer with a small continuous area (<c. 25 km^2). Groundwater flows through the pore spaces between sand/gravel grains, and the permeability is mainly determined by the grain size, and the 'sorting' of the material. There is a relatively uniform distribution of groundwater, good aquifer storage and long groundwater flow paths, typically limited by the aquifer's extent. Although the properties imply that this aquifer can supply 'excellent' yields, the smaller size limits the amount of recharge available to meet abstractions. Groundwater gradients are typically low, giving relatively low groundwater velocities. There is generally a strong interaction between surface water and groundwater, with groundwater discharging into streams if the water table is high, or conversely, the surface water moving into the aquifer, if the surface water level is high.

21.7.7 Groundwater status

The Soils, Geology and Hydrogeology Study Area, lies mainly within the Louth (IEGBNI_NB_G_019) Groundwater Body (GWB), except the relatively small area of the onshore cable route underlain by Clogher Head Gravel GWB (IE_NB_G_023) (at the coast).

The Louth GWB is poorly productive bedrock comprised primarily of low transmissivity rocks and most of the flows are likely to occur in the top three metres of the aquifer within a broken and weathered zone. Recharge is likely to occur diffusely through the subsoil and rock outcrops, and while it can be limited by thicker till, the low permeability of the bedrock will also only accept low rates of recharge. Flow paths in the GWB are expected to be short (30-300 m) with groundwater discharging rapidly to the streams and to small

springs and seeps. The overall ground flow direction is expected to be to the east and vary locally as determined by the topography. It should be noted that Louth GWB intersects the surface water body of the River Dee (Dee_020), and therefore has connectivity to the surface water environment.

Sand and gravel deposits of Clogher Head Gravel GWB are known to be highly but variably productive, with transmissivities ranging from 3-1000 m^2/d. Groundwater flow path length depends on the size and dimensions of the sand/gravel deposit, and also upon the spacing of internal groundwater divides and the distance between streams. Due to the geometry of the bodies, flow path lengths are <1,000 m, and will mainly be <500 m. Overall, groundwater flows eastwards, towards the coast.

The GWB WFD Status (2016-2021) is Good for Clogher Head Gravel GWB and Louth GWB. The risk rating for both groundwater bodies is currently 'Not at Risk', as classified under the Water Framework Directive (2000/60/EC).

21.7.8 Aquifer vulnerability

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease at which potential contamination may reach groundwater. Irish bedrock aquifers are protected by the subsoil and therefore the type and thickness of the subsoil will determine the aquifers vulnerability.

The aquifer vulnerability over the Soils, Geology and Hydrogeology Study Area is predominately 'Low' to 'Medium', as can be seen in Figure 21-7.

There are small numbers of localised areas, within the Soils, Geology and Hydrogeology Study Area with 'Extreme' vulnerability and rock near or at surface i.e. the eastern section of the onshore cable route between Corstown and the R166, and wider areas of this level of vulnerability in proximity to the onshore components at the Simsonstown, Tullydonnel, Verdonstown and Clonmore (Castle) townlands. To the western end, (i.e. towards the onshore substation site), there is also a relatively small area of 'Extreme' to 'Moderate' vulnerability, situated south of the Ardee N2 road, north of Cappoge townland.

At the landfall location, a relatively small area surrounding the eastern onshore cable route section is classified as 'High', confined to the area that is overlapping the Clogher Head Gravel GWB.

21.7.9 Groundwater wells and public water supplies

GSI well locations along the proposed onshore cable route are illustrated on Figure 21-6. It should be noted that the GSI record of well locations is not comprehensive as licensing of wells is not currently a requirement in the Republic of Ireland (ROI).

There are 22 GSI listed boreholes within the Soils, Geology and Hydrogeology Study Area. Listed uses include agricultural and domestic and most are listed with a "Poor" yield class. Table 21-7 summarises all boreholes from east to west.

Note the location accuracy (defined by GSI mapping data) for each well varies significantly (from 20 to 1000 m).

Table 21-7: List of wells (boreholes) identified within the Soils, Geology and Hydrogeology Study Area.

Borehole ID	Drill year	Locational accuracy (m)	Depth (m)	Well use	Coordinates	Yield class
2929SEW016	1997	50	50.4	Agricultural & Domestic	E:314,780.00 N:290,640.00 N:291,380.00	Poor
2929SEW010	1899	50	4	Agricultural & Domestic	E:314,840.00 N:290,280.00	Poor
2929SEW011	1899	50	3	Agricultural & Domestic	E:314,840.00 N:290,280.00	Poor

Borehole ID	Drill year	Locational accuracy (m)	Depth (m)	Well use	Coordinates	Yield class
2929SEW074	1999	100	31.4	Domestic	E:314,520.00 N:289,710.00	Good
2927NEW073	2001	50	24.4	Domestic	E:314,300.00 N:289,300.00	Poor
2927NEW016	1899	50	5	Agricultural & Domestic	E:314,190.00 N:289,250.00	Poor
2929NEW001	1899	1000	12.2	Agricultural & Domestic	E:314,170.00 N:289,440.00	Good
2927NEW002	1899	1000	24.1	Agricultural & Domestic	E:314,170.00 N:289,380.00	Good
2927NEW046	1997	50	48.8	Agricultural & Domestic	E:312.890.00 N:289,070.00	Poor
2927NEW075	1998	200	30.5	Domestic	E:312.030.00 N:890,160.00	Poor
2927NEW045	1997	50	42.7	Agricultural & Domestic	E:311.940.00 N:288,990.00	Good
2927NEW011	1899	50	6	-	E:311,110.00 N:291,310.00	Poor
2927NEW039	1996	50	79.2	Agricultural & Domestic	E:311,100.00 N:291,510.00	Poor
2927NEW068	2001	20	37.8	Domestic	E:309,340.00 N:298,790.00	Poor
2927NEW012	1899	50	44	Agricultural & Domestic	E:309,600.00 N:289,350.00	-
2927NEW037	1977	50	36.6	Agricultural & Domestic	E:307,050.00 N:289,010.00	Poor
2927NEW043	1997	50	67	Agricultural & Domestic	E:306,980.00 N:289,070.00	Poor
2929SEW008	1899	50	6	Agricultural & Domestic	E:306,050.00 N:291,080.00	Poor
2929SEW009	1899	50	3	Agricultural & Domestic	E:291,820.00 N:291,130.00	Poor
2929SWW005	1899	50	6	Agricultural & Domestic	E:305,220.00 N:291,400.00	Poor
2929SWW164	1899	50	21	Agricultural & Domestic	E:304,080.00 N:291,630.00	Moderate
2929SWW190	1899	50	52.4	-	E:298,750.00 N:290,320.00	Poor

The Grangebellew Group Scheme Preliminary Source Protection Area is located outside of the Soils, Geology and Hydrogeology Study Area approximately 2 km south of the onshore cable route at Grangebellew and the closest public supply Outer Source Protection area is Ardee Public Water Supply

(PWS), located approximately 3.5 km west of the onshore substation site in Stickillin, within the Ardee townland. These sources are located up-gradient of the Project.

There is no additional available data that could be used for defining groundwater levels in proximity to the onshore components.

21.7.10 Groundwater quality

Information from the GSI GWB description indicates that the water within the Louth GWB is non-calcareous; with alkalinity ranging between 9-470 mg/l as calcium carbonate ($CaCO_3$), hardness ranging between 5-481 mg/l and electrical conductivity ranging between 80-477 µS/cm.

The Clogher Head Gravel GWB has a hydro-chemical signature defined from four sampling points within this body (Clogher Head Gravel GWB description, GSI, 2015). A calcium bicarbonate signature is present in the GWB. The average alkalinity is 233 mg/l, average hardness-288 mg/l and average conductivity is 698 µS/cm.

21.7.11 Surface water quality

Details of the surface water quality baseline is presented in chapter 22: Hydrology and Flood Risk. Surface water quality is Poor to Moderate, which has potential to impact on the underlying aquifer depending on the degree of surface water / groundwater interactions. The eastern section of Louth GWB, from Ardee townland eastwards to Dillonstown, Verdonstown and Simonstown townland (approximately 2/3 of the total Soils, Geology and Hydrogeology Study Area) is interacting with the River Dee surface waterbody.

Based on EPA mapping, the River Waterbody WFD Status (2016-2021) for the Dee_080 section of the River Dee is Moderate. The River Waterbody WFD Status (2016-2021) for the Dee_090 section of the River Dee is Poor. River Waterbody Risk WFD is projected as at risk of not achieving Good status.

21.7.12 Historic waste bodies

The historic Ordnance Survey Ireland (OSi) six-inch mapping indicates the presence of an unnamed sand pit at Mullincross which directly intersects the onshore cable route, east of the onshore substation site. There is limited information on this site and its presence on aerial imagery is not evident. The area is comprised of a greywacke, mudstone and conglomerate bedrock, low permeability subsoil and low groundwater vulnerability. There are no known mineral localities close to the site. As sand will most likely contain non-hazardous material, it is therefore considered a low-risk site in regard to soils, geology and hydrogeology.

No other potential historic waste bodies were identified within the Soils, Geology and Hydrogeology Study Area.

21.7.13 Conceptual hydrogeological model

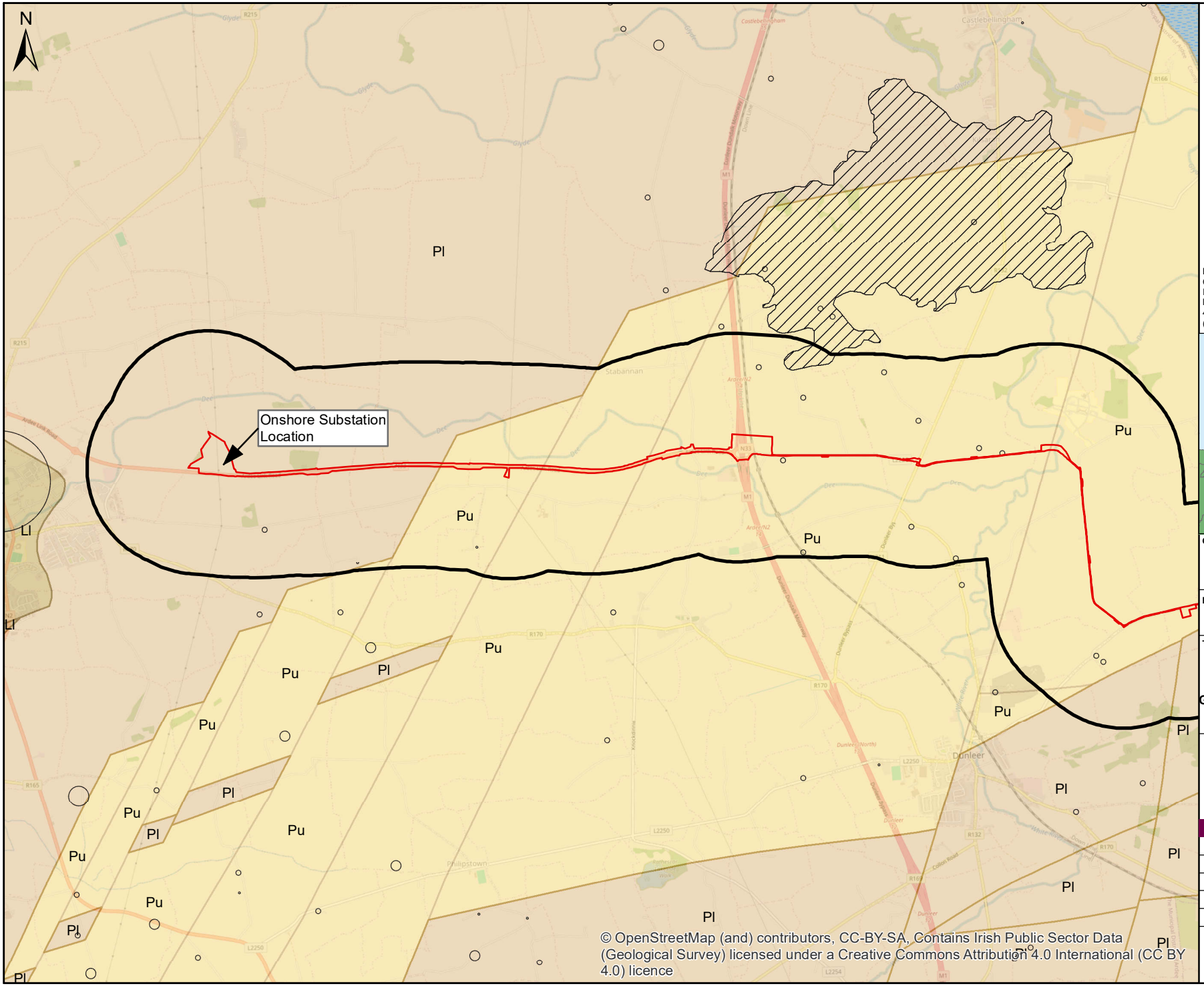
A conceptual hydrogeological model has been prepared to provide an interpretative summary of the hydrogeology at the Soils, Geology and Hydrogeology Study Area, and associated pathways and receptors, and is as follows:

- Mineral, poorly drained (mainly acidic) soils, derived mainly from non-calcareous parent materials are predominately covering the Soils, Geology and Hydrogeology Study Area including the onshore substation site, onshore cable route and landfall location, with the presence of westwards deep well drained soils (mainly acidic and mainly basic), derived from mainly non-calcareous and calcareous parent materials and relatively small localisations of alluvium. The underlying subsoil or quaternary sediments of eastern section comprises primarily till derived from Lower Palaeozoic sandstones and shales (IrSTLPSsS) and western section of the subsoils comprised of limestone till. The onshore cable route is characterised by low to moderate permeability subsoil overlain by well-drained soil in the western section from Stickillin to the M1 and underlain with low permeability subsoils along the eastern section of the onshore cable route, from the M1 towards the landfall location.

- As per the groundwater vulnerability baseline environment (section 21.7.8), 0.27% of the area within the planning application boundary is classified as Extreme groundwater vulnerability, representing shallow bedrock. Therefore, shallow bedrock is not common within the planning application boundary.
- The onshore cable route is situated on relatively gently sloping ground, almost flat, with a ground elevation ranging between 0 m to +45 mAOD (Malin Head datum).
- As part of previous investigations, the fields adjoining the public road along the cable route appear to be well drained and it is expected that very little groundwater will be encountered during the ducting trench work. As the route approaches the shoreline, the groundwater table may rise.
- The bedrock aquifer within the majority of the Soils, Geology and Hydrogeology Study Area is classed as a poorly productive aquifer, and due to low transmissivity, most of the flows are likely to occur in the top three metres of the aquifer within a broken and weathered zone. Short term dewatering may be required for the construction of the onshore substation site foundations or joint bays, Horizontal Directional Drilling (HDD) crossings and entry/exit pits with possibility at varying section along the onshore cable route. Regional groundwater flow is likely to be to the east. Discharges to surface water may occur along watercourses where drift cover is thin or within the eastern section (surroundings of Mitchelstown townland) within relatively small sections of gravel aquifer (Lg).
- Dunany Point (LH017) CGS and pNHA, intersects the Project at the landfall location where TJB Option 1 and Option 2 are proposed.
- The North West Irish Sea candidate Special Protection Area (Site Code: 004236) is located in the north eastern application boundary of the Project. Designated sites are discussed in chapter 19: Onshore Biodiversity.
- The Port Raised Beach (LH025) (CGS) also intersects the application site boundary, which is located south of the eastern route section in Togher town. However, the Project will not require works to take place within its boundary.
- Review of the geology and hydrogeology in the surrounding region indicates that there are no sensitive receptors such as groundwater-fed wetlands, significant public water supplies / Group Water Schemes within the Soils, Geology and Hydrogeology Study Area.

Table 21-8: Conceptual hydrogeological model pathways and receptors identified within the Soils, Geology and Hydrogeology Study Area.

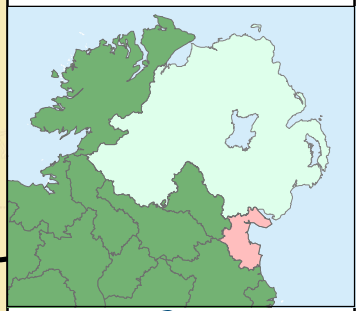
Source	Pathway	Receptor
• Loss of soil reserves. • Damage to soil structure through compaction and replacement. • Removal of rock if shallow bedrock is encountered. • Potential contamination from importation of engineering fill, crushed stone, concrete, reinforcement and other construction materials. • Contamination of groundwater. • Impact to groundwater level or flow path from temporary dewatering. • Change to groundwater level or flow path from works.	• Direct discharge of surface water run-off or slippage during wet weather conditions into local watercourses and which in turn may infiltrate into the underlying aquifer. • Vertical and horizontal groundwater flow. • Short groundwater pathways in bedrock (e.g. weathered zone, faults, void spaces). • Bedrock outcrops at Togher townlands and surrounding Clonmore area, eastwards the proposed route, indicated at GSI map as 'Extreme' vulnerability area.	• Soils and subsoils. • Groundwater body and potential domestic wells. • Bedrock and gravel aquifers. • Surface water body; users and aquatic life. • Private domestic and agricultural groundwater wells. • Dunany Point (LH017) CGS and pNHA.



