Environmental Impact Assessment Report - Volume 2B

Chapter 7
Marine Processes

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

A TETRA TECH COMPANY

PARKWIND
JERA GROUP

Energy for generations

ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report
Chapter 7: Marine Processes

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7.1 Introduction

This chapter of the EIAR assesses the potential impacts of the Oriel Wind Farm Project (hereafter referred to as “the Project”) on marine processes and water quality. Specifically, this chapter considers the potential impact of the Project below the High Water Mark (HWM) during the construction, operational and maintenance, and decommissioning phases.

Marine processes (i.e. currents, waves, and sediment transport) are not receptors in themselves; however, they are potential pathways for impacts on other receptors. As such, the assessment presented is used to inform the following technical chapters:

- Chapter 8: Benthic Subtidal and Intertidal Ecology;
- Chapter 9: Fish and Shellfish Ecology;
- Chapter 10: Marine Mammals and Megafauna; and
- Chapter 16: Infrastructure, Marine Recreation and Other Users.

This chapter considers changes to suspended sediment concentrations and associated physical changes such as settlement. Impacts from changes to water and sediment quality are discussed in the chapters listed in the bullet points above.

This chapter summarises information contained within a technical report, which is included in appendix 7-1: Marine Processes Technical Report.

A Water Framework Directive Assessment, which supports the assessment on marine water quality is provided in appendix 7-2: Water Framework Directive.

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

7.2 Purpose of this chapter

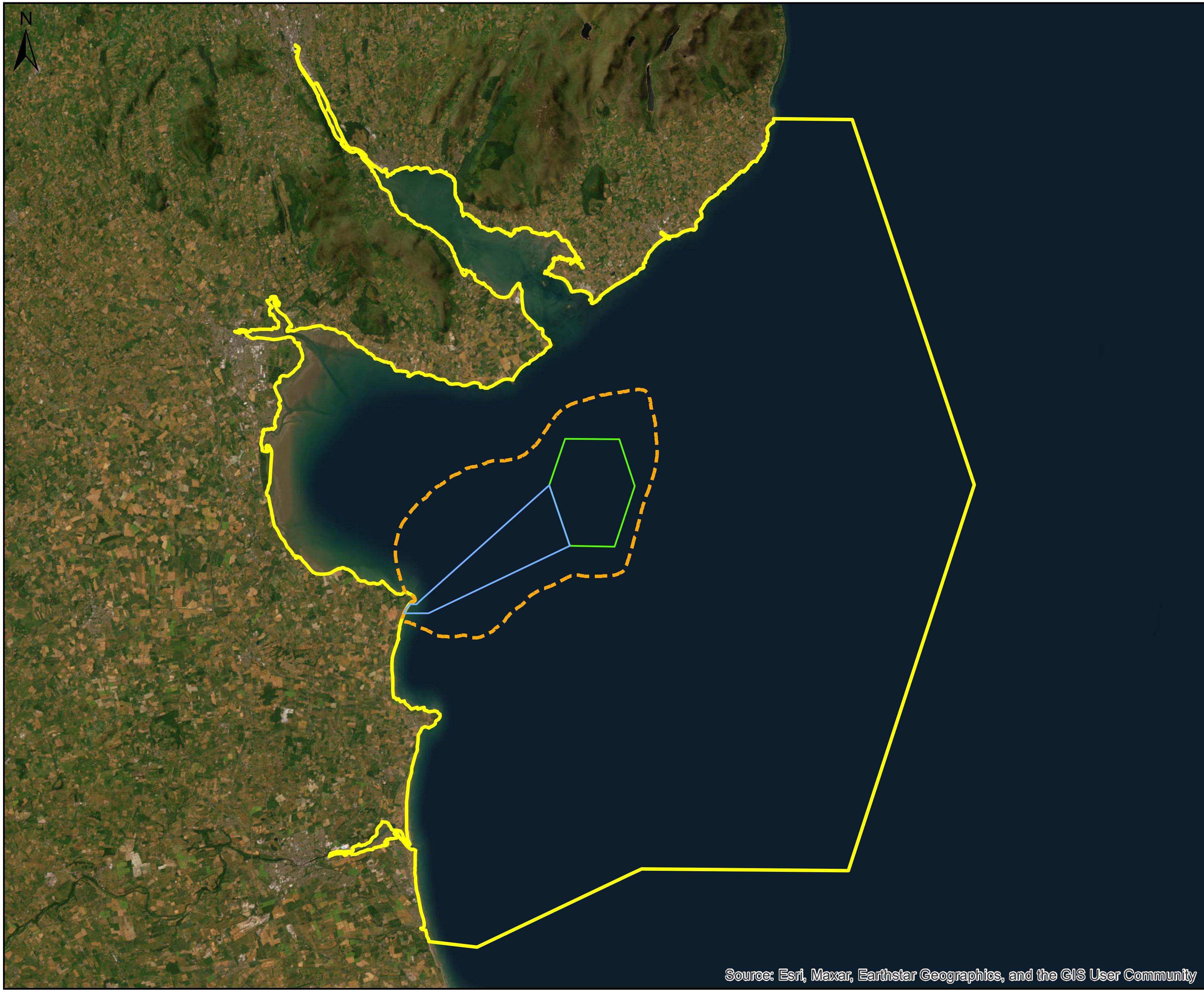
The primary purpose of the EIAR chapter is to provide an assessment of the likely direct and indirect significant effects of the Project on marine processes. In particular, this EIAR chapter:

- Presents the existing environmental baseline established from desk studies (section 7.8);
- Identifies any assumptions and limitations encountered in compiling the environmental information (section 7.8.3);
- Presents an assessment of the potential likely significant effects on marine processes arising from the Project, based on the information gathered and the analysis and assessments undertaken (section 7.10). An assessment of potential cumulative impacts is provided in section 7.11 and an assessment of transboundary effects is outlined in section 7.12; and
- Highlights any necessary monitoring (section 7.10.7) and/or measures (see section 7.10.5 and 7.10.6) which could prevent, minimise, reduce or offset the possible environmental effects identified in the assessment.

7.3 Study area

Numerical modelling techniques were used to describe tide, wave, and sediment transport regime. Section 7.8 outlines the physical conditions associated with the Marine Processes Study Area as shown in Figure 7-1. In this figure the Marine Processes Study Area (i.e. a 20 km buffer relative to the offshore wind farm area) is illustrated by the solid yellow line. For reference, the extent of one spring tidal excursion (i.e. maximum tidal excursion of 3.5 km based on typical tidal conditions) is illustrated by the dashed line in Figure 7-1. An additional buffer beyond the tidal excursion was selected to examine the potential for overlap with the Project.

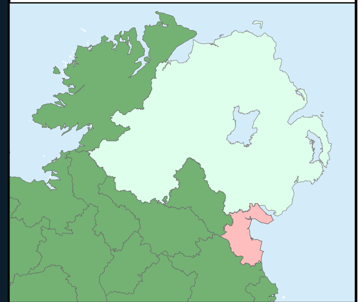
The tidal excursion was quantified by utilising the calibrated numerical model described in appendix 7-1: Marine Processes Technical Report. Specifically, neutrally buoyant particles were released across the extent of the offshore wind farm area and offshore cable corridor. The excursion of these particles was examined over the course of a typical spring tide cycle and represents the maximum extent of possible effects based on typical tidal conditions. The offshore wind farm area and offshore cable corridor are illustrated in Figure 7-1.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Typical Tidal Excursion Zone
- Marine Processes Study Area

Data Sources: OWL, OSi.



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 7-1
Marine Processes Study Area

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Issue Details

Drawn By: NR	**Project No.** MDR1520b
Checked By: CC	**File Ref:**
Approved By: CC	MDR1520bArc3027F02
Scale: 1:315,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 11/03/2024	

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.

7.4 Policy context

Planning policy on renewable energy infrastructure is presented in volume 2A, chapter 2: Policy and Legislation. This section presents planning policy that specifically relates to marine processes which is contained in the Offshore Renewable Energy Development Plan (OREDP) (Department of Communications, Energy and Natural Resources (DCENR), 2014) and the National Marine Planning Framework (NMPF) (Department of Housing, Local Government and Heritage (DHLGH), 2021). The OREDP and NMPF provides guidance on what matters are to be considered in the assessment. These are summarised in Table 7-1 and Table 7-2 below.

The NMPF has also highlighted where planning policies are addressed via other activities operating alongside the NMPF. The Marine Strategy Framework Directive (MSFD) established a framework through which EU Member States are required to develop strategies for achieving or maintaining Good Environmental Status (GES) in the marine environment (DHPLG, 2021). GES descriptors in relation to marine processes are provided in

Table 7-3. The key environmental descriptors in terms of GES relevant to water quality are listed as the minimisation of human-induced eutrophication (GES Descriptor 5) and concentrations of contaminants at levels not giving rise to pollution effects (GES Descriptor 8). Water Quality Policy 1 of the NMPF is particularly relevant to the Project and states that: “Proposals that may have significant adverse impacts upon water quality, including upon habitats and species beneficial to water quality, must demonstrate that they will, in order of preference and in accordance with legal requirements; avoid, minimise, or mitigate significant adverse impacts”. The NMPF requires that proposals should be compliant with and contribute to the aims and objectives of the WFD, and associated River Basin Management Plans, and also ensuring the achievement of the objectives of the MSFD, i.e. GES particularly in the context of GES Descriptor 5, eutrophication and GES Descriptor 7, contaminants.

The assessment of the status of the marine environment and the determination of the characteristics of GES, including threshold values and environmental targets, inform decisions about how to use marine resources sustainably.

In February 2023, the ‘OREDP II - National Spatial Strategy (DECC, 2023) for the transition to the Enduring Regime’ was published in draft and subject to consultation. The draft OREDP II does not define specific provisions similar to OREDP I. The key objectives of OREDP II are:

- *“Assess the resource potential for ORE in Ireland’s maritime area;*
- *Provide an evidence base to facilitate the future identification of Broad Areas of Interest most suitable for the sustainable deployment of ORE in Ireland’s maritime area; and*
- *Identify critical gaps in marine data or knowledge and recommend prioritised actions to close these gaps.”*

The OREDP II will provide an evidence base to facilitate the future identification of Broad Areas of Interest most suitable for the sustainable deployment of ORE in Ireland’s maritime area, to be assessed in greater detail at regional scale. This assessment will subsequently inform the identification of more refined areas as part of the designation process for Designated Maritime Area Plans (DMAP). When published, the OREDP II will update the original OREDP published in 2014.

Table 7-1: Summary of OREDP provisions relevant to marine processes and water quality.

Summary of OREDP – suggested project-level mitigation measures	How and where considered in the EIAR
Geology, geomorphology and hydrography	
Changes in hydrodynamic/coastal processes and seabed morphology - Suggested Project Level Mitigation Measures:	The data used to inform this chapter, including site-specific surveys, are presented in section 7.6. Numerical modelling has been carried out to describe tide, wave, and sediment transport regimes, as presented in appendix 7-1: Marine Processes

Summary of OREDP – suggested project-level mitigation measures	How and where considered in the EIAR
• Site-specific geophysical and geotechnical surveys to establish a baseline and inform the impact assessment for individual developments; • Modelling of hydrodynamics and sediment transport; and • Avoidance of placement of devices in areas where sediment transport pathways and coastal processes are modelled as highly sensitive to change.	Technical Report. Assessment of effects on marine processes is presented in section 7.10. The Project is not located in an area where sediment transport pathways and coastal processes are modelled as highly sensitive to change (as outlined in appendix 7-1: Marine Processes Technical Report).
Water	
Protect, maintain, and improve status of classified water bodies within the OREDP II area in line with requirements of the WFD and MSFD. recommended that the OREDP II limit areas of interest for bottom-fixed wind technology to 150 m beyond the seaward limit of classified coastal water bodies (to help minimise potential influence of turbine wakes) or to >20m water depth, whichever is the greater	A Water Framework Directive Assessment, which supports the assessment on marine water quality is provided in appendix 7-2: Water Framework Directive.
Avoid pollution of the coastal and marine environment - Suggested Project Level Mitigation Measures: • Complete hazardous operations during appropriate weather/tide conditions; • Design devices to minimise risk of leakage of pollutants; • Use low toxicity and biodegradable materials; • Use minimum quantities; • Design for minimum maintenance; • Project-specific risk assessment and contingency planning; • Avoid shipping routes where collision risk is high; • Shipboard Oil Pollution Emergency Planning (SOPEP); • Avoid placement within 500 m of areas of known sediment contamination; and • Survey to identify potential sources of seabed contamination.	There are number of measures included in the Project that are proposed that will ensure that pollution of the coastal and marine environment is avoided. These are outlined in section 7.11.

Table 7-2: Summary of NMPF provisions relevant to marine processes and water quality.

Summary of NMPF provision	How and where considered in the EIAR
Sea-floor Integrity	
The following policies seek to contribute to MSFD GES descriptor (6) “Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected”. Proposals which incorporate measures to support the resilience of deep sea habitats will be supported. Proposals which may have significant adverse impacts on deep sea habitats must demonstrate that they will avoid, minimise, or mitigate significant adverse impacts on deep sea habitats.	Predicted changes to the seabed are assessed in section 7.10. The effects on marine ecosystems are considered in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology and chapter 10: Marine Mammals and Megafauna. The Project is not located in deep sea (more than 200 m) and will not therefore result in adverse effects on deep sea habitats.
Water Quality	
The following policies seek to contribute to MSFD Good Environmental Status (GES) descriptors: (5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	Site specific sediment sampling for contaminants will be carried out at the detailed design phase for the Project. Although site specific sediment contamination levels are unknown at this time, it is considered unlikely that transition elements, organo-metals, hydrocarbons, PAH compounds and synthetic

Summary of NMPF provision	How and where considered in the EIAR
(8) Concentrations of contaminants are at levels not giving rise to pollution effects.	compounds will be present in any greater concentrations than trace amounts. Measures as outlined in 7.8.2 will ensure there will be no contamination that will give rise to significant pollution effects from the construction, operation and decommissioning of the Project

Table 7-3: Summary of other policies relevant to marine processes and water quality.

Summary of policy	How and where considered in the EIAR
Marine Strategy Framework Directive	
Descriptor 5: Eutrophication: Ireland has achieved Good Environmental Status (GES) for eutrophication and is classed under three criteria; nutrients chlorophyll and dissolved oxygen. There are updated targets to maintain Ireland's GES status such as Environmental target; D5T1, D5T2 and D5T5	Predicted changes to nutrient condition are assessed in Eutrophication is assessed in section 7.11.
Descriptor 6: Sea-floor integrity: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	Predicted changes to the seabed are assessed in section 7.10. The effects on marine ecosystems including benthic ecosystems are considered in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology and chapter 10: Marine Mammals and Megafauna.
Descriptor 7: Hydrographical conditions: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	Predicted changes to hydrographic conditions are assessed in section 7.10. The effects on marine ecosystems are considered in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology and chapter 10: Marine Mammals and Megafauna.
Descriptor 8: Contamination: In Ireland, the status of the marine environment is assessed under primary and secondary criteria such as contaminant concentration, acute pollution events and biological effects respectively. Ireland's GES status is aligned with the following environmental targets; D8T1a, D8T1b, D8T2 and D8T3.	Predicted changes to contaminant status are assessed in section 7.11. The effects on marine ecosystems are considered in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology and chapter 10: Marine Mammals and Megafauna.

7.5 Consultation

A summary of the key issues raised during consultation specific to marine processes is outlined in Table 7-4 below, together with how these issues have been considered in the preparation of this EIAR chapter. Consultation responses in relation to the potential impacts on specific environmental receptors arising from the effects of changes to marine processes are presented in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology, chapter 15: Marine Archaeology and chapter 16: Infrastructure and Other Users. No issues were raised during consultation on marine water quality.

Volume 2A 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 7-4: Summary of key consultation issues raised during consultation on marine process.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
February 2023	Geological Survey Ireland (GSI) (Letter)	The Dunany Point County Geological Site (CGS) should not be damaged, or integrity impacted or reduced in any manner due to the project. The cliffs at Dunany Point are prone to slumping and consequently excavation, construction and burial of the proposed transition joint bay chamber may cause this to increase and result in excessive damage and increased erosion of that portion of the CGS. This should certainly be assessed as part of the EIAR and impacts on the site.	Potential impacts on the cliff at the Dunany Point CGS are addressed in volume 2C chapter 21: Soils, Geology and Hydrogeology. The chapter outlines the impact assessment for the CGS (section 21.10) and suitable mitigation in relation to management of the CGS (section 21.10.8). Impacts on Dunany Point CGS during the construction of the offshore cable in the intertidal area (i.e. below the HWM) are scoped out of this assessment (see Table 7-15).
2023	Public consultation	Concerns over impacts on marine water quality?	Potential impacts on water quality in the marine environment from pollution are assessed in section 7.10.5
2023	Isle of Man – Department of Infrastructure; Transboundary scoping consultation	Will the wind farm have the potential to disrupt hydrological patterns and sediment transport?	This is assessed in sections 7.10.2 and 7.10.4.

7.6 Methodology to inform the baseline

7.6.1 Desktop study

Marine Processes

To determine the detailed baseline conditions for the Marine Processes Study Area a comprehensive numerical modelling study was undertaken. The modelling was undertaken using the MIKE suite of software developed by the Danish Hydraulic Institute (DHI). This is an industry standard approved for use by government bodies including the Environmental Protection Agency (EPA). The models were constructed using a number of datasets including those shown in Table 7-5.

The key sources (i.e. data and reports) used to inform the baseline characterisation of the Marine Processes Study Area are summarised in Table 7-5 below.

Table 7-5: Summary of data sources.

Sources	Study	Data type	Format
UK Hydrographic Office	Admiralty	Tidal statistics and harmonics	Tide tables

Sources	Study	Data type	Format
Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR)	Seabed Mapping Programme	Bathymetry / Light Detection and Ranging (LiDAR)	Digital source
Office of Public Works (OPW)	Irish Coastal Protection Strategy Study	Bathymetry / LiDAR	Digital source
	Catchment Flood Risk Assessment Management Studies	Bathymetry / LiDAR	Digital source
	Wave, tide, and surge forecast trial for Dundalk	Bathymetry, water level, wave, and current data	Digital source
	Port Oriel and Giles Quay gauge data	Water level data	Digital source
Marine Environmental Data and Information Network (MEDIN)	Seabed Mapping Programme	Bathymetry / LiDAR	Digital source
C-MAP	Digital Charts	Bathymetry	Digital source
RPS	Irish Sea Surge model	Water level and current speed boundary data	Digital source
British Oceanographic Data Centre (BODC)	UK Moored Current Meter Dataset	Current speed	Digital source
European Centre for Medium-Range Weather Forecasts (ECMWF)	ERA-40	Wave data	Digital source
	ERA5	Wind data	Digital source
Marine Institute	M2 buoy	Wave and wind data	Digital source
Gavin and Doherty Geosolutions (2018)	Oriel Wind Farm Project Site Data Review	Sedimentology Information: including GSI assessment of Foreshore Licence Area analysis	PDF Document
Gavin Doherty Geosolutions (2020)	Oriel Ground Model Update and Cable Route Interpretation	Sedimentology Information: geophysical data, geotechnical data, grab samples and boreholes collected for the Project.	PDF Document
PARTRAC (2020)	Oriel Wind Farm – Floating LiDAR Buoy 12 Month Measurement Campaign Data Report	Wave, current and wind data	Digital source and PDF Document
European Marine Observation and Data Network (EMODnet)	Sedimentology	Seabed classification	PDF Spatial data

The resulting models were calibrated against field data obtained from BODC and the OPW and validated against PARTRAC data collected specifically for this project. Numerical modelling techniques were used to describe tide, wave and sediment transport regimes and provide baseline information to inform the assessment. Details of model development are provided in appendix 7-1: Marine Processes Technical Report.

In addition to the modelling, information on marine processes within the Marine Processes Study Area was collected through a detailed desktop review of existing studies and datasets. These studies are summarised in Table 7-6 below.

Table 7-6: Summary of key desktop reports.

Title	Source	Year	Author
General			
Offshore Wind Farm, Environmental Impact Statement, Main EIS, Volume 2 of 3, Section 5: Physical Environment	Oriel Windfarm Limited	2007	Aquafact International Services Limited
Atlas of UK Marine Renewable Energy Resources: Atlas Pages. A Strategic Environmental Assessment Report	http://www.renewables-atlas.info/	2008	ABPmer *et al*.
Potential Effects of Offshore Wind Developments on Coastal Processes	Report by ABP Marine Environmental Research Ltd (ABPmer). Pp 127, Crown	2002	Beiboer and Cooper
Oriel Wind Farm – Floating LiDAR Buoy 12 Month Measurement Campaign Data Report	Oriel Windfarm Limited	2020	PARTRAC
Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDP) II in the Republic of Ireland	Department of Communications, Energy and Natural Resources	2022	SEAI *et al*.
Sedimentology			
A Further Review of Sediment Monitoring Data	Commissioned by COWRIE Ltd (project reference ScourSed-09)	2010	ABPmer Ltd *et al*.
Oriel Wind Farm Project Site Data Review	Oriel Windfarm Limited	2018	Gavin Doherty Geosolutions
Oriel Ground Model Update and Cable Route Interpretation	Oriel Windfarm Limited	2020	Gavin Doherty Geosolutions
Stratigraphic model of the Quaternary sediments of the Western Irish Sea Mud Belt from core, geotechnical and acoustic data	Geo-Marine Letters	2019	Coughlan *et al.*
Suspended Sediment Climatologies around the UK	Centre for Environment, Fisheries and Aquaculture Science (Cefas)	2016	Cefas
Cabling			
Subsea Cable Interactions with the Marine Environment	Renewables Grid Initiative	2015	NIRAS
Review of Cabling Techniques and Environmental Effects applicable to the Offshore Windfarm Industry	Technical Report, Department for Business Enterprise and Regulatory Reform (BERR), in association with Defra, 164pp. United Kingdom	2008	BERR
Scour			
Dynamics of Scour Pits and Scour Protection	Research Advisory Group	2008	Department of Energy and Climate Change
Scour Potential Evaluation of the Western Irish Sea Mud Belt	Geological Survey Ireland	2018	Geological Survey Ireland
Seabed scour assessment for offshore wind farm	3rd International Conference on Scour and Erosion, Gouda, The Netherlands	2006	Whitehouse, R.J.S., Sutherland, J. and O'Brian D.

Water quality

The key sources (i.e. data and reports) used to inform the baseline characterisation of the marine water quality within the Marine Processes Study Area are summarised in Table 7-7 below.

Table 7-7: Water Quality information sources.

Source	Data	Information consulted/provided
EPA	WFD data tables https://wfd.edenireland.ie/data (accessed January 2024)	Water body status, objectives, hydro-morphology, protected areas, sensitive habitats
	Water body data pages on Eden WFD application https://wfd.edenireland.ie/ (accessed January 2024)	Water body classification, overall status, ecological status, biological elements, physico-chemical elements, hydro-morphology, and chemical classification
		WFD objectives for water bodies
		WFD Cycle 3 Report – Newry, Fane Glyde and Dee Catchment (HA 06) WFD Cycle 2 Report - Newry, Fane, Glyde and Dee Sub-catchment Report (Burren_SC_10 Code 06_14)
	Interactive maps https://gis.epa.ie/EDENMaps/WFD (accessed January 2024)	Maps of water bodies, habitats, and protected areas.
Department of Housing, Planning and Local Government	Marine Strategy Framework Directive 2008/56/EC Article 17 update to Ireland's Marine Strategy Part 1: Assessment (Article 8), Determination of Good Environmental Status (Article 9) and Environmental Targets (Article 10)	A comprehensive set of environmental targets and associated indicators has been developed resulting in 25 revised environmental targets as outlined in Ireland's Article 17 update. These revised targets now align more closely with the requirements of the Birds and Habitats Directives, the Water Framework Directive, the Common Fisheries Policy. These are being used to demonstrate that GES has been achieved or is being maintained in accordance with the objectives of the MSFD.

7.6.2 Site-specific surveys

In order to inform the EIAR, site-specific surveys were undertaken. A summary of the surveys undertaken to inform the marine processes impact assessment is outlined in Table 7-8. These surveys were augmented with existing surveys from various sources which are summarised in Table 7-9. These included a range of bathymetric datasets from the INFOMAR project which are shown in Figure 7-2. These datasets for the offshore wind farm area were augmented with other bathymetric datasets to provide the coverage shown in Figure 7-3.

Table 7-8: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Oriel Site Investigation	Offshore wind farm area including offshore cable corridor	Geophysical survey, geotechnical survey	Alpha Marine	2019 to 2020	Oriel Ground Model Update and Cable Route Interpretation, Gavin Doherty Geosolutions (2020).
Oriel metocean survey	Located within offshore wind farm area	Floating LiDAR Buoy 12 Month Measurement Campaign: wind, wave and current data	PARTRAC	2019 to 2020	Oriel Wind Farm – Floating LiDAR Buoy 12 Month Measurement Campaign Data Report, PARTRAC (2020).

Table 7-9: Summary of existing survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Oriel Site Investigation	Offshore wind farm area	Part of Irish National Seabed Survey, Bathymetry, profiling and sampling	GSI	2004 to 2006	Oriel Wind Farm Project Site Data Review, Gavin Doherty Geosolutions (2018).
INIS Hydro	Dundalk Bay	Multi-beam echosounder, magnetometer and shallow seismic (pinger) data.	INFOMAR	2011 to 2013	Oriel Wind Farm Project Site Data Review, Gavin Doherty Geosolutions (2018).
INFOMAR project	Irish Coastline	Bathymetry, profiling and sampling	INFOMAR	2004 to 2016	Information https://www.infomar.ie/data Download https://jetstream.gsi.ie/iwdds/map.jsp
OPW Wave, tide, and surge forecast trial for Dundalk	Dundalk Bay	Bathymetry and wave monitoring	Hydrographic Surveys Ltd	2016	OPW, Coastal Section, Stephen's Green, Dublin

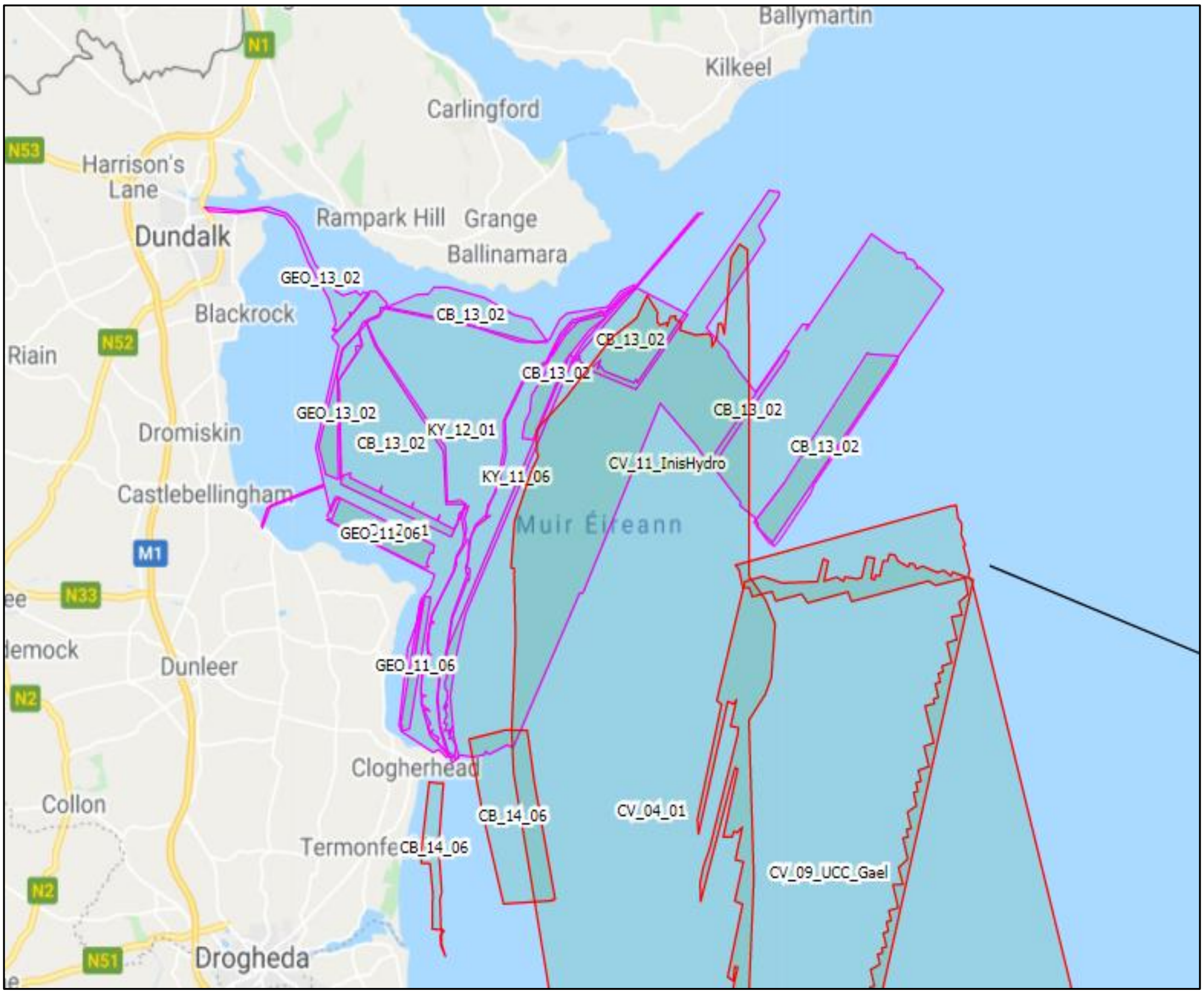


Figure 7-2: Available INFOMAR bathymetric survey data (references relate to the different surveys undertaken in the area).

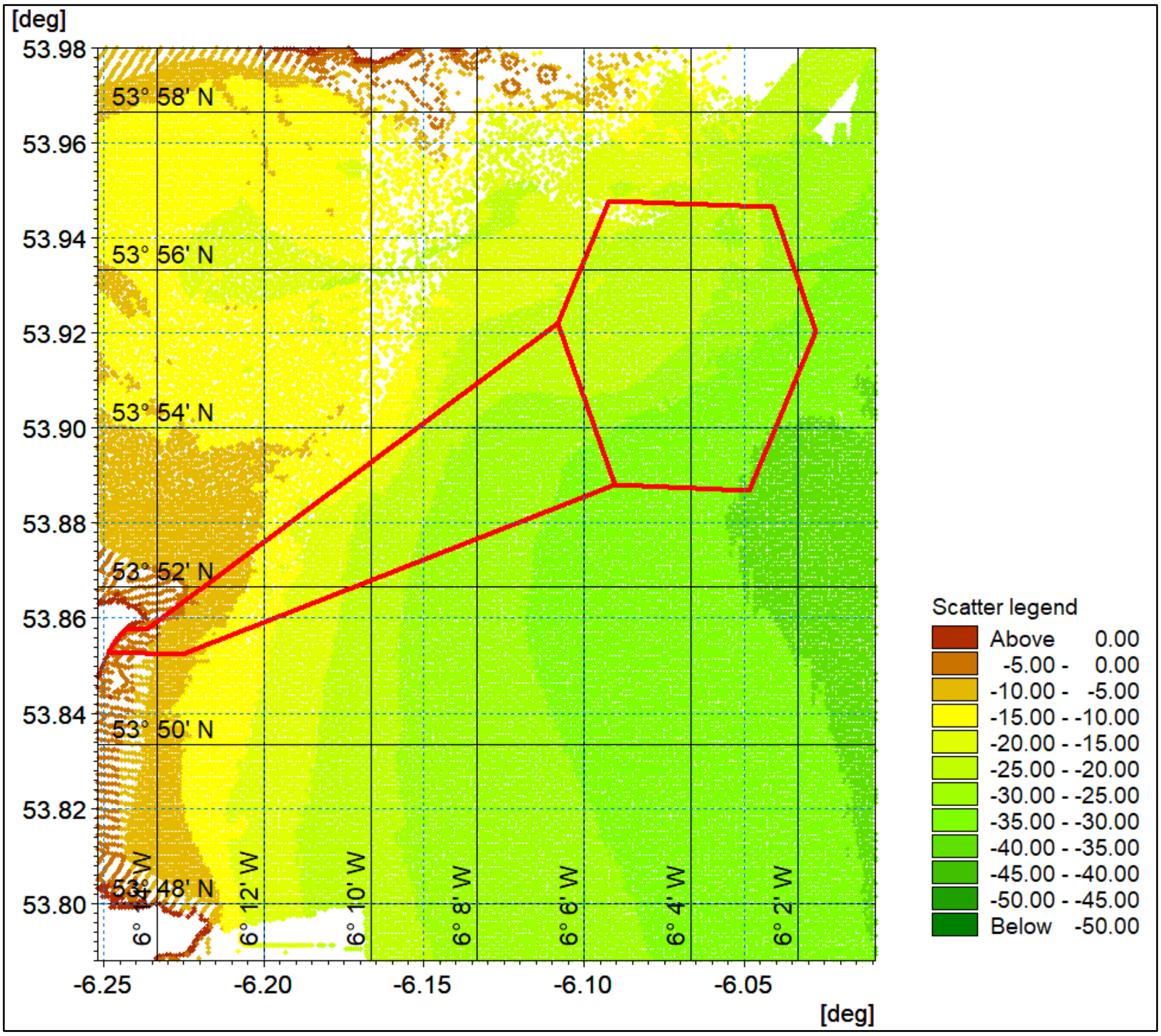


Figure 7-3: Augmented bathymetry data.

7.6.3 Identification of designated sites

All designated sites within the Marine Processes Study Area and qualifying features that could be affected by the construction, operation, and maintenance, and decommissioning of the Project were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the Marine Processes Study Area were identified using a number of sources. These included the National Parks and Wildlife Service website (NPWS, 2022) and the Marine Protection Atlas (Marine Protection Atlas, 2022);
- Step 2: Information was compiled on the relevant geomorphological/coastal features for each of these sites; and
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:

- A designated site with geomorphological/coastal features directly overlaps with the offshore wind farm area or offshore cable corridor and therefore has the potential to be directly affected by the Project; or
- A designated site and associated features are located within the Marine Processes Study Area for impacts associated with the Project and therefore have the potential to be indirectly affected by the Project.

7.7 Baseline environment

A summary of the marine processes baseline environment is provided below. Full details of the analysis undertaken to develop the marine processes baseline is provided in appendix 7-1: Marine Processes Technical Report. This includes information of model development, resolution, calibration, and the modelling techniques implemented during the course of the study.

7.7.1 Marine processes

Bathymetry

Seabed levels across the offshore wind farm area range between 15 m Chart Datum (CD) in the northwest deepening to 33 m CD in the southeast as illustrated in Figure 7-4.

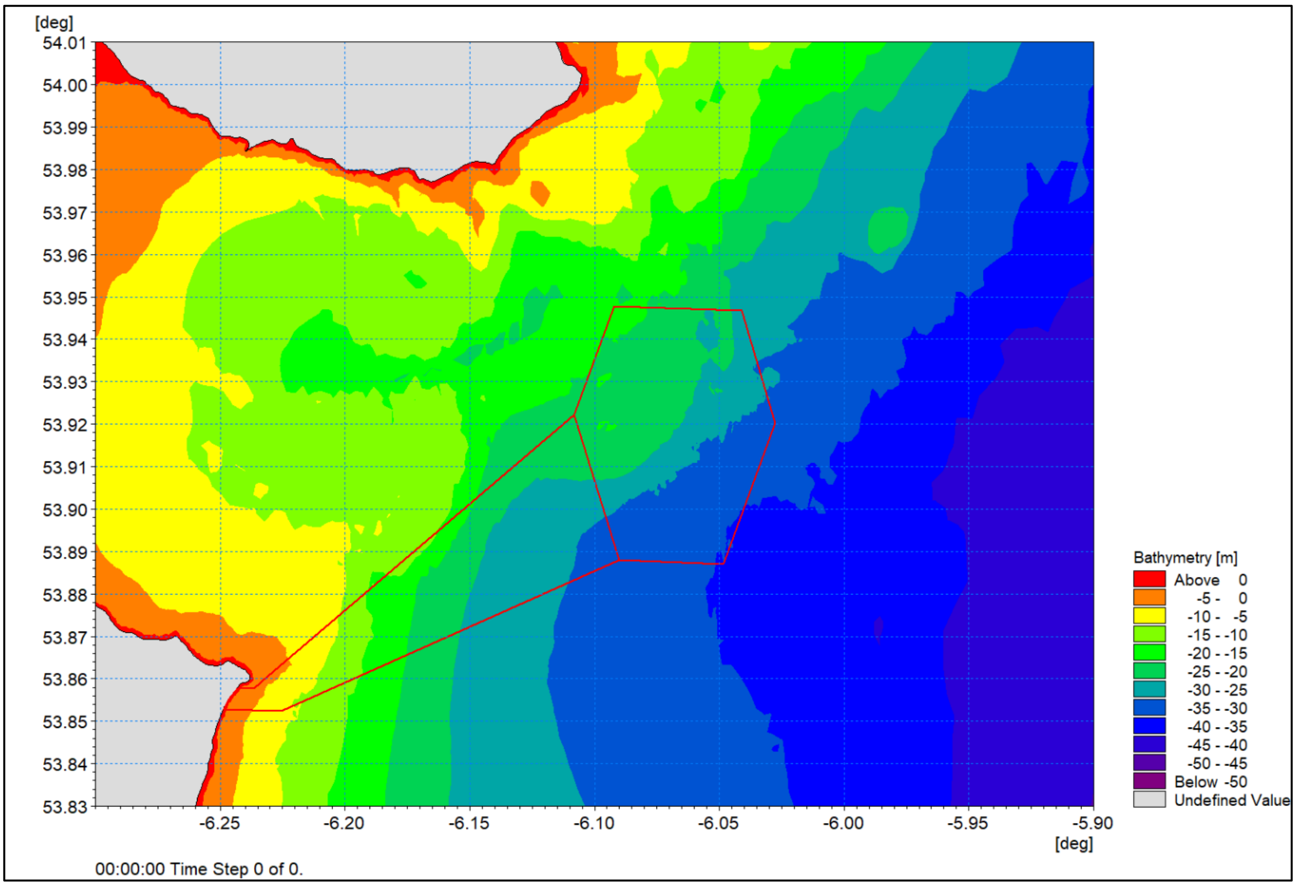


Figure 7-4: Bathymetry vicinity of offshore wind farm area.

Tidal flow

The Marine Processes Study Area has an average tidal range of 3.5 m as recorded by the OPW gauge at Giles Quay. This is within approximately 10 km of the offshore wind farm area which is characterised by relatively weak tidal currents with water depths ranging between approximately 15 m and 33 m.

Across the offshore wind farm area the tidal current floods to the northwest and ebbs to the southeast. The flows are relatively weak, with tidal current speeds typically less than 0.2 m/s, with ebb and flood currents being of a similar magnitude. This was confirmed by the floating LiDAR data, collected specifically for the Project, which showed current speeds were below 0.2 m/s for 80% of the 12-month monitoring period giving rise to stable seabed sediment. Within the offshore cable corridor, tidal currents remain largely consistent with the offshore wind farm area. In the nearshore area between Dunany Point and Clogher Head the tidal currents are decreased within the embayment whilst there is increased current speeds where tidal flows are accelerated around Dunany Point.

Waves

The Marine Processes Study Area is sheltered from northerly winds and the associated waves however larger waves may reach the offshore wind farm area from the south due to a greater fetch within the Irish Sea. The modelling study demonstrated that during a one in two-year return period storm, the significant wave height at the offshore wind farm area varies from 2 to 3 m depending on the direction of approach (i.e. larger waves approach from the south). This was confirmed by the floating LiDAR data, collected specifically for the Project. During more arduous 1 in 50-year events, significant wave heights may reach 4 m. As waves propagate towards the shore, wave heights within the offshore cable corridor decrease due to the reduction in water depth and wave breaking. Further detail of the wave climate analysis is provided in appendix 7-1: Marine Processes Technical Report.

Sedimentology

Seabed sediments within the offshore wind farm area range from muddy sand to coarse gravel, with exposed rock outcrops at some locations, as illustrated in Figure 7-5. It has been noted however that there is little evidence of significant sediment transport within this area as the limited tidal current is not sufficient to mobilise and transport coarser sandy material. This is corroborated by the lack of sand wave features in the field data although some sand waves are visible to the south of the offshore wind farm area. The offshore cable corridor seabed sediment is comprised of finer seabed material with some areas of muddy sand.

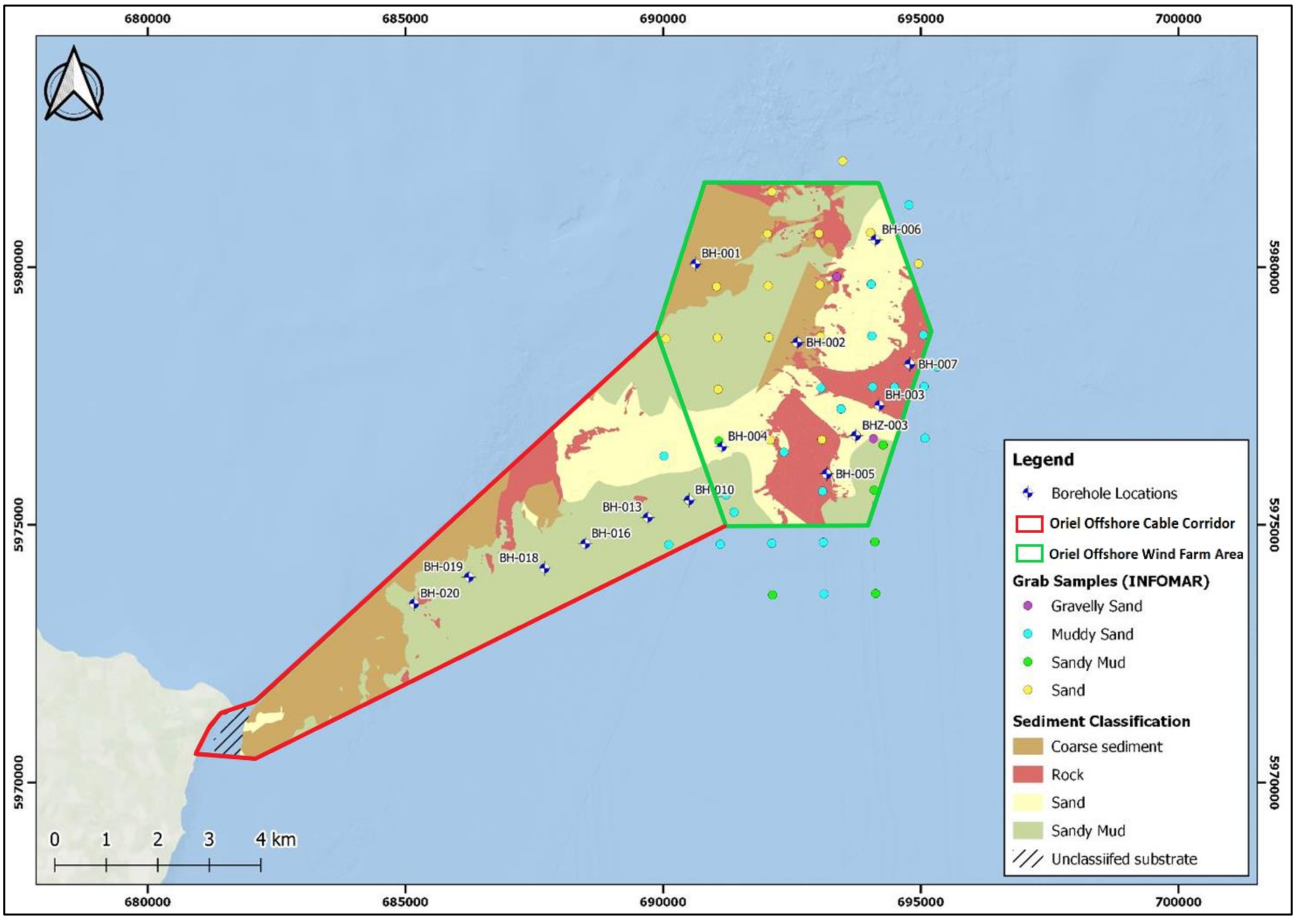


Figure 7-5: INFOMAR Sediment classification with Grab Samples used to ground truth (Source: Gavin and Doherty Geosolutions, 2020).

Shoreline/Nearshore

Dundalk Bay stretches some 16 km from Castletown River and the Cooley Peninsula in the north to Annagassan and Dunany Point in the south. The inner bay is shallow, sandy and intertidal. The hydraulics of the bay are dominated by the sea, but the bay encompasses the mouths and estuaries of the rivers Dee, Glyde, Fane, Castletown (Dundalk), Flurry and Castletown (Cooley). It is characterised by extensive saltmarshes and intertidal sand/mudflats with a beach located at Blackrock, an area which is exposed to waves. The sandy material within the bay means that the harbour navigation channel is prone to siltation and is dredged by the Dundalk Harbour Commissioners with sand waves forming post completion of the dredging campaigns.

Landfall

Marine processes at the landfall exhibit limited longshore transport due to the sheltering effect of Dunany Point to the north and Clogher Head to the south giving rise to lesser residual currents. The landfall location would be exposed to storm events approaching from the southeast. Potential trenching works will not be undertaken during adverse weather conditions when increased sediment transport occurs. In addition, the site experiences a high rate of natural morphological change from mudslides and cliff collapses The Dunany Point proposed Natural Heritage Area (pNHA) along the cliff and beach traverses the offshore cable corridor.

7.7.2 Marine water quality

Water Framework Directive Water Body Status

The fundamental objectives of the WFD are to maintain “high status” of surface waters where it exists, prevent deterioration in the existing status of waters, and achieve at least “good status” in relation to all waters by the end of the current river basin management cycle unless a water body is subject to an extended deadline under Article 4(7) of the Directive. A water body must achieve both good ‘ecological status’ and good ‘chemical status’ before it can be considered to be at good overall status. An assessment of the risks to the achievement of these objectives for water bodies has been undertaken by the EPA through the extensive characterisation of water bodies and the key pressures acting upon them. This characterisation process allows the development of a programme of measures to aid the achievement of the WFD objectives.

A Programme of Measures (POMs) outlines the steps that will be taken to meet WFD objectives applicable to each water body. This Programme is contained within an overarching River Basin Management Plan (RBMP). These measures will require implementation at strategic level but also at regional and local level through the establishment of Regional Integrated Catchment Management Programmes. Areas for Action are areas where focused action will be carried out in the river basin management cycle. The Areas for Action were selected based on the priorities in the draft river basin management plan, the evidence from the Water Framework Directive characterisation process, and the expertise, data and knowledge of public body staff with responsibilities for water and the different pressure types.

There are two marine water bodies within the Marine Processes Study Area that could be potentially affected by the Project. These are Outer Dundalk Bay and the Louth Coast coastal water bodies which are intersected by the cable corridor and the boundary of one spring tidal excursion. Neither of these water bodies are included in Areas for Action as they are both achieving High ecological status and therefore have an environmental objective of protect, meaning that a deterioration in status in not permitted.

Environmental Quality Standards (EQSs) for classifying surface water status are established in the European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (SI No. 272 of 2009), as amended. These regulations set standards for biological quality elements, physico-chemical conditions supporting biological elements (including general conditions and specific pollutants), priority substances and priority hazardous substances.

As shown in the ‘ecological status’ of a water body is established according to compliance with the EQSs for biological quality elements, physico-chemical conditions supporting biological elements and relevant pollutants and hydromorphological quality elements. The ‘chemical status’ of a water body is established according to compliance with the EQSs for priority substances and priority hazardous substances.

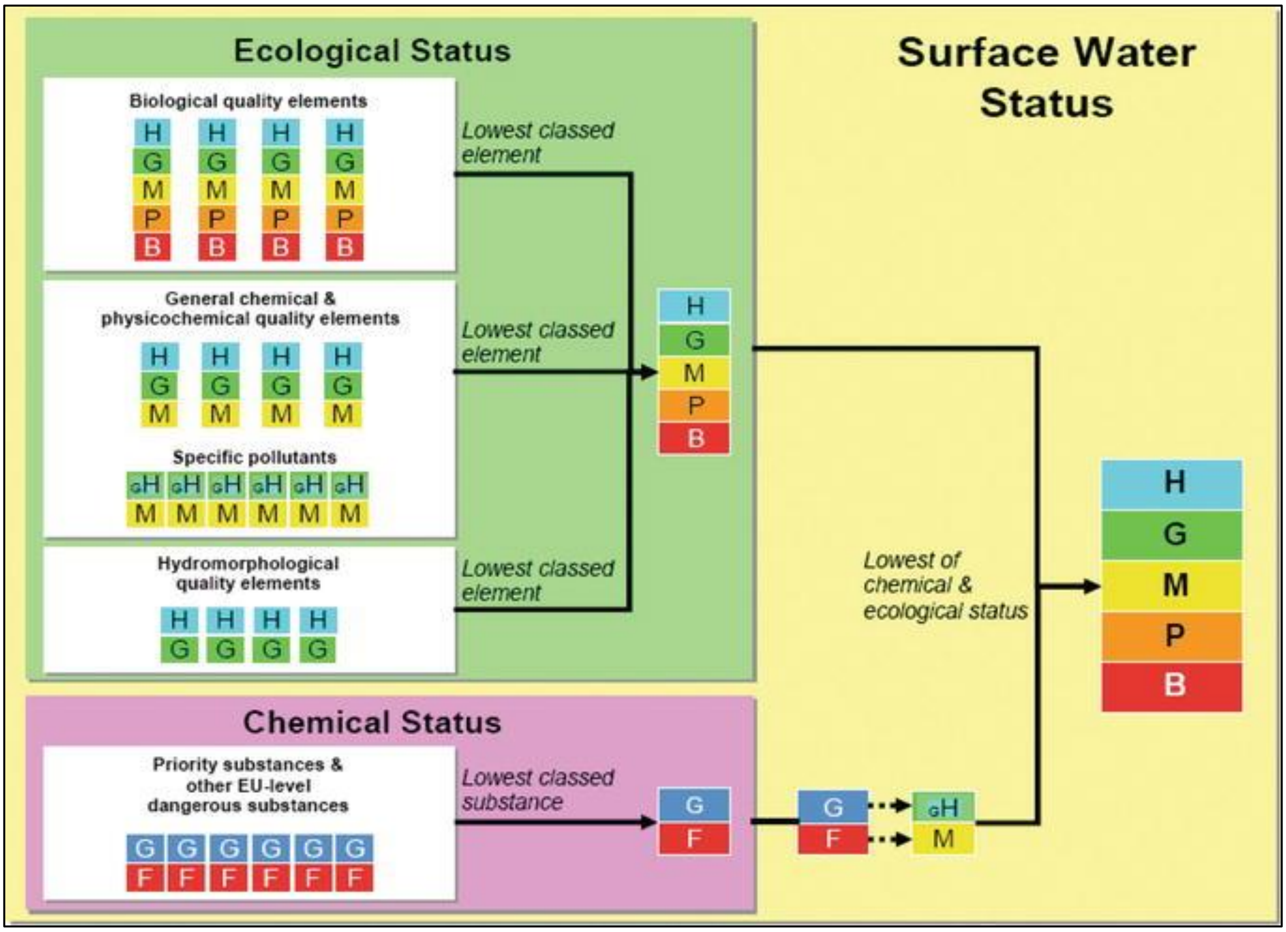


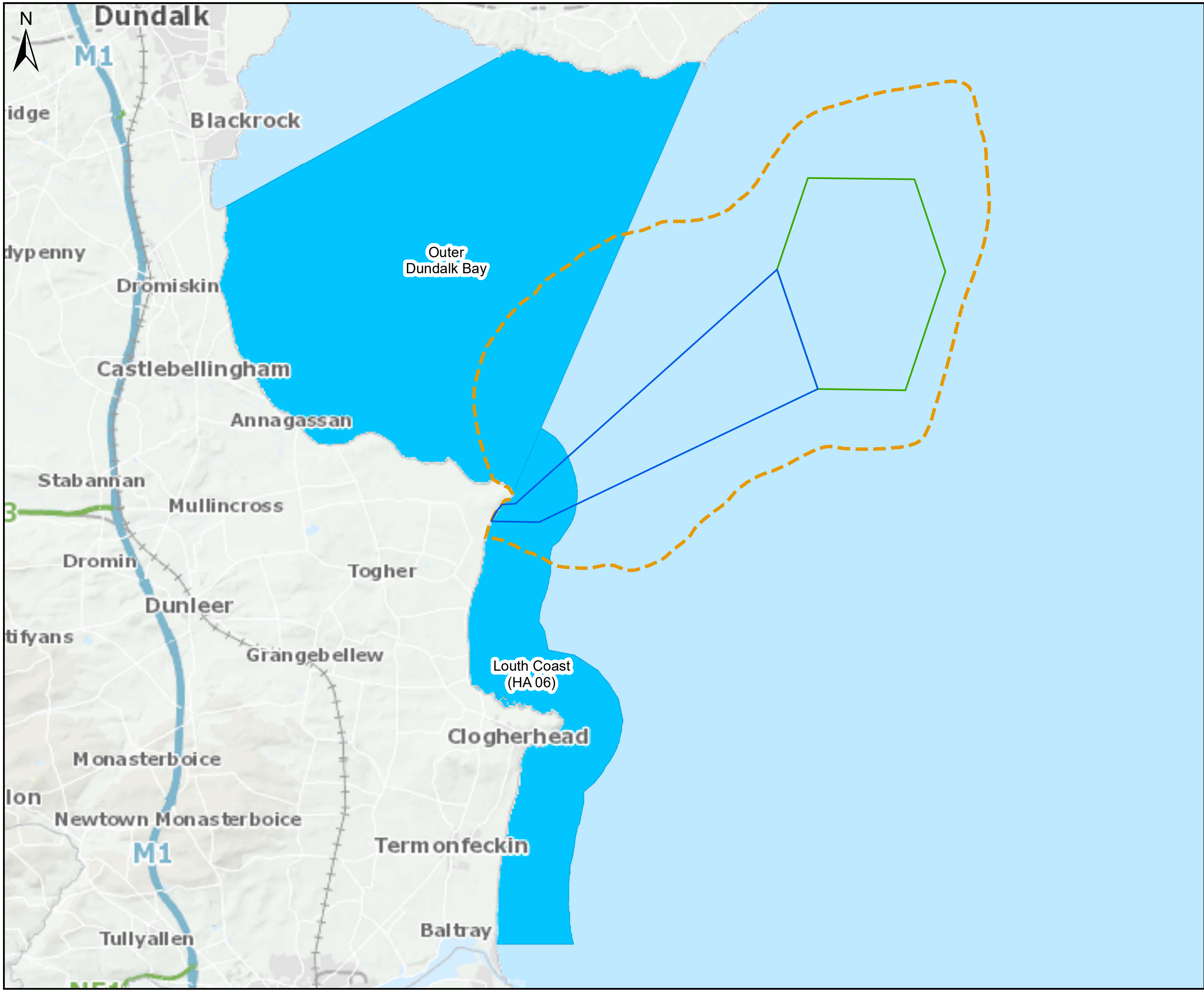
Figure 7-6: Elements of the Water Framework Directive Status.

In addition to achieving good ecological and chemical status, a water body must achieve compliance with standards and objectives specified for protected areas, which include areas designated by the Bathing Water Directive; the Urban Waste Water Treatment Directive; the Shellfish Waters Directive; the Habitats Directive and the Birds Directive. Waters bodies that are compliant with WFD standards, but that contain protected areas that are non-compliant with protected area standards are downgraded to 'less than good' status.

Based on monitoring information and data from 2016 to 2021, the current WFD status classification of water bodies potentially affected by the Project is illustrated in Figure 7-7. The Louth (Coast HA 06) coastal waterbody is currently assigned high under the 2016 to 2021 monitoring programme. A summary of all waterbody statuses is provided in Table 7-10 with more detail include in the following sub sections.

Table 7-10: WFD waterbodies close to the Project (WFD Status 2016 to 2021).

Water body (WFD Code)	Waterbody Type	Overall Status	Ecological status	Chemical status	WFD Risk
Louth Coast (HA 06) (IE_NB_025_0000)	Coastal	High	High	Not Available	Not at Risk
Outer Dundalk Bay (IE_NB_040_0000)	Coastal	High	High	Not Available	Not at Risk



Legend

- Offshore Wind Farm
- Offshore Cable Corridor
- Typical Tidal Excursion Zone

WFD Coastal Waterbodies Status (WFD Status 2016-2021)

- High

Data Sources: OWL, OSi.

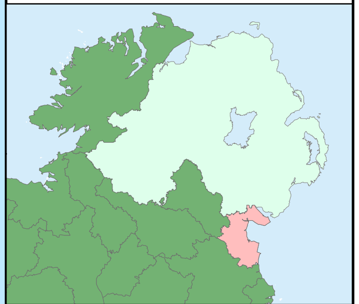


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Figure 7-7
WFD status classification of marine water bodies close to the Project

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Louth Coast (HA 06) (IE_NB_025_0000)

Biological quality elements **-** There is no monitoring information available for the biological elements

Physico-chemical supporting elements **-** There is no monitoring information available for the Physico Chemical elements.

Hydromorphology **-** There is no monitoring information available for the supporting hydromorphology.

Chemical Status **-** There is no monitoring information available for priority and priority hazardous substances.

Characterisation – The water body is not at risk of failing to achieve the objectives of the WFD and there are no significant pressures on status identified

Overall water body status – High, the EPA have assigned a high ecological status to the Louth Coast Water Body based on a modelling approach, i.e. whilst there is not monitoring information available the status is assigned based on water bodies with similar typology and pressures.

Outer Dundalk Bay (IE_NB_040_0000)

Biological quality elements **-** There is monitoring information available for the phytoplankton and macroinvertebrate elements of biological status, both of which are indicative of high ecological status for the Outer Dundalk Bay coastal water body.

Physico-chemical supporting elements – Dissolved inorganic nitrogen and orthophosphate conditions Outer Dundalk Bay are indicative of conditions suitable for high ecological status. Chlorophyll a is also consistent with conditions for high ecological potential and all parameters are on a downward trend although these trends are not statistically significant.

Hydromorphology **-** There is no monitoring information available for the supporting hydromorphological elements.

Chemical Status **-** There is no monitoring information available for priority and priority hazardous substances.

Overall water body status – High

Protected Areas

A significant proportion of the area of Dundalk Bay is protected under existing EU legislation requiring special protection due to the sensitivity to pollution or are of particular environmental importance. All areas requiring special protection in the Irish River Basin District have been identified by EPA, mapped, and are listed in a national register of protected areas (required under Article 6 of the WFD Directive). The register of protected areas includes:

- Areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas) – Freshwater only;
- Areas designated for the protection of economically significant aquatic species, i.e., Freshwater Fish and Shellfish;
- Bodies of water designated as recreational waters, including areas designated as bathing waters;
- Nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste Water Treatment Directive; and
- Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant Natura 2000 sites Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).

These protected areas have their own monitoring and assessment requirements to determine their condition. They are often assessed for additional pollutants or requirements relevant to their designation. The water dependent protected areas within the WFD Study area are illustrated in

Shellfish Waters

Shellfish waters are designated under the Water Framework Directive (2006/113/EC) and all shellfish protected waters will be assigned an objective under this directive. The directive is transposed into Irish law under the European Communities (Quality of Shellfish Water) Regulations 2006 (SI No 268 of 2006), which was further amended in 2009. It is essential that 'good' water quality is maintained within these areas to ensure the production of high-quality shellfish.

The Project is located within the Dundalk Bay Shellfish Waters designated area. The Carlingford Shellfish Waters designated area is located approximately 6 km from the offshore wind farm area.

The significant pressures on the Shellfish Designation are from urban wastewater (Blackrock, Dundalk, Annagassan agglomerations), domestic wastewater treatment systems (DWWTS) Agriculture (pasture) and agriculture (arable).

Bathing Waters

The Bathing Water Directive (2006/7/EC) came into force in March 2006, and was transposed into Irish law by the Bathing Water Quality Regulations, 2008, as amended. The previous 1976 Directive was repealed with effect from 31 December 2014. Since 2014, the annual water quality classification (rating) of a beach or lake has been based on water quality results covering a four-year period rather than a single previous season's data. Water quality at beaches and lakes is classified as Excellent; Good, Sufficient or Poor (Table 7-11). This approach is common across all EU Member States and there is a requirement to ensure that bathing waters are of 'Sufficient' standard or better. Any 'Poor' bathing water requires a programme of adequate management measures to be implemented. A minimum of 16 samples are required for formal annual assessment.

Table 7-11: Annual assessment criteria for bathing waters.

Parameter	Excellent	Good	Sufficient
E. coli (Freshwater) cfu/100 ml	500*	1000*	900**
E. coli (Coastal) cfu/100 ml	250*	500*	500**
Intestinal enterococci (Freshwater) cfu/100 ml	200*	400*	330**
Intestinal enterococci (Coastal) cfu/100 ml	100*	200*	185**

*based on 95-percentile value **based on 90-percentile value

There are five designated bathing waters within close proximity the Project. The closest bathing waters are Port-Lurganboy (1.4 km to boundary of the Project) and Shelling Hill/Templetown (5.2 km to boundary of the Project) which currently have excellent bathing water status.

Natura 2000 Protected Areas

Natura 2000 is a European network of important ecological sites. The EU Habitats Directive (92/43/EEC) places an obligation on Member States of the EU to establish the Natura 2000 network. The network is made up of Special Protection Areas (SPAs), established under the EU Birds Directive (79/409/EEC), and Special Areas of Conservation (SACs), established under the Habitats Directive itself.

The Project is adjacent to and within Natura 2000 sites (i.e., SPAs or SACs) (see section 7.7.3. The Project may therefore have an impacts on Natura 2000 sites. One of the main purposes of the water quality assessment is to ascertain whether the Project will cause significant effects on the ecological status of the water bodies affected having regard to the environmental objectives for the water bodies, including conservation objectives for qualifying features of the Natura 2000 network. It should also be noted that potential effects on Natura 2000 or "European" sites are considered extensively in the NIS.

Therefore the Project must not introduce pressures that could result in a deterioration in the status of these water bodies or their protected area objectives. This impact assessment demonstrates that the Project will not impact on the WFD status of the water bodies affected.

Marine Strategy Framework Directive (MSFD) - Environmental Status

The MSFD establishes a legal framework for the development of marine strategies designed to achieve Good Environmental Status (GES) in the marine environment by the year 2020. The marine strategy involves defining GES, setting environmental targets and indicators, implementing monitoring programmes for ongoing assessment, and developing and implementing programmes of measures to achieve or maintain GES.

GES is defined as 'the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations.'

The assessment of GES is undertaken by reference to qualitative descriptors which define overarching objectives in respect of key socio-economic or ecological aspects of the marine environment. These specifically require the consideration of the following:

- Biodiversity;
- Non-indigenous species;
- Commercial fish and shellfish;
- Food webs;
- Human-induced eutrophication;
- Sea-floor integrity;
- Alteration of hydrographical conditions;
- Contaminants in water and biota
- Contaminants in seafood;
- Marine litter; and
- The introduction of energy including underwater noise.

To date, an Initial Assessment (constituting a comprehensive review of the physical, chemical and biological characteristics of the marine area, as well as the human pressures acting upon it) has been undertaken (DEHLG 2013)). A comprehensive set of environmental targets and associated indicators has been developed resulting in 25 revised environmental targets as outlined in Ireland's Article 17 update to Ireland's Marine Strategy Part 1: Assessment (Article 8), Determination of Good Environmental Status (Article 9) and Environmental Targets (Article 10) (DHPLG, 2020). These revised targets now align more closely with the requirements of the Birds and Habitats Directives, the Water Framework Directive, the Common Fisheries Policy. These are being used to demonstrate that GES has been achieved or is being maintained in accordance with the objectives of the MSFD.

An updated monitoring programme has been established by the Department of Housing, Local Government and Heritage, and the Marine Institute to gather and provide scientific data and information for associated assessments, to determine if our marine waters are achieving or maintaining Good Environmental Status (GES) (DHLGH, 2021). The information is also used to identify changes in the environmental quality of Ireland's maritime area over time, to track the progress in achieving environmental targets, and to examine the effectiveness of measures designed to improve environmental outcomes. The programme of measures, first developed in 2015, has also been updated (DHLGH, 2022) which established 152 measures, built on existing national, European and International policy frameworks.

Almost half of the 11 qualitative descriptors for determining Good Environmental Status (GES) have fully achieved GES:

- Non-indigenous species;
- Human-induced eutrophication;
- Alteration of hydrographical conditions;
- Contaminants in water and biota; and
- Contaminants in seafood.

For marine litter and the introduction of energy both of these descriptors have fully achieved GES for some of the primary criteria assessed but lack of data and methodologies has prevented assessment of other primary criteria. Three have also partially achieved GES (Biodiversity, Commercial Fish and Shellfish and Sea Floor Integrity) due to different results for key elements assessed within descriptors. The environmental status of marine food webs in Ireland is currently unknown.

The key indicators for water quality, human-induced eutrophication and contaminants in water and biota, are currently achieving their objectives under the MSFD. Therefore the Project must not introduce pressures that could result in a deterioration in GES for these indicators.

This impact assessment demonstrates that the Project will not impact on the GES under the MSFD.

7.7.3 Designated sites

Designated sites and relevant Qualifying Interests (QI) identified within the Marine Processes Study Area are described in Table 7-12 below and presented in Figure 7-8.

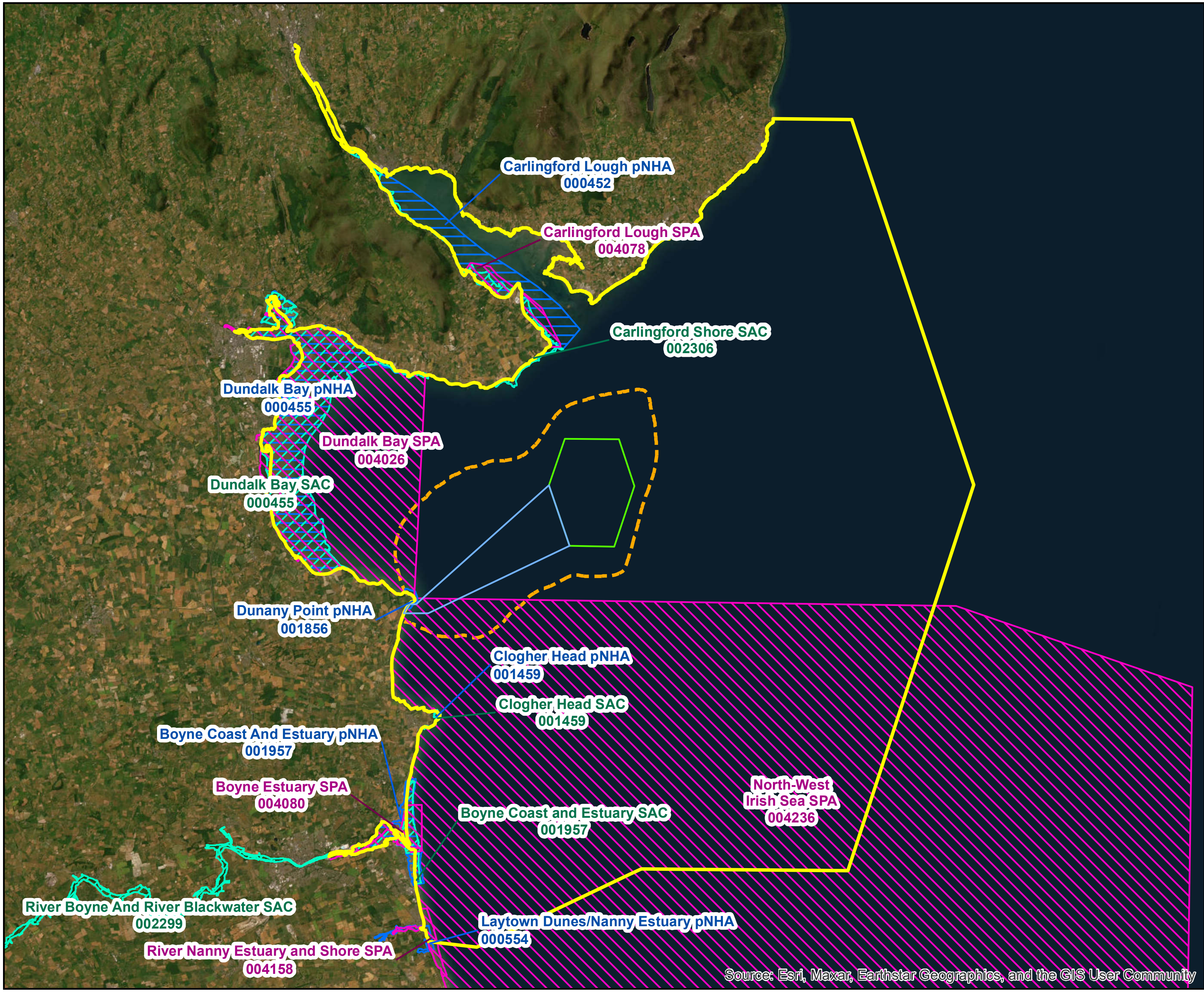
Table 7-12: Designated sites and relevant Qualifying Interests, Special Conservation Interests or Ecological Features of Interest in the Marine Processes Study Area.

Designated site	Closest distance to offshore wind farm area (km)	Closest distance to offshore cable corridor (km)	Relevant Qualifying Interest, Special Conservation Interest or Ecological Feature of Interest
Dundalk Bay SAC and pNHA (000455)	9.3	4.4	Estuaries [1130] Mudflats and sandflats not covered by seawater at low tide [1140] Perennial vegetation of stony banks [1220] Salicornia and other annuals colonising mud and sand [1310] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] Mediterranean salt meadows (*Juncetalia maritimi*) [1410]
North West Irish Sea cSPA	3.5	Cable corridor crosses through this designation	Red-throated Diver (*Gavia stellata*) [A001] Great Northern Diver (*Gavia immer*) [A003] Fulmar (*Fulmarus glacialis*) [A009] Manx Shearwater (*Puffinus puffinus*) [A013] Cormorant (*Phalacrocorax carbo*) [A017] Shag (*Phalacrocorax aristotelis*) [A018] Common Scoter (*Melanitta nigra*) [A065] Little Gull (*Larus minutus*) [A177]

Designated site	Closest distance to offshore wind farm area (km)	Closest distance to offshore cable corridor (km)	Relevant Qualifying Interest, Special Conservation Interest or Ecological Feature of Interest
			Black-headed Gull (*Chroicocephalus ridibundus*) [A179] Common Gull (*Larus canus*) [A182] Lesser Black-backed Gull (*Larus fuscus*) [A183] Herring Gull (*Larus argentatus*) [A184] Great Black-backed Gull (*Larus marinus*) [A187] Kittiwake (*Rissa tridactyla*) [A188] Roseate Tern (*Sterna dougallii*) [A192] Common Tern (*Sterna hirundo*) [A193] Arctic Tern (*Sterna paradisaea*) [A194] Little Tern (*Sterna albifrons*) [A195] Guillemot (*Uria aalge*) [A199] Razorbill (*Alca torda*) [A200] Puffin (*Fratercula arctica*) [A204]
Clogher Head SAC and pNHA (001459)	13.1	5.9	Vegetated sea cliffs of the Atlantic and Baltic coasts [1230] European dry heaths [4030]
Carlingford Shore SAC and pNHA (002306)	4.4	6.5	Annual vegetation of drift lines [1210] Perennial vegetation of stony banks [1220]
Dundalk Bay SPA (004026)	8.0	0.1	Great Crested Grebe (*Podiceps cristatus*) [A005] Greylag Goose (*Anser anser*) [A043] Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] Shelduck (*Tadorna tadorna*) [A048] Teal (*Anas crecca*) [A052] Mallard (*Anas platyrhynchos*) [A053] Pintail (*Anas acuta*) [A054] Common Scoter (*Melanitta nigra*) [A065] Red-breasted Merganser (*Mergus serrator*) [A069] Oystercatcher (*Haematopus ostralegus*) [A130] Ringed Plover (*Charadrius hiaticula*) [A137] Golden Plover (*Pluvialis apricaria*) [A140] Grey Plover (*Pluvialis squatarola*) [A141] Lapwing (*Vanellus vanellus*) [A142] Knot (*Calidris canutus*) [A143] Dunlin (*Calidris alpina*) [A149] Black-tailed Godwit (*Limosa limosa*) [A156] Bar-tailed Godwit (*Limosa lapponica*) [A157] Curlew (*Numenius arquata*) [A160] Redshank (*Tringa totanus*) [A162] Black-headed Gull (*Chroicocephalus ridibundus*) [A179] Common Gull (*Larus canus*) [A182] Herring Gull (*Larus argentatus*) [A184] Wetland and Waterbirds [A999]
Carlingford Lough SPA (004078)	5.7	8.6	Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] Wetland and Waterbirds [A999]
Dunany Point pNHA (001856)	10.0	0	Stony shore and clay cliffs.
Dundalk Bay RAMSAR (834)	10.4	4.3	Habitat: An open sea bay with extensive saltmarshes, intertidal sand and mudflats encompassing the estuaries of the four rivers. Fauna The intertidal flats support a rich fauna of bivalve molluscs, marine worms and crustaceans. Internationally

Designated site	Closest distance to offshore wind farm area (km)	Closest distance to offshore cable corridor (km)	Relevant Qualifying Interest, Special Conservation Interest or Ecological Feature of Interest
			important for waterbirds regularly holding over 20,000 birds and supporting over 1% of the Northwest European/East Atlantic flyway populations.

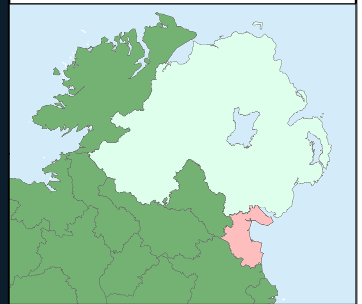
However, of the QIs and Ecological Features of Interest listed in Table 7-12, the following habitats are located above the HWM and are not considered in this chapter: annual vegetation of drift lines [1210], perennial vegetation of stony banks [1220] and European dry heaths [4030]. Habitats above the HWM are considered in volume 2C chapter 19: Biodiversity.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Typical Tidal Excursion Zone
- Marine Processes Study Area
- Special Protection Area (SPA)
- Proposed Natural Heritage Area (pNHA)
- Special Area of Conservation (SAC)

Data Sources: OWL, OSi, NPWS



Client

ORIEL WINDFARM
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Project

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Title

Figure 7-8
Designated Sites within the Marine Processes Study Area

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7.7.4 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 is not constructed, an assessment of the future baseline conditions has been carried out and is described within this section.

Marine processes

The baseline environment for marine processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the Project in place due to natural variability. Future baseline conditions would be altered by climate change resulting in sea level rise and increased storminess. This is unlikely to substantially alter tidal patterns or sediment transport regimes offshore at the offshore wind farm area. However, the return period of the wave climates could be altered (e.g. what is defined as a 1 in 50-year event may become a 1 in 20 year event) as deeper water would allow larger waves to develop. There is, however, a notable degree of uncertainty regarding how future climate change will impact prevailing wave climates within the Irish Sea and beyond.

In terms of water quality given that the WFD Status is currently high for both the Louth Coast and Outer Dundalk Bay coastal water bodies it is assumed that the programme of measures under the River Basin Management Plan will ensure that these water bodies will not deteriorate, i.e. they have a protect objective and deterioration is not permitted.

The same is applicable to marine water quality under the MSFD, both indicators linked to water quality, i.e. human induced eutrophication and contaminants in water and biota are currently achieving their objective of GES under the MSFD and it is assumed that the measures currently in place will ensure that the indicator status will not change.

7.7.5 Data validity and limitations

Data collection campaigns have been undertaken by government and academic institutions which have been utilised for the marine processes assessment (see section 7.6.1). A significant data collection campaign has been undertaken as part of this assessment (see section 7.6). While some of the marine processes are complex and inter-related, there is a significant amount of data available. It is therefore considered that the data employed are robust and sufficient for the purposes of the impact assessment presented.

Baseline suspended sediments within the Marine Processes Study Area relating to both calm and storm conditions have been estimated based on the Cefas Climatology Report (2016). Although site-specific data would provide context to suspended sediment levels, it is by nature a highly variable phenomenon both temporally and spatially and is therefore difficult to capture. It is therefore considered that the data employed are sufficient for the purposes of the impact assessment presented.

The site specific data used to inform this assessment was collected in 2019 to 2020. There is no specific guidance on the age (or timeframe) of data to be used to inform an assessment on marine processes. However, RPS consider the age of the site specific survey data to be valid to describe the current baseline environment for the purposes of EIA. This is due to the following reasons:

- All tidal regimes are governed by the gravitational interaction between the Earth, the Moon, the Sun and other planetary bodies. These interactions are considered constant. Current meter data collected by Acoustic Doppler Current Profiler (ADCPS) therefore remains representative of tidal conditions within the offshore wind farm area indefinitely, assuming there are no significant changes to the bathymetry beyond natural variation within close vicinity.

- The wave climate assessment is based on a statistical analyses of data from the European Centre for Medium Range Forecasts (ECMWF) ERA-40 model for a 22-year period. