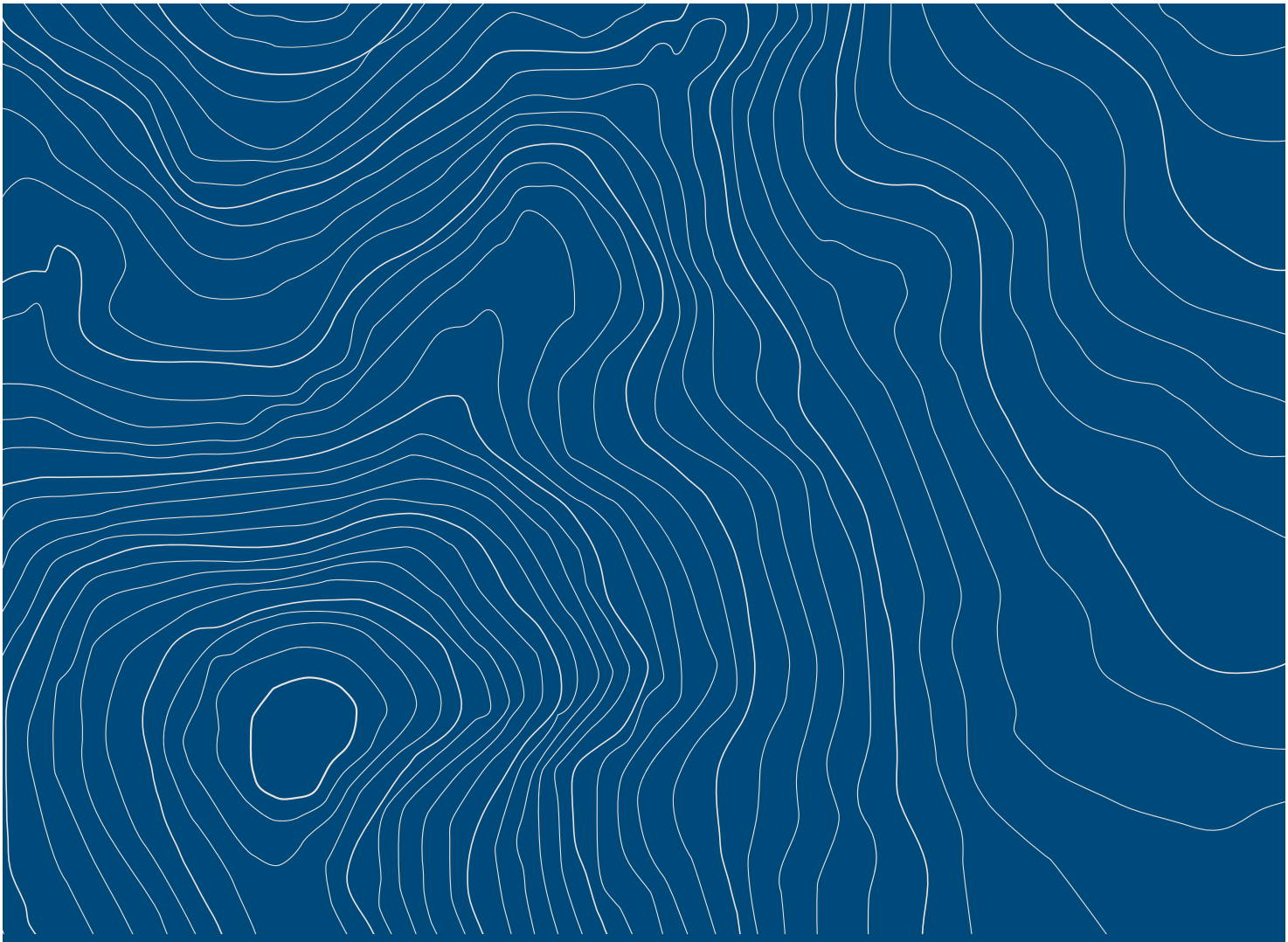

DublinArray
Generation for generations

EIAR Volume 6: Onshore Infrastructure Technical Appendices Appendix 6.5.3-1: Land, Soils and Geology Onshore Technical Baseline Report

Kish Offshore Wind Ltd.

RWE SLR GoBe APEM Group

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Dublin Array Offshore Wind Farm

Environmental Impact Assessment Report

Volume 6, Appendix 6.5.3-1: Land, Soils and Geology Onshore Technical Baseline Report

Contents

Annexes

Figures

Tables

Acronyms

Term	Definition
CGS	County Geological Site
CIWEM	The Chartered Institution of Water and Environmental Management
DCC	Dublin County Council
DLRCC	Dún Laoghaire–Rathdown County Council
ECR	Export Cable Route
EIAR	Environmental Impact Assessment
EPA	Environmental Protection Agency
GI	Ground Investigation
GPR	Ground penetrating radar
GSI	Geological Survey of Ireland
IFS	Irish Forestry Soils
IGI	Institute of Geologists of Ireland
ISIS	Irish Soil Information System
LAT	Lowest Astronomical Tide
m bgl	meters below ground level
MTBM	Micro-tunnelling boring machine
OES	Onshore Electrical System
OSi	Ordnance Survey of Ireland
OSS	Onshore Substation
SDZ	Strategic Development Zone
SI	Site Investigation
TBM	Tunnel boring machine
TJB	Transition Joint Bay
WTG	Wind Turbine Generators
WWTP	Wastewater Treatment Plant

1 Introduction

1.1 Baseline Characterisation Report

1.1.1 Dublin Array Offshore Wind Farm (Dublin Array) is a proposed offshore wind farm on the Kish and Bray banks. The Kish and Bray banks are located, approximately 10 km off the east coast of Ireland, immediately south of Dublin city off the coast of counties Dublin and Wicklow. The offshore wind farm will be located within an area of approximately 54 km^2, in water depths ranging from 2 m to 50 m lowest astronomical tide (LAT[1]).

1.1.1 The purpose of the technical baseline report is to robustly characterise the baseline land, soils and geology environment for the purposes of informing the impact assessment of the onshore infrastructure works, comprising the Onshore Electrical System (OES) and Operations and Maintenance (O&M) Base.

1.1.2 This baseline characterisation report has been prepared specifically for the Land, Soils and Geology chapter of the EIAR relating to the Dublin Array onshore infrastructure works.

1.1.3 The report considers potential impacts which may occur as a result of the construction, operation and decommissioning of the Dublin Array onshore infrastructure works and the determination of sensitivity of the receiving environment; the magnitude of the effect, and the overall significance of each effect will be presented within the relevant chapter of the Environmental Impact Assessment Report (EIAR).

1.1.4 This report makes reference to the following two technical appendices associated with the EIAR Volume 5, Chapter 3: Land, Soils and Geology:

- Volume 6, Appendix 6.5.3-2: Causeway Geotech – Dublin Array Onshore Site Investigation Report (Report No. 21-1443E, May 2023) (hereafter referred to as the Onshore SI Report);
- Volume 6, Appendix 6.5.3-3: Causeway Geotech – Dublin Array Onshore Cable Route Ground Investigation Report (Report No. 23-0343, February 2024) (hereafter referred to as the Onshore Cable Route Ground Investigation Report).

[1] The Lowest Astronomical Tide is the height above the lowest tidal water level, which can be used for a level alone on the basis of the contained locally dominant tidal conditions.

1.2 Project overview

1.1.5 Dublin Array will comprise between 39 and 50 Wind Turbine Generators (WTG) and will include infrastructure that is required to transmit the power generated at the turbines to the offshore substation via inter-array cables, before then being transmitted via onshore export cables to the onshore substation (OSS). The offshore turbine array will be located within an area of approximately 54 kilometres squared (km^2), in water depths ranging from 2 m to 50 m lowest astronomical tide (LAT). The maximum export capacity is expected to be 824 MW (megawatts). The proposed development also includes export cables and onshore transmission infrastructure which will facilitate connection to the national electricity grid.

1.1.6 The proposed onshore substation (OSS) is located on the former Ballyogan Landfill and Recycling Facility, with the onshore export cable route (ECR) connecting into the OSS compound. The configuration of the onshore ECR for the proposed development will include two underground electricity cable circuits and associated infrastructure connecting the proposed OSS to the existing 220 kV electricity substation at Carrickmines.

1.1.7 In order to service and maintain the offshore infrastructure, a storage and coordination facility is required, referred to as the O&M Base, which will act as a storage and loading area for small and medium spare parts for the wind turbines and small ancillary equipment such as tools and consumables. The proposed O&M Base will be located on, and directly adjacent to St. Michael's Pier, within Dún Laoghaire Harbour, Co. Dublin.

1.1.8 A more detailed description of the project is provided within the Volume 2, Chapter 6: Project Description (hereafter referred to as the Project Description Chapter). This technical appendix describes the baseline relevant to the assessment of potential environmental effects that might result from the OES and O&M Base.

1.3 Practitioner Competency

1.3.1 This Baseline Technical Appendix to the EIAR has been prepared by SLR Consulting. The competent practitioners responsible for the preparation of this baseline report is:

- Peter Glanville (PhD, MSc, PGeo, EurGeol) Quaternary Geology.

1.3.2 Peter Glanville is a chartered geologist with over 20 years of experience in environmental consultancy. He is a Professional Geologist (PGeo. EurGeol.) with the Institute of Geologists of Ireland and has experience in preparation of EIA reports and the assessment of Geology, Geomorphology, Resource Assessments, Regional and National Mineral Constraints, Hydrology, Flood Risk, Quaternary and Hydromorphology.

1.3.3 SLR staff are chartered members of The Chartered Institution of Water and Environmental Management (CIWEM) and chartered Engineers with Institute of Civil Engineers.

1.3.4 Further information in relation to SLR Consulting can be found at www.slrconsulting.com.

2 Methodology

2.1 Approach

2.1.1 The methodology for baseline characterisation has comprised a combination of a detailed desktop review to establish the baseline information available on the onshore land, soils and geology environment within the defined study areas (described in section 2.2), combined with a site walkover of the majority of the study area and a number of site investigations.

2.2 Study areas

2.2.1 The two study areas are shown in the figures with this report and comprise:

- The Onshore Electrical System (OES) study area; and
- Operations and Maintenance (O&M) Base study area.

2.2.2 The study areas are shown in Figure 1. The onshore ECR is subdivided into seven 'Sectors' between the Landfall Site and the OSS.

Application Site Boundary

Onshore Electrical System (OES) and Operations and Maintenace Base (O&M) 2 km Study Area

Export Cable Route (ECR) Sector

- Sector 1
- Sector 2
- Sector 3
- Sector 4
- Sector 5
- Sector 6
- Sector 7

DRAWING STATUS

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MAP NOTES / DATA SOURCES:

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PROJECT TITLE

Dublin Array

DRAWING TITLE

Land, Soils and Geology: Study Area

DRAWING NUMBER: 1

PAGE NUMBER: 1 of 1

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0 0.3 0.5 0.8 1 Miles

GRID NORTH

SCALE 1:50,000 PLOT SIZE A3

DATUM IRENET95 VERTICAL REF ODN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

Kish Offshore Wind Limited - Bray Offshore Wind Limited

OES study area

2.2.3 The OES study area comprises the area within which the proposed onshore works area relating to the onshore ECR and described in section 1.2 will be located (the application site boundary), alongside an extended area (buffer). The buffer has been set at 2 km, which is the limit to which direct and indirect effects relating to the land, soils and geological environment are expected to occur. The study area of 2 km is in line with the Institute of Geologists of Ireland (IGI) guidelines for Environmental Impact Statements[2].

2.2.4 Desktop soils and geological information is presented across the whole of the study area.

O&M Base study area

2.2.5 The Operations and Maintenance (O&M) Base is located in Dún Laoghaire Harbour. The O&M Base will consist of a building providing office space, warehousing and welfare facilities located along Saint Michael's Pier, as well as shared parking spaces with Dún Laoghaire-Rathdown County Council (DLRCC) harbour personnel, a new gangway providing access to a new 70 m long pontoon will be installed adjacent to St. Michael's Pier adjacent to the existing quay wall and waste storage areas at the quayside where the former ferry roll-on/roll-off ramp was located. The footprint of the existing harbour maintenance building which is currently used by the DLRCC Harbour operations team, and the main pier have been used to develop the design.

2.2.6 The study area for the proposed O&M Base extends outwards to 2 km from the base.

2.3 Data sources

2.3.1 Baseline information on the receiving environment has been obtained from available desktop sources and a number of site-specific surveys, these include the following:

- Ordnance Survey of Ireland (Osi) mapping[3];
- Teagasc/Environmental Protection Agency (EPA)/Geological Survey of Ireland (GSI) soil and subsoils mapping for Ireland;
- GSI geological information including borehole records;
- Dublin Array Onshore SI Report May 2023 (The Onshore SI Report)[4];

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

3 https://store.osi.ie/

4 Volume 6, Appendix 6.5.3-2: Dublin Array Onshore Site Investigation Report

- Dublin Array Onshore Cable Route GI Report, February 2024 (The Cable Route Ground Investigation Report); and
- Shanganagh Cliff Baseline Erosion Survey, December 2024 (Annex 1).

2.4 Summary of data sources by receptor group

2.4.1 A summary of data sources consulted for each receptor group is presented in Table 1.

Table 1 Data sources consulted for the baseline

Environmental data	Data source
Land use	▪ CORINE land cover data (2018)
Soils	▪ Teagasc (Irish Soils Information System) ▪ GSI (borehole records) ▪ Ground investigation (GI) reports
Subsoil geology	▪ Teagasc/GSI/EPA (Subsoil Mapping) ▪ Technical feasibility work undertaken by Gavin & Doherty Geosolutions on behalf of Dublin Array ▪ GSI (borehole records) ▪ Ground investigation (GI) reports
Bedrock geology	▪ GSI (Bedrock Geology) ▪ Ground investigation (GI) reports
Geological heritage	▪ GSI Irish Geological Heritage (IGH) programme

2.5 Site walkover surveys

2.5.1 The OES study area was visited in July and August 2020 by way of a walkover survey. The purpose of the walkover surveys was to provide a general overview of the study area and review key features identified from the desktop study including sensitive receptors.

2.5.2 The site walkover provided a further understanding of the study areas in relation to the land, soil and geology environment to inform the baseline description of the project's receiving environment

2.5.3 Follow up site walkovers were also undertaken by SLR staff for the purpose of this baseline, in August 2024.

2.6 Site specific ground investigations

2.6.1 The site-specific ground investigations listed above which were undertaken specifically for the purpose of this project are discussed in detail in section 3.10.

3 Baseline

3.1 Introduction

3.1.1 This section describes the baseline conditions of the study area receiving environment in terms of land use, soils and geology. Site context data is firstly presented relating to the study area in general.

3.1.2 As set out in section 2, the data described here has been derived from a mixture of desktop published information, walkover survey of the study area and site investigation (SI) data. Where relevant, data sources are cited.

3.2 County Geological Sites

OES study area

3.2.1 At the eastern most end of the study area at the landfall, the baseline study area crosses a County Geological Site (CGS) referred to as 'Killiney Bay CGS'[5].

3.2.2 The CGS comprises a 5 km coastal exposure of several units of glacial till separated in places by sand and gravel. The CGS Site Report refers to the sequence being one of the most renowned in Irish Quaternary literature and has been interpreted as being either 'glaciomarine' in origin (i.e. deposited under a floating ice sheet in the sea) or the product of a terrestrial ice sheet, interpreted as 'subglacial' tills deposited at the base of an ice sheet on land.

3.2.3 The CGS Report sets out that the unit comprises a number of till units stacked on top of each other including gravel beds, sand pockets, clay lenses and limestone rocks. Large boulders of Leinster granite and limestone are also seen in the section and strewn across the beach. Small pebbles of a distinctive microgranite from Ailsa Craig in the Firth of Clyde can also be found.

3.2.4 There are no other County Geological Sites (CGS) along the remaining sectors, OSS or Grid Connection.

O&M Base

3.2.5 There are no CGS located within the study area for the O&M Base.

[5] Dún Laoghaire Rathdown - County Geological Site Report

3.3 Topography

OES study area

3.3.1 The ground topography within the OES study area rises from sea level at Killiney Bay to c. 90 m Above Ordnance Datum (mAOD) at the far western extremity of the study area at Ballyogan, County Dublin.

3.3.2 The study area ground elevation initially rises up vertically by c.12 m at the Shanganagh cliffs to the transition joint bay beside the Shanganagh Wastewater Treatment Plant (WWTP). From there it reaches an initial high point at the Dart Rail Line and falls back down to the Shanganagh River at c. 1 mAOD.

3.3.3 From the Shanganagh River the OES study area rises gently along the Kill-o-the-Grange Stream and Carrickmines Stream before rising up to c. 70 mAOD at Laughanstown.

3.3.4 From Laughanstown the study area is relatively level to Carrickmines where it rises up to c. 90 mAOD at Ballyogan, at the far western end of the study area.

O&M Base

3.3.5 The O&M Base is to be located in Dún Laoghaire Harbour and therefore elevations within the O&M Base study area are at or close to sea level, ranging from approx. 0 to 15 mAOD.

3.4 Physical features

OES Study area

3.4.1 The principal natural physical features within the OES study area are a number of surface water courses, which have formed the valleys through the study area. These river valleys are generally broad and flat, particularly along the Kill-o-the-Grange Stream and the upper section of the Carrickmines Stream from Carrickmines to the western end of the study area at Ballyogan.

3.4.2 However, the section of the Carrickmines stream from Carrickmines to the Shanganagh River at Loughlinstown flows through a relatively steep sided valley, compared with the aforementioned broad and flat channels. At Cherrywood and Loughlinstown the valley opens out into a relatively wider section with a flat wide valley floor but with steep valley sides.

O&M Base

3.4.3 The principal natural physical features within the O&M Base study area include coastline features such as beaches and the Irish sea. The area in Dún Laoghaire is largely urbanised, with the Dart railway line running through the study area, and the active harbour contributing to a large portion of the study area.

3.5 Land-use

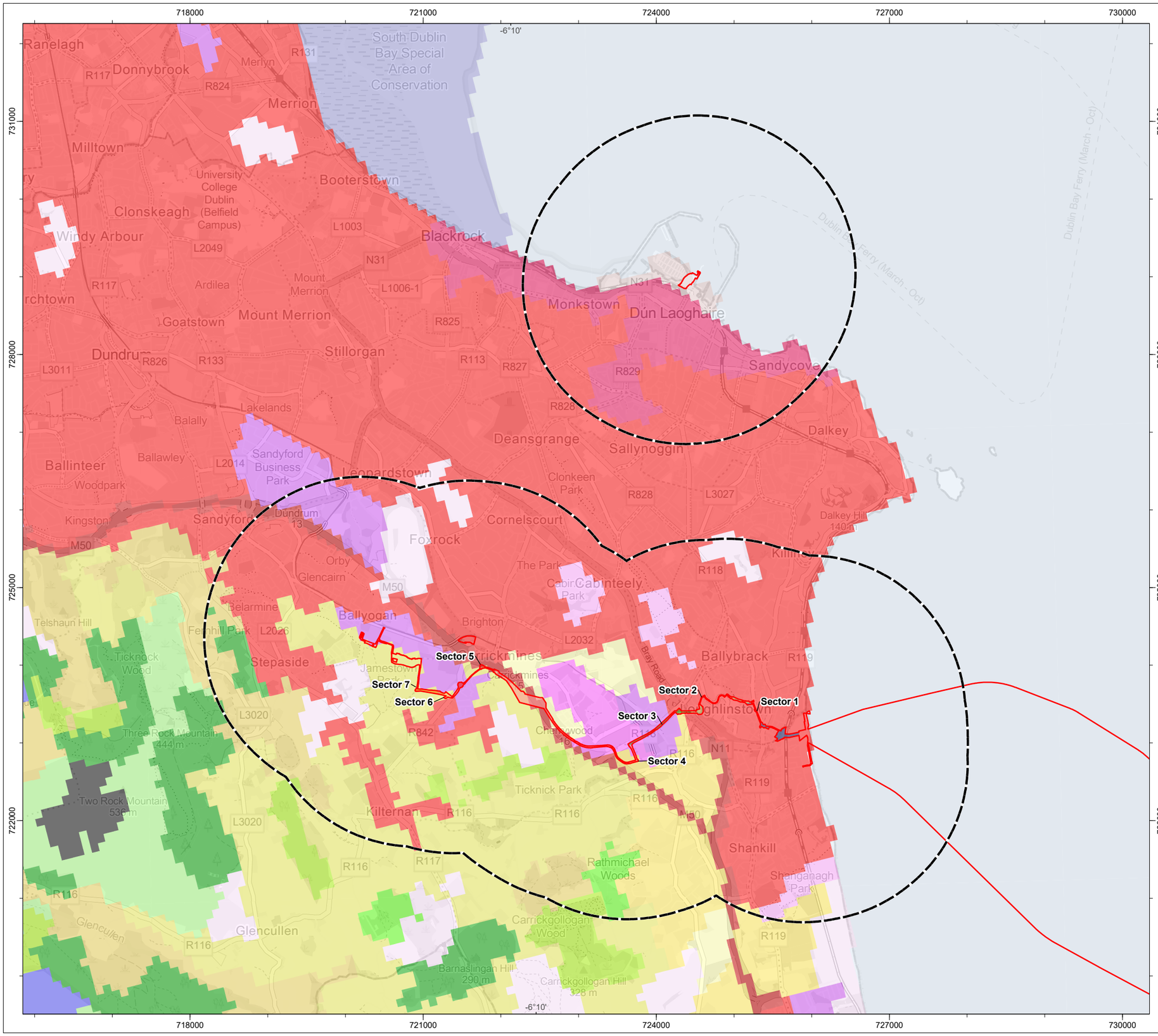
3.5.1 The following section provides a summary of the principal land uses within the onshore infrastructure study area which are relevant to the Land, Soils and Geology chapter. Volume 3 Chapter 17: Socio-Economics, Tourism, Recreation and Land Use provides a detailed description of the existing land uses at the onshore infrastructure study areas.

3.5.2 The CORINE[6] land cover mapping is a standardised inventory of land cover across Europe which is split into 44 different land cover classes. The latest 2018 CORINE land cover mapping for Ireland is a based on the interpretation of satellite imagery and national in-situ vector data. Land cover is mapped to the standard CORINE classification system and data specifications.

3.5.3 The CORINE land cover mapping reflects land use at the time of survey, in this case the latest available land cover data for Ireland is 2018. The land cover types along the proposed route are shown in Figure 2. The CORINE land cover classes along the proposed route include discontinuous urban areas around Shanganagh, Ballybrack and Loughlinstown, construction at Cherrywood, industrial and/or commercial at Cherrywood, Carrickmines and Ballyogan, and agricultural areas including arable and pasture.

3.5.4 The CORINE land cover mapping is shown in Figure 2.

[6] Accessed at CORINE Land Cover — Copernicus Land Monitoring Service



Application Site Boundary

Onshore Electrical System (OES) and Operations and Maintenace Base (O&M) 2 km Study Area

Export Cable Route (ECR) Sector

- Sector 1
- Sector 2
- Sector 3
- Sector 4
- Sector 5
- Sector 6
- Sector 7

Corrine Land Cover

- Continuous urban fabric
- Discontinuous urban fabric
- Industrial or commercial units
- Road and rail networks and associated land
- Port areas
- Construction sites
- Green urban areas
- Sport and leisure facilities
- Non-irrigated arable land
- Pastures
- Complex cultivation patterns
- Land principally occupied by agriculture, with significant areas of natural vegetation
- Coniferous forest
- Mixed forest
- Moors and heathland
- Transitional woodland-shrub
- Burnt areas
- Peat bogs
- Intertidal flats
- Sea and ocean

DRAWING STATUS

DISCLAIMER

MAP NOTES / DATA SOURCES:

PROJECT TITLE

Dublin Array

DRAWING TITLE

Land, Soils and Geology: Corrine Land Cover

DRAWING NUMBER: 2

PAGE NUMBER: 1 of 1

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0 0.3 0.5 0.8 1 Miles

N GRID NORTH

SCALE 1:50,000 PLOT SIZE A3

DATUM IRENET95 VERTICAL REF ODN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

Kish Offshore Wind Limited - Bray Offshore Wind Limited

OES study area

3.5.5 The land use throughout the OES study area is predominantly residential with areas of parkland and open space focussed mainly along the river valleys of the Shanganagh River, Kill-o-the-Grange Stream and Carrickmines Stream. Other land uses include light industrial and commercial, agriculture and transport including road, light-rail (Luas) and heavy-rail (Iarnród Éireann). While a significant portion of the Cherrywood lands were classified as construction land cover in 2018, these lands are now a combination of residential (apartments) with some construction also in 2023. The Leopardstown TCC is located within Discontinuous Urban Fabric land use.

3.5.6 In addition to these existing land uses there is one area of former landfill within Ballyogan (the Ballyogan Landfill Facility and Recycling Park) which sits inside the OSS study area. In addition, there are significant areas of development within the Cherrywood Strategic Development Zone (SDZ) where a number of significant changes are taking place with the construction of apartments and recreational facilities, and which will change the landscape in this area significantly over the coming years.

Former landfill sites

Ballyogan

3.5.7 There is one waste licence facility at Ballyogan, the Ballyogan Landfill and Recycling Facility and Recycling Park (Waste Licence No. W0015-01). The landfill activities at Ballyogan have ceased and the waste has been capped. The capped landfill features a landfill gas collection system. Associated landfill gas engines are located within the study area adjacent to the proposed OSS location.

3.5.8 The Ballyogan Waste Licence site area is approximately 50 hectares, 43 of which were previously used for landfilling. The remaining area consists of the site entrance and service roads, site compound, wetland and other services. The Ballyogan Recycling Park occupies a further 9 hectares.

3.5.9 The area within which it is proposed to construct the OSS was formerly used as settlement ponds for the landfill site.

O&M Base

3.5.10 The land-use at the O&M Base is classified as Sea Port in the CORINE land cover classification. The surrounding areas of Dún Laoghaire town centre are classified as a continuous urban fabric land cover. Land use in the study area around the O&M Base includes residential, business, administrative, retail, transport infrastructure and recreation/tourism.

3.6 Soils

3.6.1 Soil is defined as the top layer of the earth's crust and is formed by mineral particles, organic matter, water, air and living organisms. Soil is a complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

3.6.2 Soil formation is an extremely slow process and can take thousands of years to evolve. For this reason, soil is often considered a non-renewable resource.

3.6.3 As the interface between the earth, the air and the water, soil performs many vital functions. It supports food and other biomass production (forestry, biofuels etc.) by providing anchorage for vegetation and storing water and nutrients long enough for plants to absorb them. Soil also stores, filters and transforms other substances, including carbon and nitrogen, and has a role supporting habitats which in turn serve as a platform for human activity.

3.6.4 The Irish Soil Information System (ISIS) project was undertaken by the EPA and Teagasc, and has gathered together existing information and data from soil survey work in Ireland, which has been augmented with new field data, leading to the production of a new national soil map at a scale of 1:250,000[7].

3.6.5 The ISIS project has identified a number of Soil Associations across Ireland, which are each comprised of a range of soil types (or '*Series*'), each of them different in properties, with different environmental and agronomic responses. For each soil type, the properties have been recorded in a database maintained by Teagasc. The Teagasc ISIS online mapping website publishes soil maps from Teagasc, and the soil map for the study area is presented in Figure 3.

3.6.6 A summary of the soil types underlying the study areas is also included in Table 2.

OES study area

3.6.7 The OES study area is underlain by three principal soil types:

- Urban;
- Alluvium along the watercourses; and
- Clonroche Soil Association.

3.6.8 The urban areas within the study area are classified as Urban Soils where the urban development has occurred, and the natural soils have been disturbed.

[7] national soil map at a scale of 1:250,000 can be accessed at www.teagasc.ie/soils

3.6.9 Along the watercourses Alluvial soils occur which host the channel water flows.

3.6.10 The remainder of the study area is underlain by soils from the Clonroche Soil Association which is a Brown Earth soil comprised from a predominantly fine loamy glacial till parent material primarily composed of sedimentary siliceous stones/geology.

3.6.11 Typical Brown Earths, that belong to the Brown Earths Great Soil Group, are among the most commonly found soil types across the hill landscapes in Ireland, and soil Associations 1100a (Clonroche) and 1100s are the most extensively occurring within the Great Soil Group. Clonroche soil Association (1100a) is the lead series Brown Earths Great Soil Group in Ireland and can be found extensively across southeast Ireland in counties Wicklow, Wexford and Kilkenny and to lesser extents in counties Cork, Waterford and Carlow (source, Creamer and O'Sullivan, 2018).

3.6.12 The Clonroche Soil Association is extensively found in this region of Ireland. The areas of Clonroche soils within the study area comprise open space or land designated for development and none of the areas are in active agricultural production.

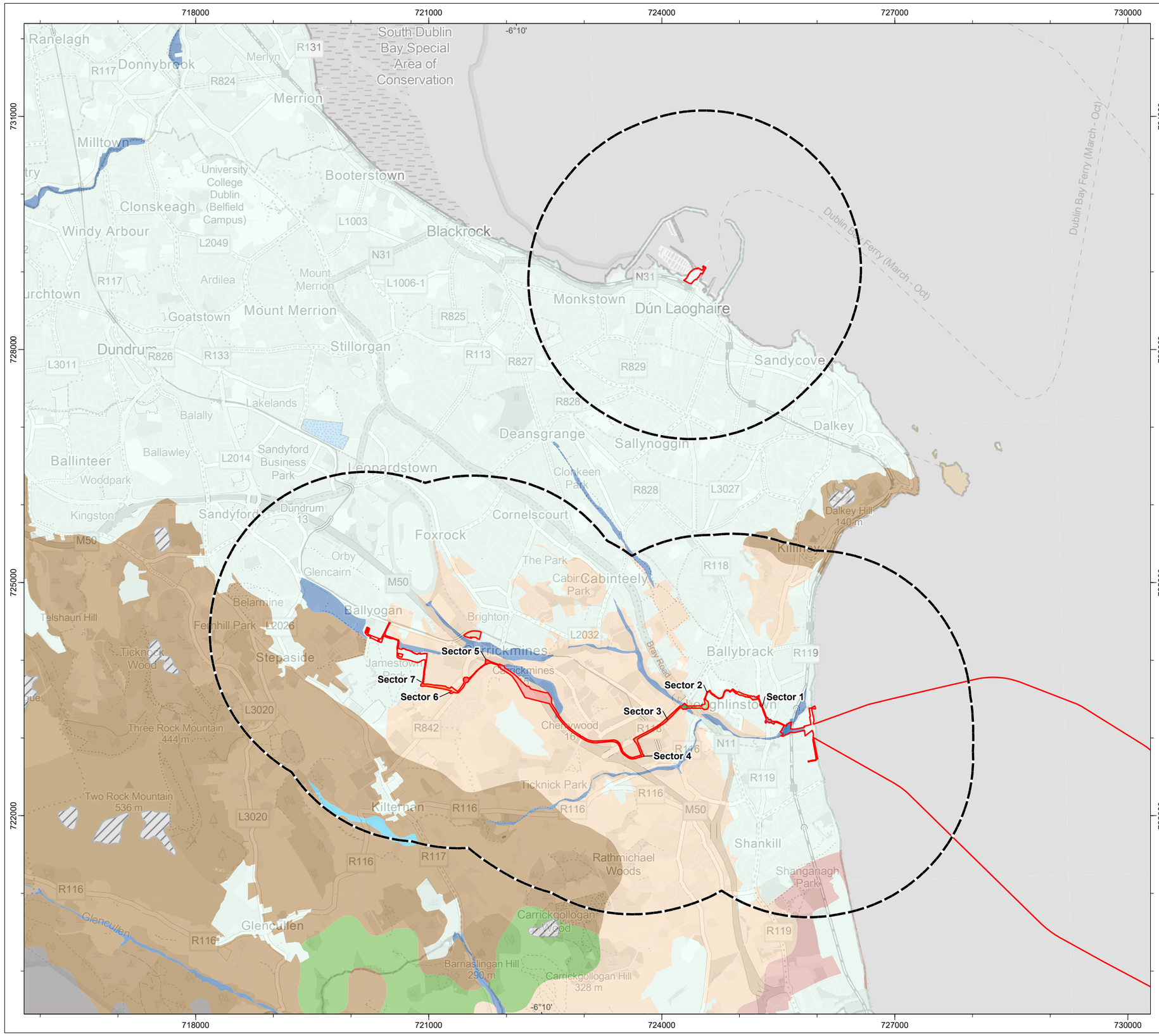
O&M Base

3.6.13 The EPA and Teagasc mapping shows the study area for the O&M Base to be underlain by an Urban soil type, indicating that urban development has occurred, and the natural soils have been disturbed. Figure 3 shows the soils within and in the surroundings of the study areas.

Table 2 Summary of soil types across the study areas

Sector/study area	Soils
OES study area	
Landfall Site	▪ Alluvium along watercourse ▪ Urban (Made Ground)
Sector 1	▪ Urban (Made Ground) ▪ Alluvium along watercourse
Sector 2	▪ Urban (Made Ground) ▪ Alluvium along watercourse
Sector 3	▪ Urban (Made Ground) ▪ Clonroche Soil Association ▪ Alluvium along watercourse
Sector 4	▪ Urban (Made Ground) ▪ Clonroche Soil Association ▪ Alluvium along watercourse
Sector 5	▪ Urban (Made Ground) ▪ Clonroche Soil Association
Sector 6	▪ Clonroche Soil Association

Sector/study area	Soils
	▪ Alluvium along watercourse
Sector 7	▪ Urban (Made Ground) ▪ Clonroche Soil Association ▪ Alluvium along watercourse
Leopardstown TCC	▪ Clonroche Soil Association
O&M Base study area	
O&M Base	▪ Urban (Made Ground)



Application Site Boundary

Onshore Electrical System (OES) and Operations and Maintenance Base (O&M) 2 km Study Area

Export Cable Route (ECR) Sector

- Sector 1
- Sector 2
- Sector 3
- Sector 4
- Sector 5
- Sector 6
- Sector 7

Soil Association

- Carrigavanagh Assoc. – Lithosol (0410a)
- Lake Alluvium (05LAK)
- River Alluvium (05RIV)
- Knockboy Assoc. – Brown Podzolic (0960e)
- Crosstown Assoc. – Luvisol (1030a)
- Clonroche Assoc. – Brown Earth (1100a)
- 1xx
- Island
- Rock
- Urban
- Water body

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PROJECT TITLE

Dublin Array

DRAWING TITLE

Land, Soils and Geology: Soils

DRAWING NUMBER: **3**

PAGE NUMBER: **1 of 1**

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0 0.3 0.5 0.8 1 Miles

N GRID NORTH

SCALE 1:50,000 PLOT SIZE A3

DATUM IRENET95 VERTICAL REF ODN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

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3.7 Subsoils

3.7.1 The study areas are comprised of a number of subsoils. The Quaternary (Subsoil) deposits were deposited during the last 2 million years, and essentially comprise the unconsolidated materials overlying bedrock. The two main types of quaternary subsoils in Ireland are glacial till, deposited at the base of ice sheets and sand & gravel deposits associated with the melting of the ice sheets which are generally termed glaciofluvial outwash sands and gravels. Other extensive quaternary subsoils in Ireland include peat, river alluvium and coastal process deposits. Most Quaternary subsoils in Ireland were deposited since the maximum of the last glaciation, the Midlandian, which occurred approximately 17,000 years ago.

3.7.2 The subsoils across Ireland have been mapped on a national basis by Teagasc[8] as part of the EPA Soil and Subsoil Mapping Project for the Irish Forestry Soils (IFS) project. The subsoil mapping was undertaken at a national basis using existing Quaternary Geology maps, publications, remote sensing, field mapping and sampling.

OES study area

3.7.3 The EPA online mapping website shows the OES study area to be underlain by glacial till and alluvium subsoils with some beach deposits at the coastline at Killiney bay, see Figure 4. There are also extensive areas of mapped 'made ground' through the study area where urban development has occurred.

3.7.4 Till derived from limestones (TLs) are extensive across Ireland in areas of limestone geology, and likewise till derived from granite (TGr) is extensive across areas with granite geology. Irish Sea glacial till is extensive along the east coast of Ireland as a result of the advance of the Irish Sea Ice sheet during the last glacial period.

3.7.5 Alluvium subsoils are more recent and are found along watercourses as a result of natural erosion and sedimentation by rivers. Alluvial soils occur throughout Ireland where there are watercourses and floodplains.

3.7.6 Minor areas of Gravels derived from Limestones (GLs) and Marine beach sands (Mbs) are located at the Landfall Site along the shoreline at Shanganagh Cliffs.

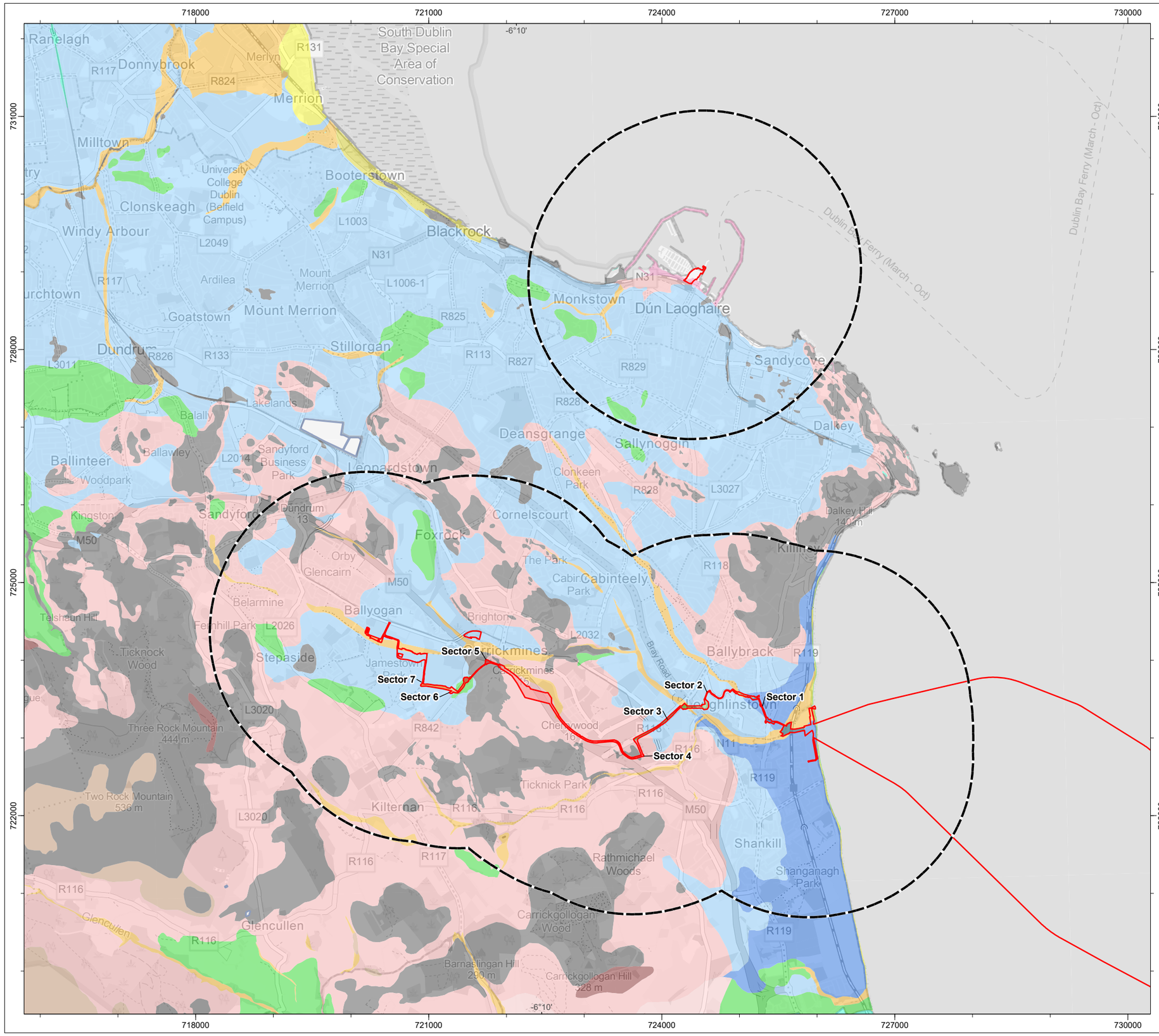
O&M Base study area

3.7.7 The EPA online mapping website identify the subsoils within the O&M Base study area as Till derived from limestones (TLs) and Till derived from Granites (TGr). A minor area of bedrock outcrop or subcrop is also located within the study area. See Figure 5 and Table 3.

[8] www.teagasc.ie

Table 3 Summary of subsoil types at the study areas

Sector/study area	Soils
OES study area	
Landfall	▪ Irish Sea Glacial Till
Sector 1	▪ Alluvium along watercourse ▪ Irish Sea Glacial Till ▪ Limestone dominated Glacial Till
Sector 1	▪ Alluvium along watercourse ▪ Irish Sea Glacial Till ▪ Limestone dominated Glacial Till
Sector 2	▪ Alluvium along watercourse ▪ Limestone dominated Glacial Till
Sector 3	▪ Alluvium along watercourse ▪ Limestone dominated Glacial Till ▪ Granite dominated Glacial Till
Sector 4	▪ Alluvium along watercourse M50/N11 ▪ Granite dominated Glacial Till
Sector 5	▪ Bedrock outcrop ▪ Gravels ▪ Limestone dominated Glacial Till
Sector 6	▪ Limestone dominated Glacial Till
Sector 7	▪ Limestone dominated Glacial Till
OSS	▪ Limestone dominated Glacial Till
Grid Connection	▪ Alluvium along watercourse ▪ Limestone dominated Glacial Till
Leopardstown TCC	▪ Limestone dominated Glacial Till
O&M Base study area	
O&M Base	▪ Urban (Made Ground)



Application Site Boundary

Onshore Electrical System (OES) and Operations and Maintenance Base (O&M) 2 km Study Area

Export Cable Route (ECR) Sector

- Sector 1
- Sector 2
- Sector 3
- Sector 4
- Sector 5
- Sector 6
- Sector 7

Superficial Geology

- Peat
- Alluvium
- Embankment
- Gravels Derived from Chert, Granite and Limestones
- Irish Sea Till Derived from Limestones
- Marine Beach Sands
- Esturine Silts and Clays
- Pier
- Bedrock Outcrop or Subcrop
- Scree
- Till Derived from Granites
- TLs, Till derived from limestones
- Till Derived from Metamorphic Rocks
- Urban
- Water

DRAWING STATUS

PUBLIC

DISCLAIMER

MAP NOTES / DATA SOURCES:

PROJECT TITLE

Dublin Array

DRAWING TITLE

Land, Soils and Geology: Subsoils

DRAWING NUMBER: **4**

PAGE NUMBER: **1 of 1**

VER	DATE	REMARKS	DRAW	CHEK	APRD
01	2024-12-18	DRAFT	JK	SW	AE

0 0.3 0.5 0.8 1 Kilometres

0 0.3 0.5 0.8 1 Miles

N GRID NORTH

SCALE 1:50,000 PLOT SIZE A3

DATUM IRENET95 VERTICAL REF CDN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

Kish Offshore Wind Limited - Bray Offshore Wind Limited

3.8 Bedrock geology

3.8.1 The GSI online mapping was referred to for published bedrock geology data[9]. Regionally the area is underlain by Caledonian-age granites and granodiorite, as well as deep marine slate, schist and minor greywacke which is Palaeozoic/Lower-Middle Ordovician in age.

3.8.2 The local bedrock geology that underlies the study areas is presented in Figure 5 and is summarised in Table 4.

OES study area

3.8.3 The GSI online bedrock mapping shows the OES study area to be underlain Ordovician Schist and Granite bedrock, comprising four different geological formations, see Figure 5.

3.8.4 The Maulin Formation is found underlying the eastern sectors of the onshore ECR covering the Landfall Site and Sectors 1 and 2. The formation consists of Ordovician dark blue-grey slate, phyllite and schist and is described by the GSI as penetratively cleaved dark blue grey slates and phyllites which are commonly striped with pale siltstone laminae. Bands of granitiferous quartzite that are 20 m thick occur in the granite aureole. There are also thick lenses of orthoquartzite.

3.8.5 Sectors 3 to 7 of the onshore ECR, Leopardstown TCC, the OSS and Grid Connection, are underlain by granite bedrock formations including:

- Type 2p Granite is encountered. This granitic unit consists of Caledonian granite with microcline phenocrysts. Type 2p has in addition euhedral microcline phenocrysts up to 30mm. Accessory minerals are Fe-oxide, sphene, apatite, zircon, garnet and rutile.
- Type 2e Granite, consisting of quartz, plagioclase, microcline, muscovite and biotite with grainsize 1-5 mm; and
- Type 3 Granite. Type 3 Granite is similar to Type 2e with muscovite phenocrysts in addition, and with accessory tourmaline and topaz.

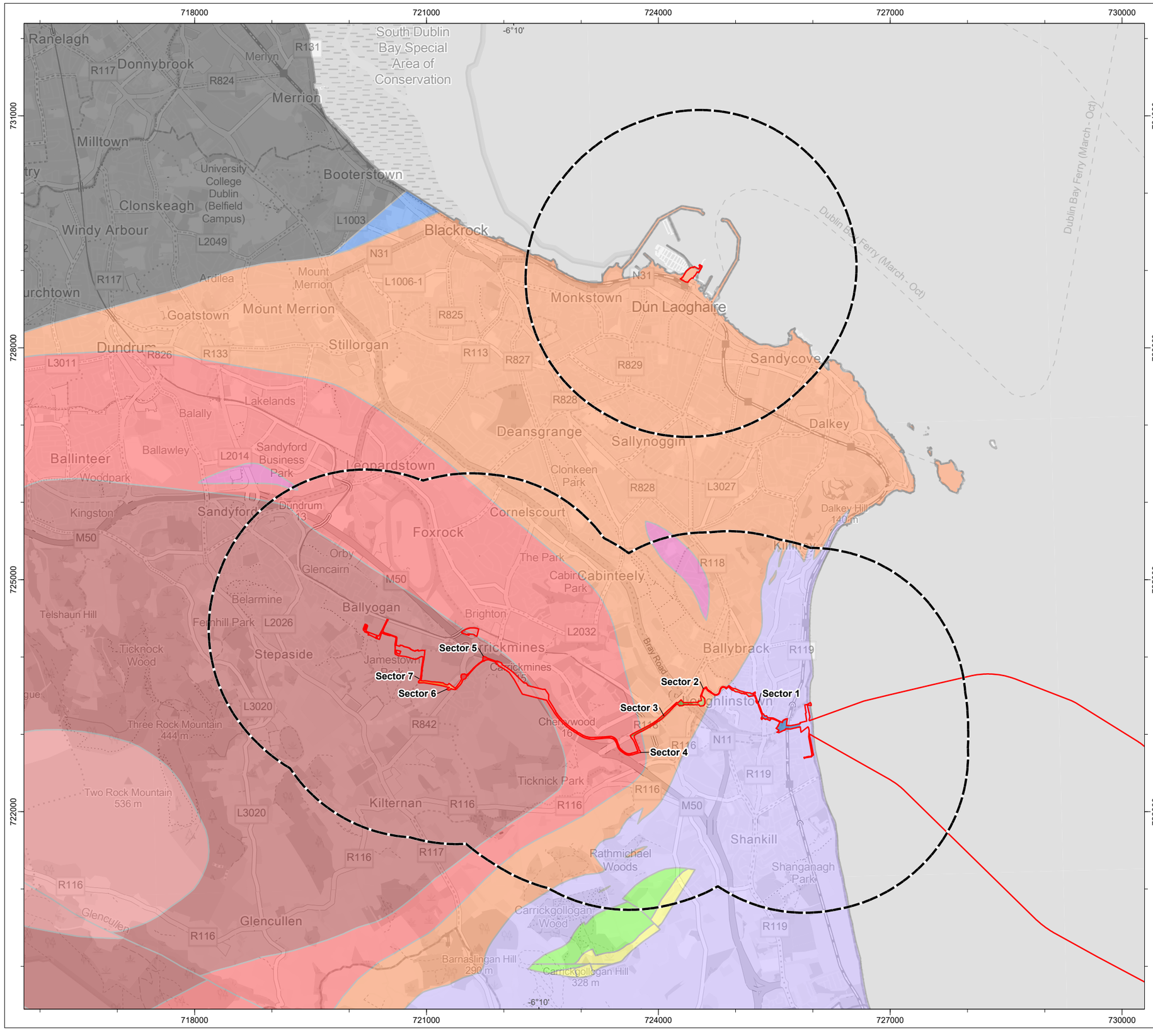
O&M Base study area

3.8.6 The GSI online bedrock mapping shows the O&M Base study area to be underlain by Type 2p microcline porphyritic Granite.

[9] published bedrock geology data can be found at www.gsi.ie

Table 4 Summary of bedrock geology at the study area

Sector/study area	Soils
OES study area	
Landfall Site	▪ Ballysteen Formation (Ordovician Schist)
Sector 1	▪ Ballysteen Formation (Ordovician Schist)
Sector 2	▪ Ballysteen Formation (Ordovician Schist) ▪ Granite (Type 2p)
Sector 3	▪ Granite (Type 2p) ▪ Granite (Type 2e)
Sector 4	▪ Granite (Type 2e) ▪ Granite (Type 3)
Sector 5	▪ Granite (Type 3)
Sector 6	▪ Granite (Type 3)
Sector 7	▪ Granite (Type 3)
OSS	▪ Granite (Type 3)
Grid Connection	▪ Granite (Type 3)
Leopardstown TCC	▪ Granite (Type 2e)
O&M Base study area	
O&M Base	▪ Urban (Made Ground)



Application Site Boundary

Onshore Electrical System (OES) and Operations and Maintenance Base (O&M) 2 km Study Area

Export Cable Route (ECR) Sector

- Sector 1
- Sector 2
- Sector 3
- Sector 4
- Sector 5
- Sector 6
- Sector 7

Bedrock Geology

- Bray Head Formation
- In Bray Head Formation
- Ballysteen Formation
- Lucan Formation
- Type 1 Granodiorite
- Type 3 Muscovite Porphyritic
- Type 4 Muscovite/Microcline Porphyr
- Type 2e Equigranular
- Type 2p Microcline Porphyritic
- Maulin Formation

DRAWING STATUS

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PROJECT TITLE

Dublin Array

DRAWING TITLE

Land, Soils and Geology: Bedrock Geology

DRAWING NUMBER: 5

PAGE NUMBER: 1 of 1

VER	DATE	REMARKS	DRAW	CHEK	APRD
01	2024-12-18	DRAFT	JK	SW	AE

0 0.3 0.5 0.8 1 Kilometres

0 0.3 0.5 0.8 1 Miles

N GRID NORTH

SCALE 1:50,000 PLOT SIZE A3

DATUM IRENET95 VERTICAL REF DDN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

Kish Offshore Wind Limited - Bray Offshore Wind Limited

3.9 Borehole records ground investigation

3.9.1 Previous works have been carried out at certain focus areas at the Landfall Site and along the onshore ECR and a number of ground investigation reports were available for review from the GSI's online map viewer.

3.10 Site specific ground investigations

3.10.1 A number of geotechnical ground investigations have been undertaken along the onshore ECR, including:

- Dublin Array Onshore SI Report May 2023, undertaken for Dublin Array (see The Onshore SI Report); and
- Dublin Array Onshore Cable Route GI Report, February 2024, undertaken for Dublin Array (see The Cable Route Ground Investigation Report);

Landfall Site and OSS site investigation

3.10.2 A site investigation (SI) was undertaken across two sites, the Landfall Site at Shanganagh Cliffs and at the proposed OSS location in Ballyogan immediately west of Carrickmines [Retail] Park, see The Onshore SI Report.

3.10.3 The SI was conducted between 5th September and 7th October 2022, comprised:

- Eleven boreholes by sonic drilling methods;
- Standpipe installation in nine boreholes for groundwater and gas monitoring;
- Sixteen machine dug trial pits;
- An infiltration test performed in six trial pits;
- Thirteen variable head tests (falling head); and
- Eight plate load tests.

3.10.4 The boreholes extended between 10.5 mbgl and 15 mbgl at Ballyogan and 30 mbgl at Shanganagh Cliffs. Sixteen trial pits were excavated using a 6 t or 13 t tracked excavator fitted with a 300 mm or 600 mm wide bucket, to depths up to 4.50 mbgl.

3.10.5 The ground conditions encountered are set out in The Cable Route Ground Investigation Report and are summarised here.

Shanganagh Cliffs

3.10.6 A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- Topsoil: encountered across the site with a thickness range of 200-300 mm.
- Made Ground (fill): reworked sandy gravelly clay/sand/gravel fill encountered across the site to a maximum depth of 2.10 m in WP2_BH02. Varying amounts of concrete, red brick, plastic, timber, rebar and ceramic pipes were encountered within the made ground.
- Glacial Sands & Gravels: Loose to dense gravelly silty sand and sandy silty gravel encountered greatest in extent in WP2_BH03 and WP2_BH04 adjacent to the coastline.
- Glacial Till: sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth often with lenses of granular material.

Ballyogan

3.10.7 A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- Topsoil: encountered across the site with a thickness range of 100-300 mm.
- Made Ground (fill): reworked sandy gravelly clay encountered across the site to a maximum depth of 3.30 m in WP1_TP03. Varying amounts of plastic, red brick, concrete, ducting, rebar, electrical cable and timber were encountered within the made ground across the site.
- Glacial Till: sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth often with lenses of granular material.
- Bedrock (Granite): Rockhead was encountered at a depth of 11.30 m in WP1_BH01.

Onshore ECR ground investigation

3.10.8 The extent of the GI included boreholes, trial pits, slit trenches, soil and rock core sampling, environmental sampling, groundwater monitoring, in-situ and laboratory testing, and the preparation of a factual report on the findings, see The Cable Route Ground Investigation Report.

3.10.9 The GI works were conducted across various sites along the proposed ECR from the proposed OSS to the proposed Landfall Site at the most eastern extent, located at Shanganagh Allotments, south of the Shanganagh WWTP, see The Cable Route Ground Investigation Report.

3.10.10 The GI was conducted between 11th September and 15th November 2023, and comprised:

- Fifteen boreholes, including:
  - Three light cable percussion boreholes (2 of which were inspection pits only);
  - Ten boreholes by light cable percussive extended by rotary follow-on drilling methods; and
  - Two boreholes by rotary drilling methods only.
- Aa standpipe installation in one borehole;
- Fifteen machine dug trial pits/slit trenches; and
- GPR surveys.

3.10.11 Following completion of site works, a groundwater data logger was installed in WP03_BH06 to monitor groundwater levels over the course of 12 months. Ground water monitoring was carried out using a water interface probe. Data from the logger will be downloaded by Causeway Geotech and issued to the Dublin Array electronically.

3.10.12 Several phases of GPR surveys were completed across the proposed cable route from March to November 2023, by Scantech Geoscience Ltd. to identify location and type of any services present. Results of the survey have been presented to the Dublin Array electronically and are included with The Cable Route Ground Investigation Report.

Ground types encountered during investigation of the site

3.10.13 A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- Topsoil: encountered across the site in either its natural state or reworked state with a thickness range of 100-300 mm.
- Made Ground (sub-base): aggregate fill was encountered within some of the slit trenches in the landfill site, generally surrounding services.

- Made Ground (fill): generally reworked sandy gravelly clay fill or gravelly clayey sand encountered to various extents across the site. Pieces of plastic were encountered within the strata in WP03_TP04A and WP03_TP08. Encountered greatest in extent in WP03_BH07, where the driller noted a hydrocarbon odour from the strata, WP03_BH10 adjacent to the M50 motorway likely built-up during construction, and WP03_BH05, the location of an old construction compound.
- Alluvium: Medium dense to dense sand and gravel encountered adjacent to a stream in WP03_BH07 and WP03_BH08 to depth of 8.00 mbgl.
- Glacial Sands & Gravels: Extensive sand and gravel deposits encountered in WP03_BH14 to a depth of 25.00 mbgl.
- Glacial Till: sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth, often with lenses of dense granular material.
- Bedrock (Granite): Granite of various strengths was encountered across the site from 2.30m in WP03_BH02 to depths of 20.30 m in WP03_BH06, with depth to bedrock generally increasing eastwards across the site towards the Irish Sea.

3.10.14 Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location in The Cable Route Ground Investigation Report. Groundwater was encountered during the ground investigation as water strikes at depths as shown in Table 6 in The Cable Route Ground Investigation Report.

3.10.15 Several phases of Ground Penetrating Radar (GPR) surveys were completed across the proposed cable route from March to November 2023, by Scantech Geoscience Ltd. to identify location and type of any services present. Results of the survey have been presented to the Dublin Array electronically and are included with The Cable Route Ground Investigation Report.

3.11 Shanganagh Cliff Baseline Erosion Survey

3.11.1 A baseline survey of the baseline erosion conditions along a 700 m section of the Shanganagh Cliffs was carried out, which included the proposed Landfall Site and the location of the existing Shanganagh WWTP outfall:

- Shanganagh Cliff Baseline Erosion Survey, December 2024 (see Annex 1).

3.11.2 The baseline walkover survey of the cliff face at Shanganagh was undertaken on the 18th April 2024 to document the baseline erosion conditions of the cliffs between the Corbawn cliff protection works and the Shanganagh River (see Annex 1).

3.11.3 The typical stratigraphic sequence in the cliff exposures across the survey area included topsoil, deglaciation deposits and glaciation deposits. The basal glacial till deposits are relatively consolidated compared to the overlying deglaciation deposits which comprise units of silts/clays, sands, gravels, cobbles and occasional boulders (see Annex 1).

3.11.4 Minor groundwater seepages out of the cliff face were observed in the unconsolidated material, either where coarser sand and gravel units occurred or at the contact with an underlying less permeable unit where present (typically silts and clays).

3.11.5 The groundwater was observed as either minor seepages and/or slightly damper areas across the cliff face. Many of the minor slumps and failures in the cliff face were observed to coincided with these minor seepages and it is inferred that a combination of groundwater pore pressure, stress relief and wash-out or erosion of fines at the cliff face is giving rise to the slumping observed across the surveyed cliff face (see Annex 1).

3.11.6 The observations from the walkover survey are that while storm wave action at the base of the cliff is the predominant driver of erosion and instability at the base of the cliffs the minor groundwater seepages daylighting in the cliff face are also likely to contribute to softening/weakening of the soil exposures and to a reduction in their strength over time. This ultimately leads to localised failure and instability in the cliff face above the beach/toe of the cliff.

3.11.7 The walkover survey and observation of the current cliff line indicates that sections of the cliff face are being actively eroded. The survey provides a photographic record of the stability and erosion of the cliff line.

3.12 Sensitive receptors

OES study area

3.12.1 In terms of land, soils and geology baseline considered here the sensitive receptors are identified as being land use, soils and geological heritage.

3.12.2 Subsoils and bedrock geology are not considered to be sensitive receptors as they do not have any specific qualifying attributes or features.

O&M Base study area

3.12.3 In terms of land, soils and geology baseline considered here the sensitive receptor at the site of the O&M Base identified as being land use.

3.12.4 Subsoils and bedrock geology are not considered to be sensitive receptors as they do not have any specific qualifying attributes or features.

4 Future receiving environment

4.1.1 The land use baseline environment will change over the coming years as a number of developments across the study area continue through construction and operation. These developments are set out below.

OES study area

- Sector 2: proposals for flood surface water storage adjacent to Kill-o-the-Grange Stream (the Glenavon Park Storage Project as part of the Deansgrange Flood Relief Scheme[10]) - as described in Volume 5 Chapter 4: Water (Hydrology, Hydrogeology and Flood Risk). Dublin Array's proposals through this area will avoid the flood storage area and is not expected to be affected by it;
- Sectors 3 and 4 at Cherrywood: various residential and commercial developments to be developed around the road infrastructure already constructed in this area, Dublin Array's proposals through this area will follow the road infrastructure and is not expected to be affected by this future development. In addition, Beckett Road is a planned road set out in the consented Cherrywood SDZ that is planned to be completed by 2026; and
- Sector 7 proposals for urban park across the capped Ballyogan Landfill Facility. The onshore ECR will cross under the Glenamuck District Distributor Road via trenchless techniques. The GDDR is currently under construction and is expected to be completed in advance of the onshore ECR construction phase.

O&M Base study area

4.1.2 The O&M Base is located in the existing Dún Laoghaire Harbour adjacent to the town and existing infrastructure including the existing DART rail line.

[10] Deansgrange Flood Relief Scheme - DeansgrangeFRS

5 Summary

OES study area

5.1.1 The onshore baseline setting for the OES straddles a number of different land use types along the route including urban areas around Shanganagh, Ballybrack and Loughlinstown; construction at Cherrywood; industrial and/or commercial at Cherrywood, Carrickmines and Ballyogan; transport infrastructure including rail, light rail and road, and some small agricultural areas including arable and pasture.

5.1.2 The soils and subsoils are predominantly classified as urban/made ground, reflecting the land use and land cover types outlined above.

5.1.3 The coastal section at the Landfall Site is designated as a geological heritage site, and this is considered to be a sensitive receptor.

O&M Base study area

5.1.4 The O&M Base is set in an existing harbour facility with urban land use on the land side in the adjacent Dún Laoghaire town centre and the existing DART rail line. There are no sensitive soils, subsoils or geology receptors at the base or study area.

Annex 1 Shanganagh Cliff Baseline Erosion Survey (SLR, December 2024)

Shanganagh Cliff Baseline Erosion Survey

Dublin Array

Prepared by:

SLR Environmental Consulting (Ireland) Ltd

7 Dundrum Business Park, Windy Arbour, Dublin, D14 N2Y7

SLR Project No.: 501.065303.0001

Client Reference No: Dublin Array

1 December 2024

Revision: FINAL

Basis of Report

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Table of Contents

Diagrams

Figures

Photos

Acronyms and Abbreviations

CVI	Coastal Vulnerability Index
DPM	Direct Pipe Method
ECR	export cable route
ECRIPP	East Coast Railway Infrastructure Protection Projects
GCP	Grid Connection Point
GSI	Geological Survey of Ireland
HDD	Horizontal directional drilling
ICPS	Irish Coastal Protection Study
ICPS	Irish Coastal Protection Strategy Study
LiDAR	Light Detection and Ranging
OSS	Onshore Compensation Compound
OSi	Ordnance Survey of Ireland
TCC	Temporary construction compound
TJB	Transition Joint Bay
WTG	Wind Turbine Generator
WWTP	Wastewater treatment plant

1.0 Introduction

This baseline survey report for the sea cliffs at Shanganagh, Co. Dublin, the 'Survey Area' has been prepared by SLR Environmental Consulting (Ireland) Ltd. (SLR) for RWE Renewables Ireland Ltd. (RWE). The Survey Area is shown in Figure 1.

The aim of the baseline survey is to provide a record of the erosion of the Shanganagh Sea Cliffs across the Survey Area at a point in time (April 2024), which can be used as a reference point for any future survey of the sea cliffs across the Survey Area.

The baseline survey undertaken here is a qualitative walkover survey to record the cliff erosion across the Survey Area as of the survey date in April 2024.

1.1 Project Overview

Dublin Array will comprise between 39 and 50 Wind Turbine Generators (WTG) and will include infrastructure that is required to transmit the power generated at the turbines to the offshore substation via inter-array cables, before then being transmitted via onshore cable installations to the Carrickmines 220 kV substation Grid Connection Point (GCP).

The maximum export capacity of the proposed offshore windfarm is expected to be up to 824MW (megawatts). The proposed development also includes onshore cable installations and onshore works which will facilitate connection to the national electricity grid.

The proposed Onshore Substation (OSS) for the Project is located on the former Ballyogan Landfill Facility in Jamestown. The configuration of the onshore export cable route (onshore ECR) for the proposed development will include up to two underground electricity cable circuits and associated infrastructure connecting the proposed transition joint bays (TJBs) at the Landfall Site to the OSS in Jamestown and to the existing 220 KV electricity substation at Carrickmines.

It is proposed to lay the cable under the sea cliffs at Shanganagh to the tidal zone where the offshore cable installation and the onshore cable installation will be connected (the Landfall Site).

1.1.1 Construction Area at Shanganagh

At Shanganagh the proposed development is shown on Figure 1 and will include the following items required for the delivery of the project:

i. Transition Joint Bays (TJBs);
ii. Landfall Site Temporary Construction Compound (TCC) area for the TJB and cable construction across the Shanganagh Cliffs to the tidal Zone;
iii. Creation of an exit pit in tidal zone to allow connection of offshore - onshore cable installation;
iv. Cable duct laydown area;
v. Temporary access road through Shanganagh Cliffs to the Landfall Site TCC; and

1.2 Study Area

The baseline survey covers the Shanganagh section of coastal cliffs between the Corbawn Cliff protection works at Shankill Beach, at the southern end of the site, to the Shanganagh River at the northern end of the survey area as shown in Figure 1 and covers a distance of approximately 700m along the cliffs.

1.3 Sources of Information

The following sources of information were consulted in the preparation of this baseline report:

- East Coast Railway Infrastructure Protection Projects (ECRIPP) Emerging Preferred Scheme for CCA2/3 Dalkey Tunnel to Shanganagh Bray Wastewater Treatment Plant. Public Consultation. Irish Rail and Jacobs, December 2024.
- Irish Coastal Protection Strategy Study Phase 2 - South East Coast Work Packages 2, 3 & 4A - Technical Report (June, 2010);
- Irish Coastal Protection Strategy Study Phase 2 - South East Coast Work Packages 2, 3 & 4A - Technical Report Appendices 1-6, 9 (June, 2010);
- Irish Coastal Protection Strategy Study Phase 2 - South East Coast Work Packages 2, 3 & 4A - Appendix 8 - Erosion Mapping (June, 2010); and
- Geological Survey of Ireland Coastal Vulnerability Index (www.gsi.ie);
- Walkover survey (April, 2024)

1.4 SLR Personnel

The walkover baseline survey and this report has been undertaken by:

- Peter Glanville (PhD, MSc, PGeo, EurGeol) Quaternary Geomorphology; and
- Derek Luby (MSc BEng ICE GSI IEI IMQS) Geotechnical Engineering.

Peter Glanville is a Technical Director with SLR based in Dublin and he is a chartered geologist with over 20 years of experience in environmental consultancy. Peter is a Professional Geologist (PGeo. EurGeol.) with the Institute of Geologists of Ireland and has experience in preparation of EIA reports and the assessment of Quaternary Geology, Geomorphology, Resource Assessments, Regional and National Mineral Constraints, Hydrology, Flood Risk, and Hydromorphology.

Derek Luby is a Technical Director of SLR Consulting, based in Dublin, with more than 25 years of experience of geological, geotechnical and related environmental aspects of construction and development projects, principally in the infrastructure, extractive and waste sectors. He has worked with other engineering and geoscience professionals on many multi-disciplinary projects over the course of his career and has acted as expert witness on geology and geotechnical issues at oral hearings, public enquiries and arbitrations. His work has provided him with significant insight and experience of land / soil / groundwater quality investigations, remediation of brownfield sites, planning and environmental impact assessment and licensing / permitting of waste management, extractive and industrial facilities.

2.0 Shanganagh Cliff Desk Study

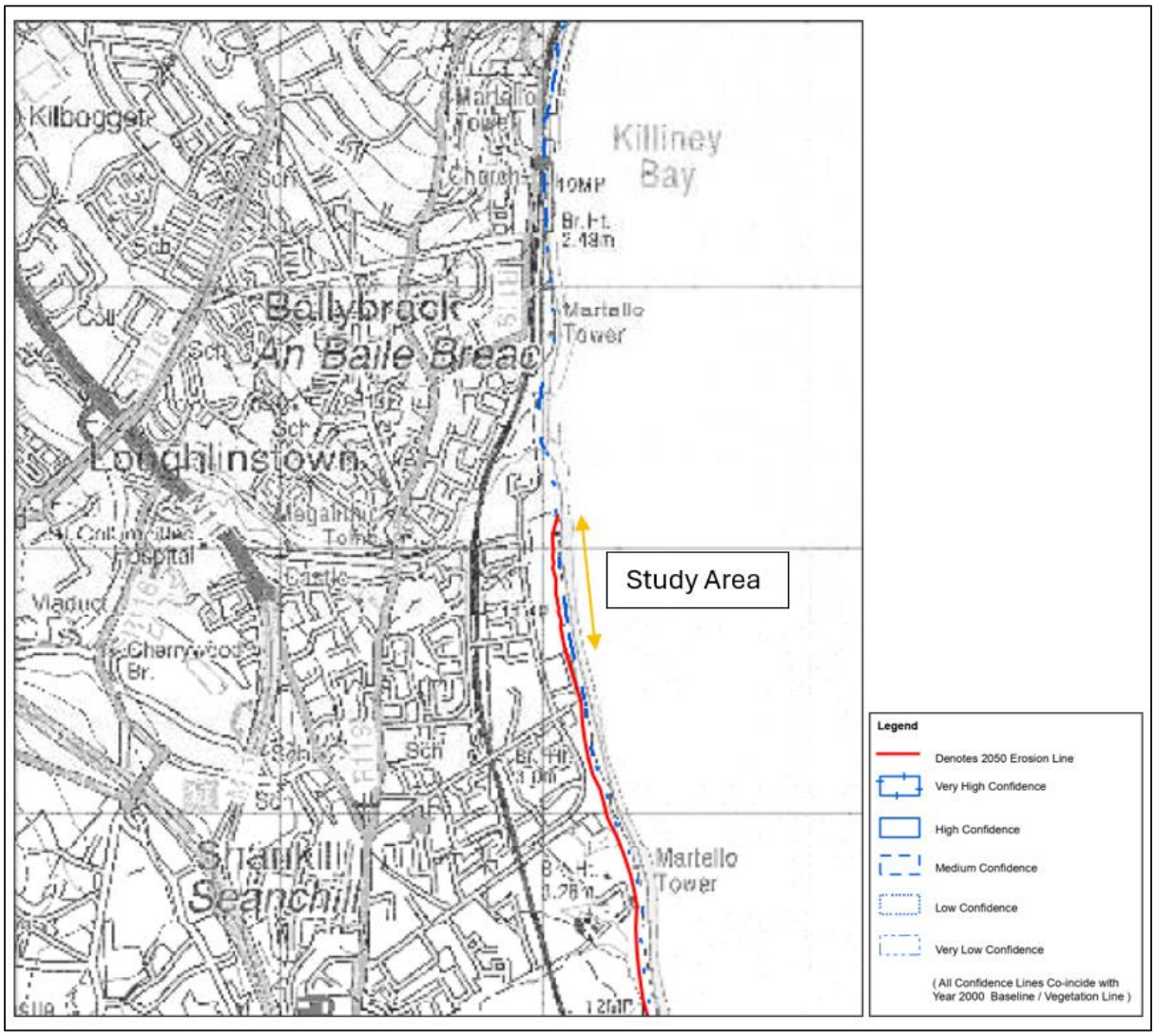
2.1 Irish Coastal Protection Study

The Irish Coastal Protection Study (ICPS) report (RPS 2010) produced a set of erosion maps for the Southeast Coast of Ireland which included the coastline at the Study Area. The ICPS report predicted cliff line retreat at the Shanganagh Cliffs by c. 30-35m by 2050.

The ICPS report indicates active cliff retreat at the Study Area.

An excerpt from the ICPS coastline retreat maps at the Study Area with the estimated retreat line by 2050 is shown in Diagram 2-1 below.

Diagram 2-1
ICPS Coastline Erosion Map to 2050



2.2 Coastal Erosion Rates

A number of projects have estimated coastal erosion and coastal erosion rates in the vicinity of the development at Shanganagh, see Table 1 below. The estimated coastal erosion rates vary from 0.65m/yr. to 0.88m/yr. with estimated cliff erosion of between c. 32.5m and 44m over the lifetime of the project, which is c. 35 years.

The Irish Rail and Jacobs East Coast Railway Infrastructure Protection Projects (ECRIPP) has undertaken modelling of future shoreline changes out to 2100. The ECRIPP project section at the site is Coastal Cell Area CCA2/3 - Dalkey Tunnel to Shanganagh-Bray Wastewater Treatment Plant (WWTP). The ECRIPP model of future shoreline change indicates that:

- From Killiney station to north of the Shanganagh WWTP the model predicts that the shoreline will erode by up to 45m by Year 2055 up to 55m by 2100; and
- South of the WWTP, the model predicts that the shoreline will accrete, but the accretion will gradually reduce with time.

Table 1
Estimated Cliff Erosion Rates

Estimated coastal erosion rate	Estimated cliff regression over lifetime of project (35 years)	Data Source
0.65m/yr. (stated)	22.75m	ICPS Report, 2010 (OPW / RPS)
0.88m/year (derived from map sources)	30.8m	Coastal vulnerability assessment, 2018 (Caloca-Casado)
Shoreline accreting south of Shanganagh Wastewater Treatment Plant	Shoreline accretion but gradually reducing over time	ECRIPP Public Consultation, December 2024 (Irish Rail and Jacobs)

The project TJBs will be located c. 90m back from the present-day cliff face at Shanganagh and therefore will not be impacted by cliff retreat even during the most conservative scenario for estimated coastal erosion which is c. 44m over the lifetime of the project.

2.3 Geological Survey of Ireland Coastal Vulnerability Index

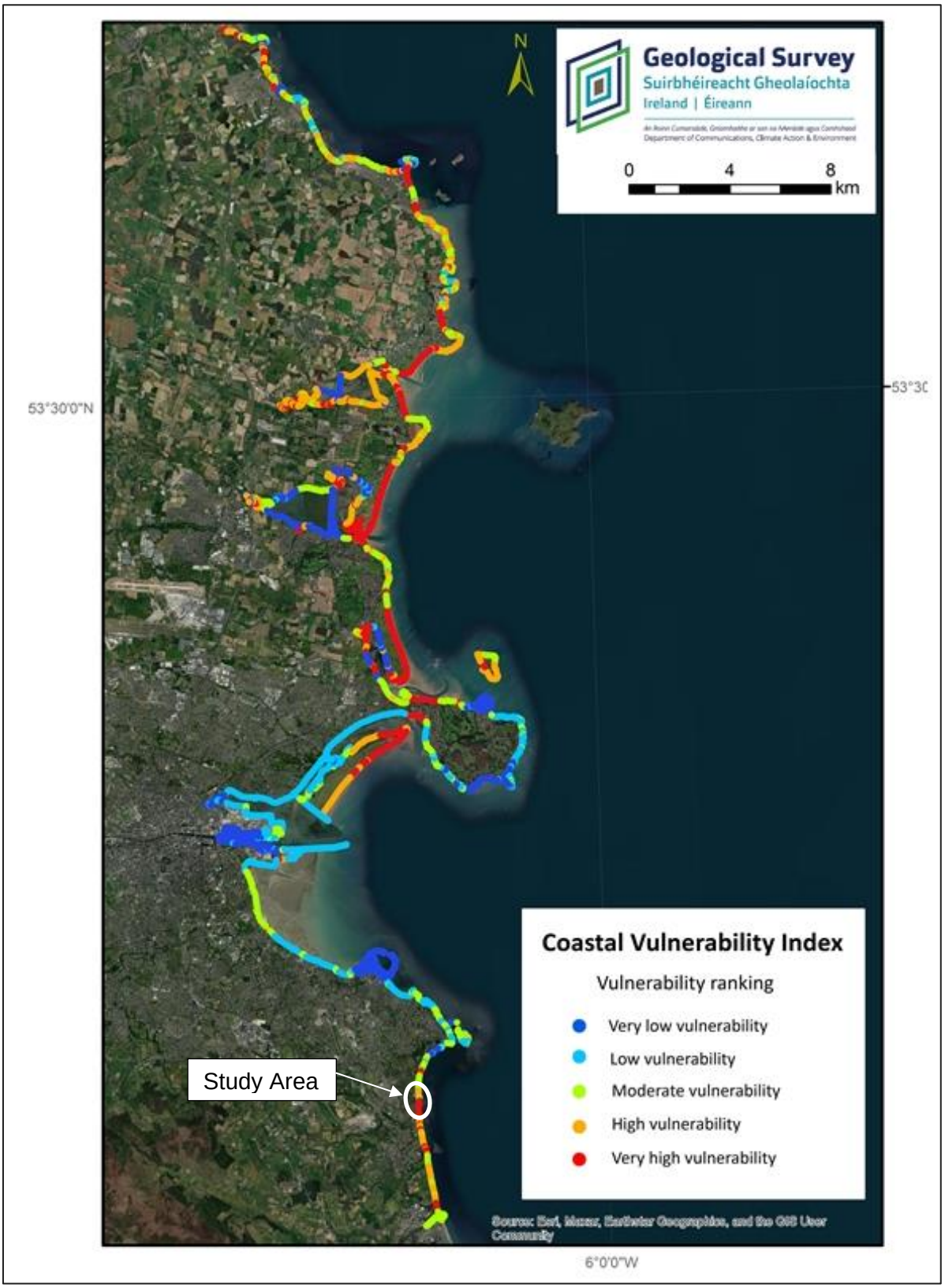
Geological Survey Ireland (GSI) is currently undertaking coastal vulnerability mapping to provide an insight into the relative susceptibility of the Irish coast to the impacts of sea level rise through the use of a Coastal Vulnerability Index (CVI). The CVI is based on physical parameters and was adapted to the local context to explore the relationships between drivers such as sea level rise, geological boundary conditions and the coast's responses.

The CVI offer a visual representation of sensitive areas, enabling coastal managers to prioritize or concentrate efforts on adaptation. The principal areas of vulnerability are identified by both CVI and the analysis of individual variables such as: geomorphology, cliff type, coastline orientation, regional coastal slope, tidal range, significant wave height, relative sea-level rise, long-term shoreline erosion and accretion rates.

The GSI have a copy of the Dublin coastal CVI output available on their website, see Diagram 2-2 below, which indicates a CVI is ‘High’ to ‘Very High’ vulnerability at the Shanganagh Cliffs Study Area.

The GSI website states the CVI map shown in Diagram 2-2 is the outcome of a first phase of CVI mapping.

Diagram 2-2
GSI Coastal Vulnerability Index Vulnerability Rating for Dublin Area



3.0 Shanganagh Cliff Baseline Survey - April 2024

A baseline walkover survey of the cliff face at Shanganagh was undertaken on the 18th April 2024 to document the baseline erosion conditions of the cliffs between the Corbawn cliff protection works and the Shanganagh River, see Figure 1.

3.1 Stratigraphic Sequence

The typical stratigraphic sequence in the cliff exposures across the survey area are shown in Photo 3-1 below and the geological sequence is summarised in Table 2.

Table 2
Summary of Geological Sequence

Unit	Description
Topsoil	Recent topsoil development with vegetation and root system.
Deglaciation deposits	Relatively unconsolidated material including layers of silts / clays, sands, gravels, cobbles and occasional boulders throughout unit.
Glacial Till deposits	Relatively consolidated sediments comprising glacial till material.

The description used here between unconsolidated material and consolidated material in the exposed cliff faces is a relative term. The basal glacial till deposits are relatively consolidated compared to the overlying deglaciation deposits which comprise units of silts / clays, sands, gravels, cobbles and occasional boulders.

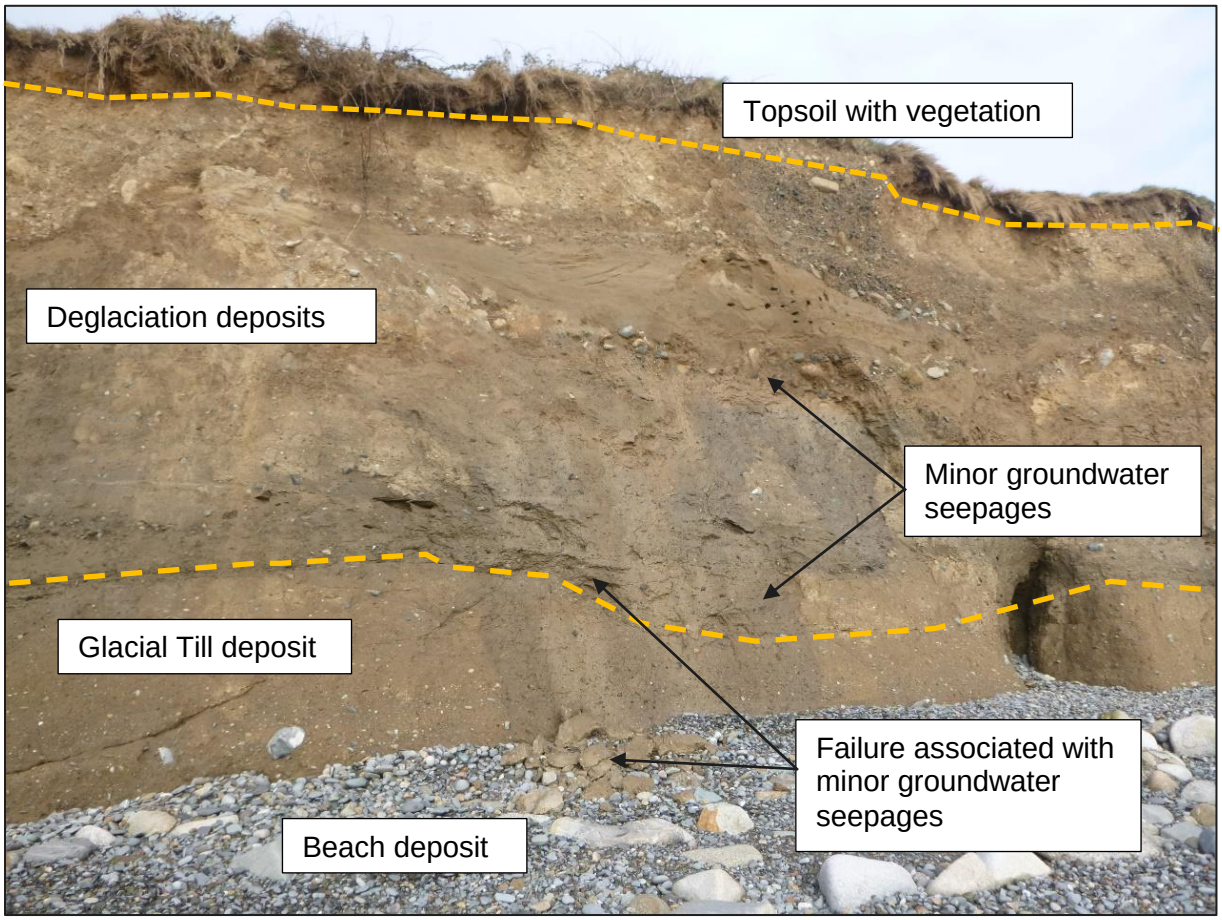
3.2 Groundwater

Minor groundwater seepages out of the cliff face were observed in the unconsolidated material, either where coarser sand and gravel units occurred or at the contact with an underlying less permeable unit where present (typically silts and clays).

The groundwater was observed as either minor seepages and / or slightly damper areas across the cliff face. Many of the minor slumps and failures in the cliff face were observed to coincided with these minor seepages and it is inferred that a combination of groundwater pore pressure, stress relief and wash-out or erosion of fines at the cliff face is giving rise to the slumping observed across the surveyed cliff face, see Photo 3-1 below.

While storm wave action at the base of the cliff is the predominant driver of erosion and instability at the base of the cliffs the minor groundwater seepages daylighting in the cliff face are also likely to contribute to softening / weakening of the soil exposures and to a reduction in their strength over time. This ultimately leads to localised failure and instability in the cliff face above the beach / toe of the cliff.

Photo 3-1
Typical Quaternary Units and Stratigraphy along Shanganagh Cliff Study Area



3.3 Baseline Cliff Survey

The record of the cliff survey is detailed for 10 survey points along the Shanganagh Cliffs in the survey area, see below and Figure 1.

3.4 Survey Point 1

Location:	Survey Point 1
Chainage:	50m
Description:	Cliff face erosion with overhanging vegetation carpet and evidence of recent slumping of material onto beach deposits

Photo 3-2 SP1 - Cliff with overhanging vegetation carpet

Photo 3-3 SP1 - Minor material erosion slump from the base of the unconsolidated unit

3.5 Survey Point 2

Location:	Survey Point 2
Chainage:	100m
Description:	Near vertical cliff face with minor debris slumped at base from erosion of cliff face.

Photo 3-4 SP2 - Near vertical cliff face with slumped debris at base

Photo 3-5 SP2 - Sand unit with nesting Martins and with slumped debris at base

3.6 Survey Point 3

Location:	Survey Point 3
Chainage:	180m
Description:	Cliff face erosion with overhanging vegetation carpet and significant slump of material onto beach including topsoil and vegetation from top of cliff. Material slumped from a relatively 'sandy' unit / section of cliff face.

Photo 3-6 SP3 - Significant cliff erosion

Photo 3-7 SP3 - Slumped material on beach, including topsoil with vegetation.

3.7 Survey Point 4

Location:	Survey Point 4
Chainage:	230m
Description:	Minor cliff face erosion with small overhanging vegetation carpet. Large boulders at back of beach provide are likely to provides a degree of protection against erosion by dissipating wave energy and armouring the back of the beach against erosion.

Photo 3-8 SP4 - Near vertical cliff face with boulders present at back of beach

Photo 3-9 SP4 - Minor erosion and slumping at the base of the cliff.

3.8 Survey Point 5

Location:	Survey Point 5
Chainage:	320m
Description:	Basal material beneath beach is consolidated till layer. Wave action erosion at base of cliff is in the overlying unconsolidated material with dominant erosion from a NE wave / storm direction. Overhanging vegetation carpet indicates recent erosion.

Photo 3-10 SP 5 - Consolidated Till at base of beach

Photo 3-11 SP5 - Slumping of unconsolidated sand material onto beach

3.9 Survey Point 6

Location:	Survey Point 6
Chainage:	400m
Description:	Cliff face almost vertical with minor slumping of material to base of cliff where it is washed away during storm events

Photo 3-12 SP6 - Consolidated till beneath beach with cliff face

Photo 3-13 SP6 – Unconsolidated material in cliff face with minor slumping to base of cliff

3.10 Survey Point 7

Location:	Survey Point 7 - Proposed Cable Location
Chainage:	420m
Description:	Near vertical cliff face. Minor erosion with some limited slumping of sand material to beach. Small sections of overhanging vegetation carpet at top if cliff indicates some erosion, see Photo **3-14** below.

Photo 3-14 Vertical cliff with minor slumping from face

Photo 3-15 SP7 - Section of cliff face failure in sand and gravel material with slumping

3.11 Survey Point 8

Location:	Survey Point 8 – Shanganagh WWTP Outfall
Chainage:	440m to 480m
Description:	Protection measures at outfall from Shanganagh WWTP with erosion of cliff face at both southern and northern ends of the outfall protection

Photo 3-16 SP8 - Cliff erosion at southern end of WWTP outfall

Photo 3-17 SP8 - Cliff erosion at northern end of WWTP outfall

3.12 Survey Point 9

Location:	Survey Point 9
Chainage:	500m
Description:	Major slump in cliff face with significant c. 2m of overhanging vegetation carpet and evidence of recent slumping of material onto beach deposits.

Photo 3-18 SP 9 - Vertical Cliff section to north of WWTP outfall

Photo 3-19 SP9 - Major slump onto beach with vegetation carpet overhanging by c. 2m

3.13 Survey Point 10

Location:	Survey Point 10
Chainage:	500m to 660m
Description:	The northern most section of cliff face is significantly lower than further south along the survey area, at only c. 5m in height. At c. 560m to 580m there is small section of C&D material in cliff face.

Photo 3-20 SP10 - Northern lower section of cliff face

Photo 3-21 SP10 - C&D Material ‘made ground’ in cliff face

4.0 References

Caloca-Casado, S., August 2018, Coastal vulnerability assessment of Co. Dublin and Co. Wicklow to impacts of sea-level rise.

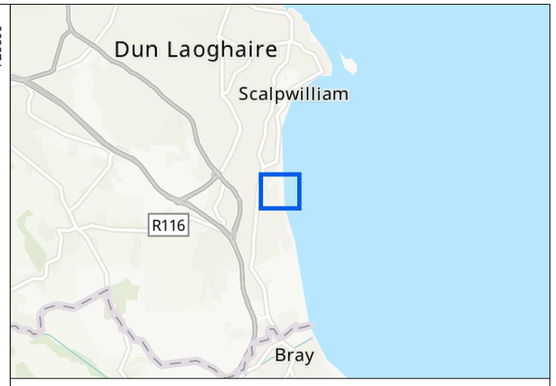
Irish Rail and Jacobs, December 2024. East Coast Railway Infrastructure Protection Projects (ECRIPP) Emerging Preferred Scheme for CCA2/3 Dalkey Tunnel to Shanganagh Bray Wastewater Treatment Plant. Public Consultation. Accessed December 2024 https://www.irishrail.ie/en-ie/about-us/iarnrod-eireann-projects-and-investments/ecripp

RPS, June 2010, for Office of Public Works (OPW), Irish Coastal Protection Strategy Study Phase 2 - South East Coast, Work Packages 2, 3 & 4A, Final Technical Report.

RPS, June 2010, for Office of Public Works (OPW), Irish Coastal Protection Strategy Study Phase 2 - South East Coast, Work Packages 2, 3 & 4A - Appendix 8 - Erosion Mapping.

FIGURES

Figure 1
Shanganagh Cliff Survey Area and Survey Point Locations



- Application Site Boundary
- Temporary Construction Compound (TCC)
- Location Marker
- Cliffs Survey Area
- Corbawn Cliff Protection Works

DRAWING STATUS

PUBLIC

DISCLAIMER

MAP NOTES / DATA SOURCES:

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PROJECT TITLE

Dublin Array

DRAWING TITLE

Shanganagh Cliff Walkover

DRAWING NUMBER: **Figure 1**

PAGE NUMBER: **1 of 1**

VER	DATE	REMARKS	DRAW	CHEK	APRD
01	2025-02-10	DRAFT	JK	AB	AE
02	2025-02-10	PUBLIC	JK	MF	CF

0 25 50 75 100 Metres

0 25 50 75 100 Yards

N GRID NORTH

SCALE 1:3,500 PLOT SIZE A3

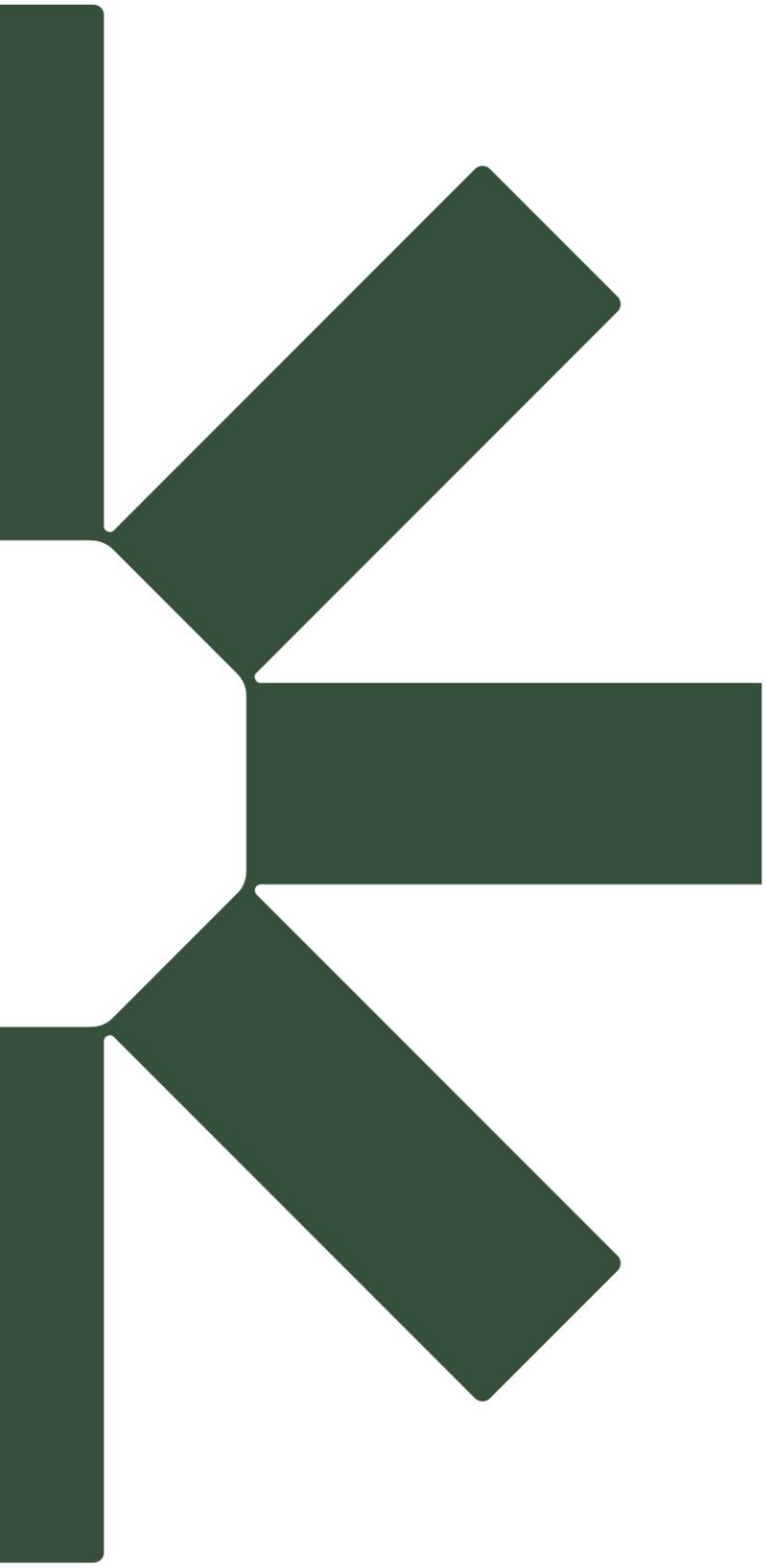
DATUM IRENET95 VERTICAL REF ODN/LAT/MLLW

PRJ IRENET95 Irish Transverse Mercator

SLR

Dublin Array Generation for generations

Kish Offshore Wind Limited - Bray Offshore Wind Limited



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Registered office:
Unit 5,
Desart House,
Lower New Street,
Kilkenny
www.RWE.com