Legend

- Planning Application Boundary
- Soil, Geology and Hydrogeology Study Area
- Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive
- Groundwater Wells and Springs
- Gravel

Data Sources: Geological Survey Ireland (GSI)
Contains Irish Public Sector Data (Geological Survey Ireland)
licensed under a Creative Commons Attribution 4.0 International
(CC BY 4.0) licence



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

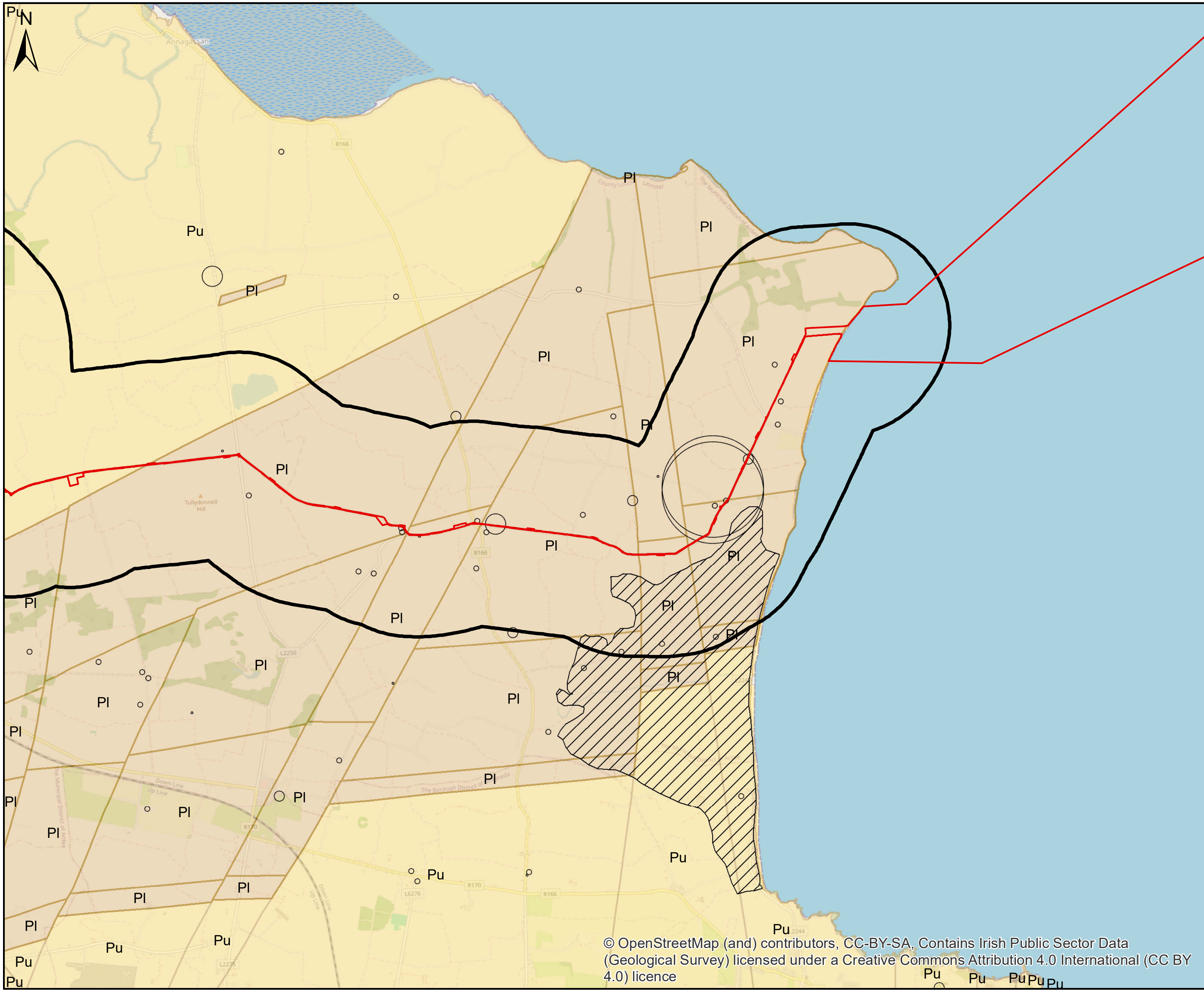
Project
Oriel Wind Farm Project

Title
Figure 21-6
Aquifers, wells and water supply identified within the Soils, Geology and Hydrogeology Study Area
Map 01 of 2

RPS
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

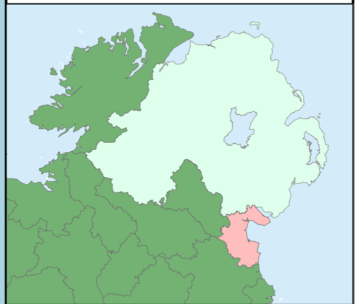
Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520Arc3010F02
Approved By: CC	
Scale: 1:50,000 @A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 12/03/2024	



Legend

- Planning Application Boundary
- Soil, Geology and Hydrogeology Study Area
- Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Poor Aquifer - Bedrock which is Generally Unproductive
- Groundwater Wells and Springs
- Gravel

Data Sources: Geological Survey Ireland (GSI)
Contains Irish Public Sector Data (Geological Survey Ireland)
licensed under a Creative Commons Attribution 4.0 International
(CC BY 4.0) licence



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 21-6
Aquifers, wells and water supply identified within the Soils, Geology and Hydrogeology Study Area
Map 02 of 2

rps
A TETRA TECH COMPANY

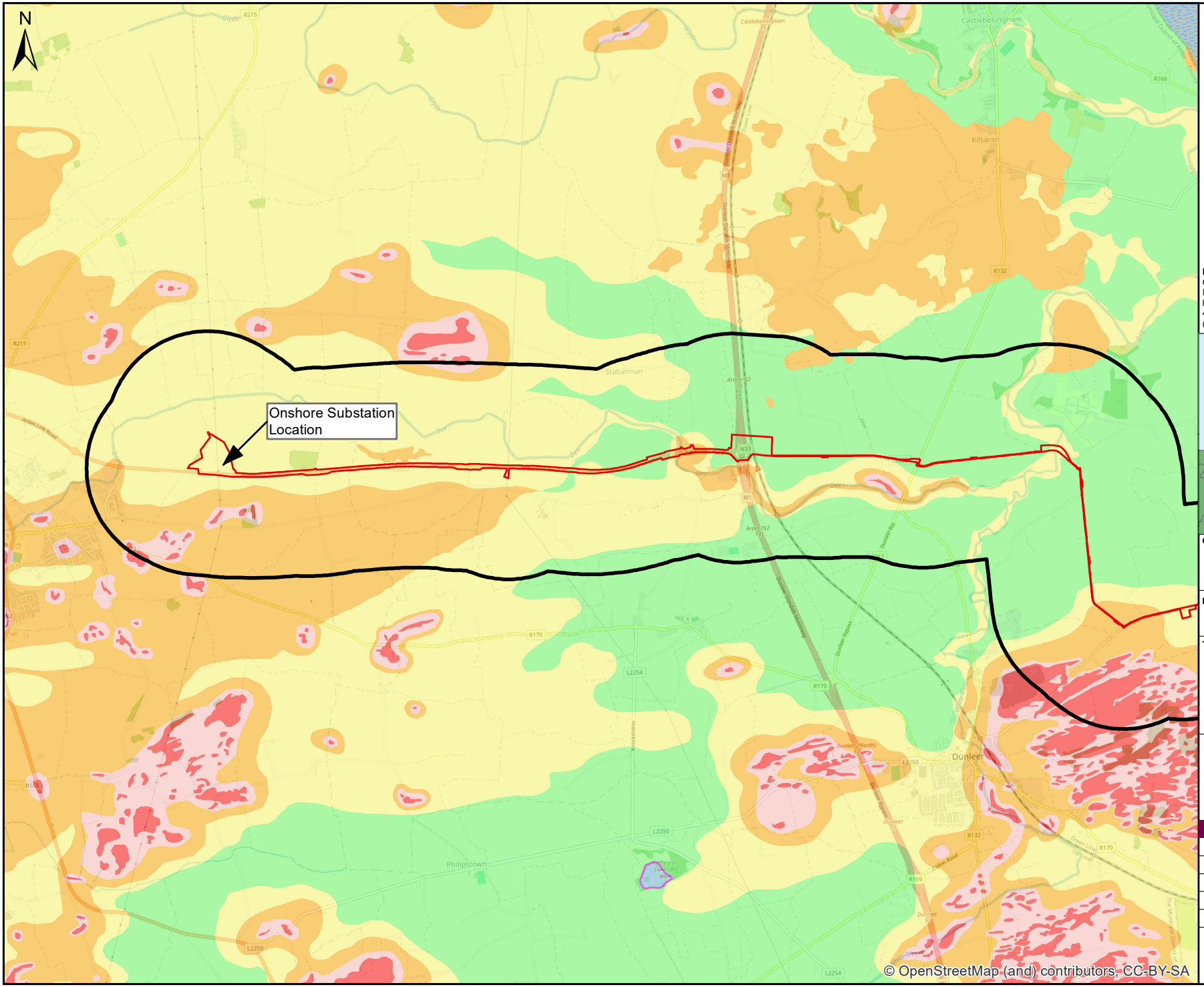
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.

Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:**
Approved By: CC	MDR1520Arc3010F02
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 12/03/2024	

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
3. ©Tailte Éireann. All rights reserved. Licence number CYAL50360216



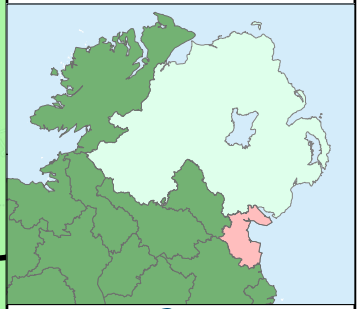
Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area

Groundwater Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

Data Sources: Geological Survey Ireland (GSI)



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

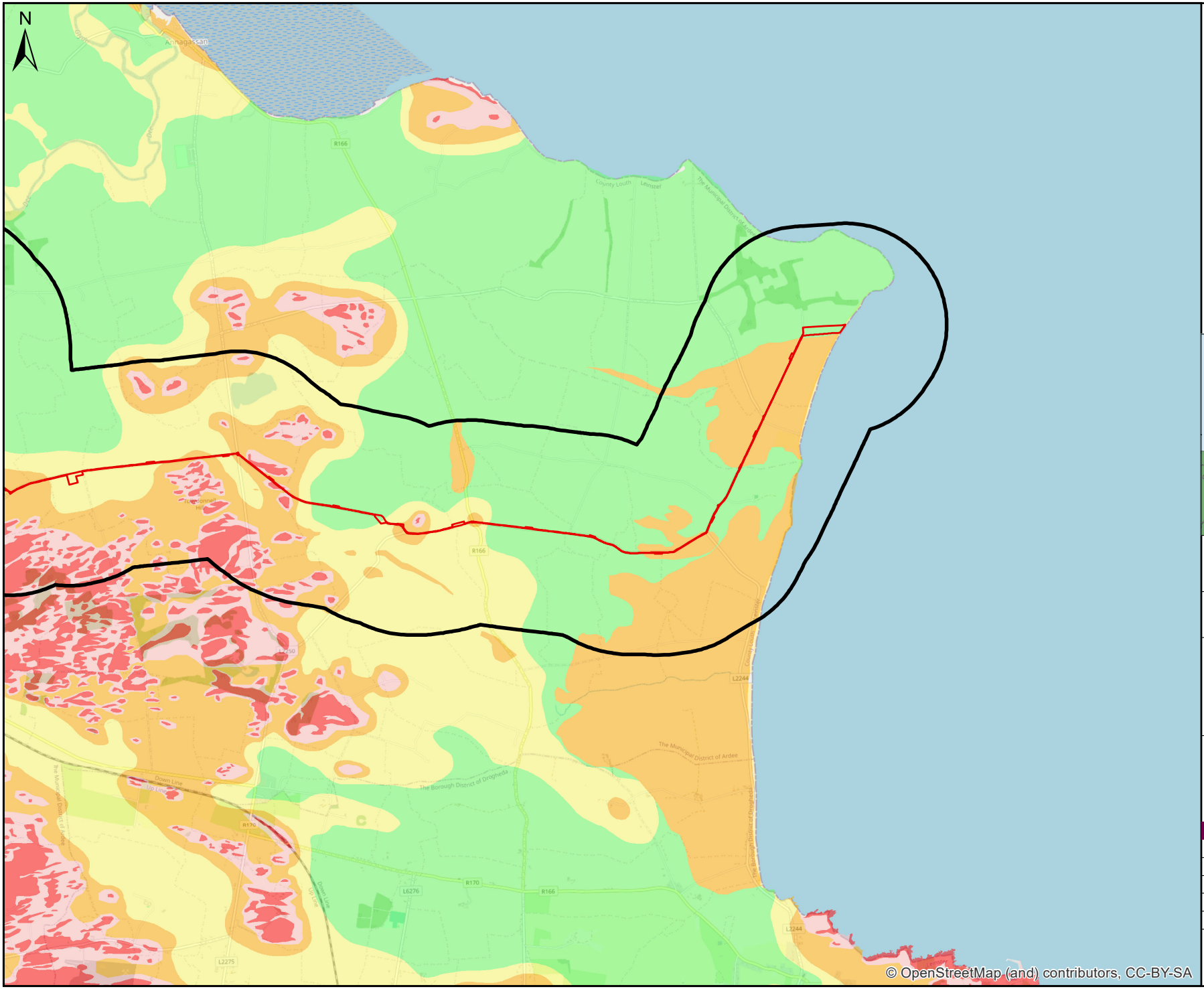
Project
Oriel Wind Farm Project

Title
Figure 21-7
Aquifers vulnerability identified within the Soils, Geology and Hydrogeology Study Area
Map 1 of 2

RPS
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3011F01
Approved By: CC	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Scale: 1:50,000 @ A4	
Date: 15/12/2023	



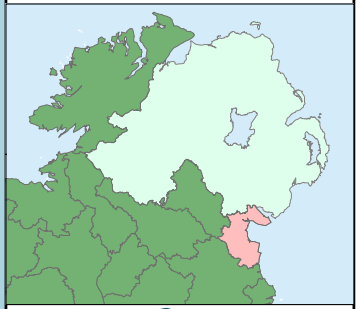
Legend

- Onshore Cable Route - planning application boundary
- Soil, Geology and Hydrogeology Study Area

Groundwater Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low

Data Sources: Geological Survey Ireland (GSI)



Client
ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project
Oriel Wind Farm Project

Title
Figure 21-7
Aquifers vulnerability identified within the Soils, Geology and Hydrogeology Study Area
Map 2 of 2

rps
A TETRA TECH COMPANY
West Pier Business Campus,
Dun Laoghaire,
Co Dublin,
Ireland.
Tel: +353 (0) 1 4882900
Email: ireland@rpsgroup.com
Web Page: rpsgroup.com/ireland

Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: MK	**File Ref:** MDR1520bArc3011F01
Approved By: CC	
Scale: 1:50,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 15/12/2023	

21.7.14 Future baseline scenario

The European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (hereafter the EIA Regulations 2018) require that "*a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*" is included within the EIAR.

In the event that the Project does not progress, an assessment of the future baseline conditions has been carried out and is described below.

If the Project does not proceed, ongoing activities would continue within the Soils, Geology and Hydrogeology Study Area to include the potential progression of residential, commercial and industrial developments. These activities will result in localised changes to the soils, subsoils and groundwater environment within the Soils, Geology and Hydrogeology Study Area depending on the footprint of any future development.

21.7.15 Data validity and limitations

The data collected to inform this assessment (see section 21.7) is up to date (accessed: November 2023) and considered valid to inform this assessment. The site-specific survey at Dunany was completed in September 2023 and provides recent information on the conditions of the slope.

Limitations do exist in the absence of project-specific field and site investigation (SI) data for the onshore cable route, onshore substation site and the landfall location. However, these have been offset by the availability of SI records for previous developments such as the M1 and N33 and boreholes drilled within the area for groundwater supply. The conclusions have been arrived at through desk study research, an Apex Geophysics Survey (2021) and a Ground Investigation undertaken by Causeway (2021). The data limitations do not have implications for the conclusions of the assessment.

21.8 Key parameters for assessment

21.8.1 Project design parameters

The project description is provided in volume 2A, chapter 5: Project Description. Table 21-9 outlines the project design parameters that have been used to inform the assessment of potential impacts of the construction, operational and maintenance and decommissioning phases of the Project on soils, geology and hydrogeology.

The final location and layout of the Transition Joint Bay (TJB) will be confirmed post consent on examination of the electrical and thermal properties of the selected offshore export cable and the ground conditions at the landfall (see chapter 5: Project Description). Both options 1 and 2 have been considered in this assessment.

Table 21-9: Project design parameters considered for the assessment of potential impacts on soil, geology and hydrogeology.

Potential impact	Phase[1]			Project design parameters	Justification
	C	O	D		
Soils					
Loss of soil reserves	✓	×	✓	The following infrastructure will require excavation: • 20.1 km trench at 0.7 m width x 1.25 m deep + 30 joint bays (i.e. 29 joint bays and one TJB (option 1 or 2) and using a 1.3 bulking factor (approximately 40,000 m^3)). • The onshore substation site will require approximately 20,650 m^3 of material to be excavated. The works include site levelling and roadways, building excavations, High-Voltage (HV)	Soil removal volumes have been based on the maximum excavation footprint and depths of each of the work areas and assuming no reinstatement of soil.

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
				equipment foundations, and ancillary works. • Other works where excavation will be required including (approximately 5,000 m^3): – HDD entry/exit pits at crossings. – Site Investigation (SI) works (for example, additional SI proposed for HDD compound areas). – Open cut crossings (water courses, gas pipelines). – Site enabling works including the stripping of topsoil. – Passing bays. – Fibre optic trenches. – Temporary construction compounds. – Temporary and permanent access tracks. The total area where works are proposed is approximately 16% of the area within the planning application boundary.	
Damage to soil structure through compaction and replacement	✓	×	✓	The construction phase of the Project will require a significant level of mobile plant. This plant will be located over a relatively small footprint (including the landfall location, the onshore cable route and the onshore substation site) with the main civils works are being undertaken over a 27-month programme. Damage to soil structure is likely to primarily impact greenfield sites away from existing roads. The Project will require access to approximately 22 hectares of grass land that are located away from existing roads.	Civil works will require a number of mobile plant. The greatest potential for compaction is likely to result during the civil works construction programme/duration of works away from the public road.
Geology					
Removal of subsoil and shallow bedrock (if required) at the landfall and potential to impact on Dunany Point CGS.	✓	×	×	Construction of the following within and adjacent to the CGS: • Offshore export cable (approximately 160 m); • TJB (option 1 or 2); and • Associated temporary works. Due to the presence of the designated County Geological Site (Dunany Point), the removal of subsoil and bedrock has the potential for negative impacts from the removal of material from a geologically sensitive area.	GSI have designated the CGS and it overlaps with the planning application boundary.
Potential contamination from importation of engineering fill, crushed stone, concrete, reinforcement and other construction materials.	✓	×	✓	Imported construction materials for construction of the following (approximately 30,000 m^3): • onshore substation; • onshore cable route including joint bays; • temporary construction compounds and access roads; • Permanent access track to TJB (option 2 only) (approximately m^3).	Data is based on the maximum material balance calculations. No site waste material will be employed as fill.

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
Hydrogeology					
Contamination of groundwater	✓	×	✓	The construction phase of the Project will require a high level of mobile plant. This plant will be located over a relatively small footprint (including the landfall location, the onshore cable route and the onshore substation site) with the main civils works being undertaken over a 27-month programme. Construction elements of the Project and further Site Investigations (SIs) are expected at the site. SI can be a source of contamination through the accidental spill and leak of hydrocarbons from on-site vehicles and equipment resulting in localised contamination.	Civil works will require mobile plant. The greatest potential for contamination is likely to result during the civil works construction programme/duration of works.
Impact to Groundwater Level or Flow Path from Temporary Dewatering	✓	×	✓	Works that have the potential to impact groundwater level or flow include: • Excavations for 29 joint bays; • Excavation for TJB; • HDD exist and entry pits (x2) at the M1, the River Dee, the Port Stream and Salterstown Stream crossings. • Temporary dewatering for open trench sections along the onshore cable; • Substation excavations; and • Open Cut - damming and fluming.	Short-term dewatering may be required for the construction of works, which may have potential to impact on the hydrogeological regime.
Change to groundwater level or flow path from works (trench or HDD)	✓	×	✓	Construction of temporary hardstanding areas has the potential to cause reduced temporary recharge to groundwater along the onshore cable route (length 20.1 km); and at the onshore substation site (including all temporary works) (approximately 5 hectares in total). Change to groundwater level or flow paths have the potential to occur during excavation of HDD pits at the crossings and where soil compaction occurs during construction.	There is potential to influence the groundwater flow regime at these locations. There will be reduced local recharge to ground due to the increase in hardstanding areas at the onshore substation site.

1. C= Construction, O = Operation, D = Decommissioning.

21.8.2 Measures included in the Project

As part of the project design process, a number of measures have been proposed to reduce the potential for impacts on soils, geology and hydrogeology (see Table 21-10). These measures include designed-in and management measures (controls). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Project and have therefore been considered in the assessment presented in section 21.11 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 21-10: Measures included as part of the Project.

Measures included as part of the Project	Justification
Excavated materials will be carefully managed in accordance with industry best practice during construction, to prevent any potential negative impact on the receiving environment and the excess material will be considered for reuse	The excavation and crossing HDD works may produce an excess of material from the Project construction

Measures included as part of the Project	Justification
or be taken directly to an appropriately licenced facility avoiding contact with any open surface water drains. Excavated material will not be left uncovered to avoid run-off of silty water and excavations will be backfilled at the earliest convenience to avoid leaving stockpiles exposed.	works, and these measures reduce the potential for pollution incidents.
During the earthworks phase of construction, all lands including those temporarily acquired, will be re-instated to pre-construction conditions. The construction of the substation, TJB, onshore cable joint bays will require lands permanently. The lands for construction compounds, passing bays and access routes will require lands temporarily and as such may be potentially damaged due to the construction and need re-instatement. The structure of soils within temporary construction and access areas will be potentially affected from being trafficked by construction vehicles. The potential to damage soil structures will become more pronounced when construction activities occur during wet periods. All drainage likely to be affected or disturbed during the construction phase will be identified and reinstated. Field drainage systems currently in-situ may be disturbed and in places disabled during construction. This disturbance may lead to wet or flooded fields during spells of wet weather and farm productivity could be reduced. Management of topsoil and subsoil will be managed in accordance with industry best practices such as the Department of Environment, Food and Rural Affairs (UK) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites and the EPA's Best Practice Guidelines for the Preparation of Resource and Waste Management Plans for Construction and Demolition Projects. For all trenching along the road, all excavated material will be taken off-site in trucks and managed, under licence from the appropriate authority, thus preventing any contaminated run-off to roadside drains during heavy rainfall. In off-road areas where the top 400-500 mm of topsoil will be set aside within the wayleave for later reinstatement, these stockpiles will be stored at least 10 m back from drains and watercourses on level ground with a silt fence inserted at the base.	To ensure all soils are returned to their pre-construction status.
Imported materials to the site will be sourced from a reputable supplier (who will provide certification of materials where required) to ensure that only clean material is brought to site.	Potential contamination from importation of engineering fill, crushed stone, concrete, reinforcement and other construction material
Dewatering all groundwater from the trench, joint bays, etc. will be managed in line with industry best practices. Groundwater and surface water accumulating in the base of trenches will not be pumped directly to roadside drains or watercourses unless it is clean and free from solids. Solids-contaminated water will be discharged to a designated percolation area designated by a competent person if the soil is not waterlogged. In the case of heavy contamination, the water will either be removed off-site for disposal in a licensed facility by tank truck or pumped to a portable on-site settlement tank for treatment. These operations will be monitored by a designated competent member of the construction team on a regular basis to ensure that they are working effectively.	To effectively manage dewatering activities, where required, and reduce the potential for sedimentation of waterbodies.
Temporary storage of Cement Bound Material (CBM) will be carefully managed. This will be stored on hardstanding areas only where there is no direct drainage to surface waters and where the area has been bunded. Measures will be applied by using sandbags and geotextile sheeting or silt fencing to contain any solids in run-off.	Bonding materials are required to be isolated from the environment to minimise the potential for accidental release.
In addition to the emptying of employed bunds, provision of spill-kits and routine maintenance of equipment, the following measures will also be implemented to reduce the potential of adverse effects on groundwater: • The storage and handling of oils, fuel, chemicals and hydraulic fluids will be in secure areas within the site compounds and will not occur within a minimum of 10 m from watercourses; and, • Storage of fuels, chemicals and lubricants at the Contractor's compound must be fenced off and have a lockable gate to prevent	To avoid contamination of soils and groundwater during excavations and site investigation.

Measures included as part of the Project	Justification
unauthorised access or vandalism. The principal control measures are as follows: – Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the TII/NRA document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be protected from potential spillages through the provision of appropriate protection measures including bunded areas and double skinned bowser units with spill kits; – Storage tanks will have secondary containment provided by means of an above ground bund to capture any oil leakage. Storage tanks and associated provision, including bunds, will conform to the current best practice for oil storage and will be undertaken in accordance with Best Practice Guide BPGCS005 – Oil Storage Guidelines (Enterprise Ireland); – Where required, the pouring of concrete, sealing of joints, application of water-proofing paint or protective systems and curing agents will be completed in the dry and allowed to cure for 48 hours in order to avoid pollution of watercourses; – The use and management of concrete will be carefully controlled to avoid spillage; – An Environmental incident and emergency response procedure will be undertaken in the event of a spillage of chemical, fuel or other hazardous wastes (e.g. concrete) to be in place prior to commencement of construction (see appendix 5-1: CEMP). – Plant and equipment will be maintained in place and in working order for the duration of the works. – Temporary construction compounds (include storage facilities) will be located at a minimum of 10 m away from surface waters. In addition, measures will be implemented to ensure that silt laden or contaminated surface water run-off from the compound does not discharge directly to the surface waters. Temporary construction compounds will not be constructed in lands at risk of flooding; – All soiled construction run-off water will be passed through settlement ponds/silt traps and/or bunds prior to outfall to the receiving surface water where appropriate; – Management of material deposition areas to prevent siltation of watercourse systems through run-off during rainstorms through construction of collector ditches surrounding material stockpiles to contain run-off and direct it to the settlement ponds / silt traps before discharge to an adjacent watercourse; and – Wheel wash facilities to be appropriately located to ensure wash waters are intercepted, contained and directed to settlement ponds / silt traps prior to discharge to surface waters. – Any contaminated soils will be removed. The contaminated soil will then require to be quarantined, removed, and disposed of at an appropriate licensed facility.	

21.8.3 Impacts scoped out of the assessment

On the basis of the baseline environment and the project description outlined in volume 2A, chapter 5: Project Description, a number of impacts are proposed to be scoped out of the assessment. These impacts are outlined, together with a justification for the scoping out decision, in Table 21-11.

Table 21-11: Impacts scoped out of the assessment for soils, geology and hydrogeology.

Potential impact	Justification
Contamination of soils, groundwater during operational and maintenance phase of onshore infrastructure	Due to the limited nature of the proposed operational activities to maintain the onshore infrastructure which are detailed in Section 5.8.3. The Project includes measures and controls for the emptying of employed bunds, provision of spill-kits and will undergo routine maintenance. No further operational phase measures are proposed.
Removal of shallow bedrock (should it be encountered)	As per the groundwater vulnerability baseline environment (section 21.7.8), 0.27% of the area within the planning application boundary is classified as Extreme groundwater vulnerability, representing shallow bedrock. Therefore, excavations into bedrock are considered unlikely.
Change to groundwater level or flow path during operational phase at the substation	Due to the limited extent of impermeable surfaces (approximately 33,000 m^2) (<0.01 % of the Louth GWB (1,621 km^2)), there is limited potential to change groundwater level. Therefore, this impact is scoped out.

21.9 Impact assessment methodology

21.9.1 Overview

The soils, geology and hydrogeology assessment has followed the methodology set out in volume 2A, chapter 3: EIA Methodology. Specific to the soil, geology and hydrogeology assessment, the following guidance documents have also been considered:

- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EIAR) (EPA, 2022);
- Draft Advice Notes for Preparing Environmental Impact Statements (EPA, 2015);
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland (IGI) 2013); and,
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA, 2009).

21.9.2 Impact assessment criteria

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on NRA (2009) guidelines.

The criteria for defining impact magnitude in this chapter are outlined in Table 21-12 below.

Table 21-12: Rating criteria for estimation magnitude of impact on geological and hydrogeological attributes (NRA, 2009).

Magnitude	Criteria	Typical examples	
		Soils and geology	Hydrogeology
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage feature. Requirement to excavate / remediate entire waste site. Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment.	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Loss of moderate proportion of future quarry or pit reserves. Removal of part of geological heritage feature. Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate / remediate significant proportion of waste site. Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils.	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute of loss of small part of attribute.	Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils.	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but not of sufficient magnitude to affect either use or integrity.	No measurable changes in attributes.	Calculated risk of serious pollution incident <0.5% annually.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.	
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.	

Magnitude	Criteria	Typical examples	
		Soils and geology	Hydrogeology
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.	

The criteria for defining sensitivity or site importance in this chapter are outlined in Table 21-13 below.

Table 21-13: Rating criteria for site importance of geological and hydrogeological attributes (NRA, 2009).

Importance	Criteria	Typical examples	
		Geology	Hydrogeology
Extremely high	Attribute has a high quality or value on an international scale.	-	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation (e.g. SAC or SPA status).
Very high	Attribute has a high quality or value on a regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource.	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale.	Contaminated soils on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertile soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource.	Regionally important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale.	Contaminated soils on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit.	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill. Site for construction and demolition wastes.	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

Importance	Criteria	Typical examples	
		Geology	Hydrogeology
		Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.	

The significance of the effect upon soils, geology and hydrogeology is determined by correlating the magnitude of the impact and the sensitivity or importance of the receptor (Table 21-14).

For the purposes of this assessment, any effects with a significance level of slight or less have been concluded to be not significant in terms of the EIA Regulations.

Table 21-14: Rating of significant environmental impacts (NRA 2009).

Importance of attribute	Magnitude of impact			
	Negligible	Small adverse	Moderate adverse	Large adverse
Low	Imperceptible	Imperceptible	Slight	Slight/moderate
Medium	Imperceptible	Slight	Moderate	Significant
High	Imperceptible	Moderate/slight	Significant/moderate	Profound/significant
Very high	Imperceptible	Significant/moderate	Profound/significant	Profound
Extremely high	Imperceptible	Significant	Profound	Profound

Note: Significance has been adapted from the NRA (2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes as follows:

- *Profound:* An impact which obliterates all previous sensitive characteristics;
- *Significant:* An impact, which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment;
- *Moderate:* An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends;
- *Slight:* An impact that alters the character of the environment without affecting its sensitivities; and
- *Imperceptible:* An impact capable of measurement but without noticeable consequences.

21.10 Assessment of significant effects

The potential impacts arising from the construction, operational and maintenance and decommissioning phases of the Project are listed in Table 21-9, along with the project design parameters against which each impact has been assessed.

As outlined in volume 2A, chapter 5: Project Description, at the end of the operational lifetime of the Project, it is anticipated that all structures above ground level will be completely removed. Onshore cables would be removed by disconnecting each section at the joint bay and pulling them through the cable ducts, however no further excavation would be required unless there was a specific requirement to remove joint bays. Therefore, the same potential for impacts as outlined in Table 21-9 can occur during decommissioning but such impacts will be lesser in nature and of a smaller scale. The potential for impacts on Dunany Point CGS will not arise.

A description of the potential effects on soil, geology and hydrogeology receptors caused by each identified impact during the construction phase is outlined below. A description of potential effects on soil, geology and during the decommissioning phase are not outlined but as discussed above, potential effects will be less than those outlined for construction phase.

21.10.1 Loss of soil reserves

The construction phase will result in the removal of soil from within the planning application boundary which includes greenfield soils that have a high local value (see Table 21-9).

Excavation of soil, together with removal of existing asphalt / bituminous surfaces, will be required for works including trenching and ducting, substation foundations and joint bays. The proportion of soil loss is considered very small on a local scale.

There will be some opportunities for reuse on site. Where reuse cannot be employed, Article 27 sites will be considered for off site management. The next management option is recovery at suitable authorised waste facility that uses soil material for ground works or to backfill voids (see volume 2C, chapter 30: Resource and Waste Management). The excavated material to be reused on site will be tested to ensure compliance with the requirements of Class 1 or Class 2 general fill as defined in Transport Infrastructure Ireland (TII) publication (TII, 2013) Specification for Road Works Series 600 – Earthworks.

Construction phase

Magnitude of impact

The total area where works are proposed (away from the local road network) is approximately 16% of the area within the planning application boundary (including construction compounds and the substation). The soil reserves excavated will be considered for reuse on site, managed off site at an Article 27 site or used for recovery at a suitably authorised facility.

The impact is predicted to be of local spatial extent, short term duration based on an estimated 27 month programme) including both site preparation and civils works, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly.

All excavated soils will be either reused on site or offsite, which will minimise the irreversible loss of local high fertility soils and therefore it is deemed a negligible magnitude of impact.

Sensitivity of the receptor

The soils, subsoils and rock are deemed to be of high vulnerability and high value due to the presence of highly fertile soils. Therefore, the sensitivity of the receptor is considered to be of high importance.

Significance of the effect

Overall, the magnitude of the impact is deemed to be negligible. The soil is a receptor with high environmental sensitivity; therefore, the effect will be of **imperceptible significance**, which is not significant in EIA terms (Table 21-12).

21.10.2 Damage to soil structure

The compaction of soils from construction traffic and machinery has the potential to result in reduced infiltration and increased surface water run-off. Soil compaction decreases porosity, aggregate stability index, soil hydraulic conductivity, and nutrient availability, thus reduces soil health.

Construction phase

Magnitude of impact

The total area where works are proposed (away from the local road network) is approximately 16% of the area within the planning application boundary (including construction compounds and the substation). During the construction phase, existing roads will be utilised to limit the damage to soil structure at greenfield sites.

The magnitude of the impact is predicted to be local spatial extent (due to the limited corridor required for works), short term duration (based on an estimated 27 month main works including both site preparation and civils works), intermittent and low reversibility. It is predicted that the impact will affect the receptor directly.

The compaction of soils will result in the irreversible loss of a small proportion of soils. However, high fertility soils will be reused either onsite or offsite and protected to minimise damage from compaction. Therefore, the magnitude is considered to be negligible.

Sensitivity of the receptor

The soils, subsoils and rock are deemed to be of high vulnerability and high value due to the presence of highly fertile soils. Therefore, the sensitivity of the receptor is considered to be of high importance.

Significance of the effect

Overall, the magnitude of the impact is deemed to be negligible. The soil is a receptor with high environmental sensitivity; therefore, the effect will be of imperceptible significance, which is not significant in EIA terms.

21.10.3 Removal of subsoil and bedrock (if required) at the landfall and in the vicinity of the Dunany Point CGS

The construction of the offshore export cable and TJB at the landfall including associated temporary works have the potential to impact on Dunany Point CGS.

Construction phase

Magnitude of impact

The impact is predicted to be of local spatial extent, short term duration (based on an estimated 27 month main works including both site preparation and civils works), intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. Table 21-10 describes the measures included in the Project.

The works to install the proposed TJB and a section of the offshore cable are located within the Dunany Point CGS boundary. The cliffs at Dunany Point are prone to slumping and consequently excavation, construction and burial of the proposed TJB may cause this to increase and result in excessive damage and increased erosion of that portion of the CGS. Without mitigation, the Project could result in removal of part of geological heritage feature through excavations and indirect impacts due to slumping. Therefore, the magnitude of impact is considered moderate adverse.

A coastal erosion assessment at the proposed landfall was undertaken by RPS in September 2023 (see appendix 21-1: Coastal Erosion Report). The study found both Option 1 and Option 2 for the installation of the TJB feasible with respect to coastal protection.

Sensitivity of the receptor

Dunany Point CGS is considered high environmental sensitivity receptors as they are considered geological features of high value on a local scale.

Significance of the effect

Overall, the magnitude of the impact is deemed to be moderate adverse. The CGS is a receptor with high environmental sensitivity, therefore, the effect will be of **significant/moderate significance**, which is significant in EIA terms and mitigation measures will be required (see section 21.10.8).

21.10.4 Potential contamination from importation of engineering fill, crushed stone, concrete, reinforcement and other construction material

Imported construction materials will be required for the construction of the onshore substation and all infrastructure along the onshore cable route including temporary construction compounds and accesses. All imported materials will be sourced from a reputable supplier to ensure that only clean material is brought to site. Sourced materials will be accompanied by certification where appropriate.

Construction phase

Magnitude of impact

The impact is predicted to be of local spatial extent, short term duration (based on an estimated 27 month main works including both site preparation and civils works), intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

The soils, subsoils and rock are deemed to be of high vulnerability high value due to the presence of highly fertile soils. Therefore, the sensitivity of the receptor is considered to be of high importance.

Significance of the effect

Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **imperceptible significance**, which is not significant in EIA terms.

21.10.5 Contamination of groundwater

Temporary storage of excavated soils and construction materials on site will be required along the onshore cable route at the joint bay locations and the temporary construction compounds. Soil stripping and foundation construction will reduce the natural protection which soils provide to the underlying aquifer. Silt-laden water can arise from exposed ground and soil stockpiles during construction. Surface water run-off containing large amounts of silt could migrate into the groundwater which can cause significant pollution of water through the generation of suspended solids.

There is potential for spillages of oils, fuels or other pollutants from the installation of access provision for construction plant in proximity to the local drainage network and for soil compaction in the temporary works areas (construction compounds). There will be reduced local recharge to ground due to the increase in hardstanding areas at the onshore substation site.

There are no known waste bodies within the Soils, Geology and Hydrogeology Study Area. However, there is always the potential to encounter an unregulated waste body (see section 21.7.12), which if disturbed could result in leaching of potential contaminated soils.

Construction phase

Magnitude of impact

The impact is predicted to be of local spatial extent, short term duration based on an estimated 27 month main works including both site preparation and civils works, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. As the proposed construction activities have the potential to cause moderate risk pollution to groundwater from routine run-off, the magnitude of impact is considered to be moderate adverse.

Sensitivity of the receptor

The groundwater is deemed to be of low vulnerability and low value. Across the Soils, Geology and Hydrogeology Study Area, the bedrock aquifers are classified as the GSI as Poor (Pl and Pu), therefore the sensitivity of the receptor is considered to be low.

Significance of the effect

Overall, the magnitude of the impact is deemed to be moderate adverse and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **slight** significance, which is not significant in EIA terms.

21.10.6 Impact to groundwater level or flow path from temporary dewatering

Short-term dewatering may be required for the construction of the joint bays, HDD crossing locations (pits), trench and substation foundations, etc. (as outlined in Table 21-9) and will have the potential to impact on the hydrogeological regime through the temporary lowering of the water table during the dewatering which would subsequently result in the localised lowering of surface waterbodies.

Construction phase

Magnitude of impact

The impact is predicted to be of local spatial extent, short term duration based on an estimated 27 month main works including both site preparation and civils work, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The activity will result in short-term changes to the underlying aquifer and the unsaturated zone resulting in minor change to river baseflow or ecosystems. Therefore, the magnitude is considered to be small adverse.

Sensitivity of the receptor

The groundwater is deemed to be of low vulnerability and low value. Across the Soils, Geology and Hydrogeology Study Area and zone of influence (i.e. the Louth Groundwater Body, the bedrock and corresponding aquifers) the bedrock aquifers are classified in the GSI as Poor (Pl and Pu), therefore the sensitivity of the receptor is considered to be low.

Significance of the effect

Overall, the magnitude of the impact is deemed to be small adverse and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **imperceptible significance**, which is not significant in EIA terms.

21.10.7 Change to groundwater level or flow path from works

Change to groundwater level or flow paths have the potential to occur during excavation of HDD pits at the crossings and where soil compaction occurs during construction.

There will be reduced local recharge to ground due to the increase in hardstanding areas at the onshore substation site.

As part of previous investigations (see section 21.6), the fields adjoining the public road along the cable route appear to be well drained and it is expected that very little groundwater will be encountered during the ducting and trenching work. As the route approaches the shoreline, the groundwater table may rise.

Construction phase

Magnitude of impact

The impact is predicted to be of local spatial extent, short term duration (based on an estimated 27 month main works including both site preparation and civils works), intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The activity will result in short-term changes to the underlying

aquifer and the unsaturated zone resulting in minor change to river baseflow or ecosystems. Therefore, the magnitude is considered to be small adverse.

Sensitivity of the receptor

The groundwater is deemed to be of low vulnerability and low value (Soils, Geology and Hydrogeology Study Area is predominately 'Low' to 'Medium', as can be seen in Figure 21-7). Across the Soils, Geology and Hydrogeology Study Area , the bedrock aquifers are classified in the GSI as Poor (Pl and Pu), therefore the sensitivity of the receptor is considered to be low.

Significance of the effect

Overall, the magnitude of the impact is deemed to be small adverse and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **imperceptible significance**, which is not significant in EIA terms.

21.10.8 Mitigation and residual effects

The assessment of impacts has concluded that one activity has the potential to result in significant/moderate impacts, namely the removal of rock if encountered. Therefore, further mitigation is proposed, as outlined below.

There are no identified significant effects for the other potential impacts outlined above with the implementation of the measures included in the Project (section 21.8.2). The residual effects are as outlined in the assessment provided in section 21.10.

Removal of subsoil and shallow rock (if shallow bedrock is encountered during works) at the landfall and in the vicinity of the Dunany Point CGS

The significance of the effects of the removal of rock if bedrock is encountered in the trench during the construction phase of the Project are considered to be of significant/moderate significance and as such will require additional mitigation.

The GSI were consulted regarding the Dunany Point CGS (see section 21.5). Following consultation, a coastal erosion assessment at the proposed landfall was undertaken by RPS (see appendix 21-1: Coastal Erosion Report) and as a result the design of the installation of the offshore cable and TJB (options 1 and 2 were adjusted to minimise the footprint of works in the CGS and also to avoid the need for coastal protection.

The implementation of these measures will reduce the magnitude of impact from moderate to negligible as they will mitigate against slumping within the cliffs north of the Project. The Project is still classed as a negligible magnitude as the proposed excavations are located at the very southern margin of the CGS. This area is already heavily vegetated. Therefore, the proposed works will not be obscuring any currently visible sedimentary exposures.

The sensitivity of the site remains as high. With the implementation of the aforementioned mitigation, the residual magnitude is negligible which results in a residual significance of effects of imperceptible, which is not significant in EIA terms.

Furthermore, the following GSI recommendations are also included within the proposed works:

(a) Access to the site is to be provided for GSI staff during construction to record the exposures of glacial till within the works.

(b) GSI are to be provided sufficient notification of the commencement of works to allow GSI staff the opportunity to schedule resources to inspect the site.

The Applicant will also discuss options with the GSI to provide explanation of the significance of the CGS in the local community.

21.10.9 Future monitoring

No soil, geology and hydrogeology monitoring to test the predictions made within the impact assessment is considered necessary.

21.11 Cumulative impact assessment (CIA)

21.11.1 Methodology

The Cumulative Impact Assessment (CIA) takes into account the impact associated with the Project together with other projects within the Soils, Geology and Hydrogeology Study Area of the Project. The projects selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise (see volume 2A, appendix 3-1: CIA Screening Annex of chapter 3: EIA Methodology). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The approach to assessment examines the cumulative effects of the Project alongside the following projects if they fall within the Study Area for soils, geology and hydrogeology:

- Other projects with consent but not yet constructed/construction not completed;
- Other projects in a consent application process but not yet determined;
- Other projects currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact; and
- Projects, which satisfy the definition of 'relevant maritime usage' under the Maritime Area Planning Act (2021) (i.e. wind farm projects designated as 'Relevant Projects' or 'Phase 1 Projects') including Arklow Bank II, Bray Bank and Kish Bank; North Irish Sea Array, Codling Wind Park (I and II).

Two specific projects were considered in this CIA. These projects are for proposed wastewater treatment works. One development, located in Stickillin, Ardee, will consist of a new proprietary wastewater treatment system, percolation area, connection to public watermains and all associated ancillary site works. It is approximately 1 km from the onshore cable route. The other development is the Ardee Wastewater Treatment Plant, an EPA licenced facility. This is also approximately 1 km from the onshore cable route.

These projects were reviewed further for potential for accidental spills and emissions during the construction phases and the requirement for treated effluent to discharge to groundwater during the operational phases, which would lead potential for impact to the underlying GWB and bedrock aquifer. The Project will not have any discharge during the operational phase, therefore, a potential for cumulative impacts can only occur in the construction phase of the Project if it coincides with the construction and/or operational phase of the wastewater treatment plants noted. However, the volumes of effluent from these treatment works are not considered significant, and therefore, the impacts are not considered to have a likely significant cumulative effects on soils, geology and hydrogeology.

21.12 Transboundary effects

The potential effects of the Project on soils, geology and hydrogeology are considered to be of local extent and therefore there is no potential for significant transboundary effects upon the interests of the UK or other EEA States.

21.13 Interactions

A description of the likely interactions arising from the Project on soils, geology and hydrogeology is provided in chapter 32: Interactions.

21.14 Summary of impacts, mitigation measures and residual effects

This chapter has examined the potential impact of the Project on soils, geology and hydrogeology. Information was established from desk studies, site-specific surveys and a conceptual hydrogeological model.

Table 21-15 presents a summary of the potential impacts, mitigation measures and residual effects in respect to soils, geology and hydrogeology during the construction phase. Potential impacts during the operational and maintenance phase have been scoped out. During the decommissioning phase, there is potential for similar impacts as outlined during the construction phase, however to a lesser extent and smaller scale.

The method for the installation of the onshore cable is designed to minimise the impact on the potential environment.

The standard construction techniques will have limited impact on the geological and hydrogeological environment as the excavation is shallow and will therefore interact with a very limited section of the geological profile.

Overall, the significance of effect will be imperceptible and slight for the environment of soils, geology and hydrogeology which is not significant in EIA terms.

No projects that spatially or temporally overlap with the Project were considered to result in significant cumulative effects.

There is no potential for transboundary impacts.

Table 21-15:Summary of potential environmental effects, mitigation and monitoring during the construction phase.

Description of impact	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Soil removal	Excavated materials will be carefully managed in accordance with industry best practice during construction, to prevent any potential negative impact on the receiving environment and the excess material will be taken directly to an appropriately licenced facility avoiding contact with any open surface water drains. Excavated material will not be left uncovered to avoid run-off of silty water and trial pits will be backfilled at the earliest convenience to avoid leaving stockpiles exposed.	Negligible	High (Soils)	Imperceptible (not significant in EIA terms)	None	N/A	None
Damage to soil structure through compaction and replacement	During the earthworks phase of construction, all lands including those temporarily acquired, will be re-instated to pre-construction conditions unless otherwise agreed with the landowner. The construction of the substation, TJB, onshore cable joint bays will require lands permanently. The lands for construction compounds, passing bays and access routes will require lands temporarily and as such may be potentially damaged due to the construction and need re-instatement. All drainage likely to be affected or disturbed during the construction phase will be identified and reinstated. Field drainage systems currently in-situ may be disturbed and in places disabled during construction. This disturbance may lead to wet or flooded fields during spells of wet weather and farm productivity could be reduced. Management of topsoil and subsoil will be managed in accordance with industry best practices such as the Department of Environment, Food and Rural Affairs (UK) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites and the EPA's Best Practice Guidelines for the Preparation of Resource and Waste Management Plans for Construction and Demolition Projects. For all trenching along the road, all excavated material will be taken off-site in trucks and managed, under licence from the appropriate authority, thus preventing any contaminated run-off to roadside	Negligible	High (Soils)	Imperceptible (not significant in EIA terms)	None	N/A	None

Description of impact	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
	drains during heavy rainfall. In off-road areas where the top 400-500 mm of topsoil will be set aside within the wayleave for later reinstatement, these stockpiles will be stored at least 10 m back from drains and watercourses on level ground with a silt fence inserted at the base.						
Removal of subsoil and bedrock (if required) at the landfall and in the vicinity of the Dunany Point CGS	-	Moderate Adverse	High (proximity to County Geological Site)	Significant/Moderate (significant in EIA terms)	Design of installation updated to reduce footprint and extent of excavation.	Imperceptible	None
Potential contamination from importation of engineering fill, crushed stone, concrete, reinforcement and other construction material	Imported materials to the site will be sourced from a reputable supplier (who will provide certification of materials where required) to ensure that only clean material is brought to site.	Negligible	High (Soils and Bedrock)	Imperceptible (not significant in EIA terms)	None	N/A	None
Contamination of Groundwater	Temporary storage of Cement Bound Material (CBM) will be carefully managed. This will be stored on hardstanding areas only where there is no direct drainage to surface waters and where the area has been bunded. Measures will be applied by using sandbags and geotextile sheeting or silt fencing to contain any solids in run-off. The storage and handling of oils, fuel, chemicals and hydraulic fluids will be in secure areas within the site compounds and will not occur within a minimum of 10 m from watercourses; and, Storage of fuels, chemicals and lubricants at the Contractor's compound must be fenced off and have a lockable gate to prevent unauthorised access or vandalism.	Moderate	Low (Poor Aquifer)	Slight (not significant in EIA terms)	Yes. See measures as outlined in section 21.10.8.	Imperceptible	None

Description of impact	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Impact to Groundwater Level or Flow Path from Temporary Dewatering	Dewatering all groundwater from the trench, joint bays, etc. will be managed in line with industry best practices. Groundwater and surface water accumulating in the base of trenches will not be pumped directly to roadside drains or watercourses unless it is clean and free from solids. Solids-contaminated water will be discharged to a designated percolation area designated by a competent person if the soil is not waterlogged. In the case of heavy contamination, the water will either be removed off-site for disposal in a licensed facility by tank truck or pumped to a portable on-site settlement tank for treatment. These operations will be monitored by a designated competent member of the construction team on a regular basis to ensure that they are working effectively.	Small Adverse	Low (Poor Aquifer)	Imperceptible (not significant in EIA terms)	None	N/A	None
Change to Groundwater Level or Flow Path from Works (trench or HDD)	All drainage likely to be affected or disturbed during the construction phase will be identified and reinstated. Field drainage systems currently in-situ may be disturbed and in places disabled during construction. This disturbance may lead to wet or flooded fields during spells of wet weather and farm productivity could be reduced.	Small Adverse	Low (Poor Aquifer)	Imperceptible (not significant in EIA terms)	None	N/A	None

References

EPA (2018) Waste Classification: List of Waste and Determining if Waste is Hazardous or Non-hazardous, Environmental Protection Agency.

EPA (2022) Guidelines on the Information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency.

European Commission (EC) (202) INSPIRE Theme Register (Protected sites). Available online at: https://inspire.ec.europa.eu/theme/ps.

Geological Survey Ireland (GSI)/Teagasc (2018)- Soils guide. [online] Available at: http://gis.teagasc.ie/soils/soilguide.php [Accessed 27 November 2023].

GSI (2013a) County Geological Site Report – Dunany Point. [online] Available at: https://secure.dccae.gov.ie/GSI_DOWNLOAD/Geoheritage/Reports/LH017_Dunany_Point.pdf [Accessed 27 November 2023].

GSI (2013b) County Geological Site Report – Port Raised Beach [online] Available at: https://secure.dccae.gov.ie/GSI_DOWNLOAD/Geoheritage/Reports/LH025_Port_Raised_Beach.pdf [Accessed 27 November 2023].

GSI (2015) Clogher Head Gravel GWB description. [online] Available at: https://secure.dccae.gov.ie/GSI_DOWNLOAD/Groundwater/Reports/GWB/ClogherHeadGravelsGWB.pdf

Institute of Geologists of Ireland (IGI) (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements.

National Road Authority (NRA) (2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

TII (2013) Specification for Road Works Series 600 – Earthworks. Transport Infrastructure Ireland.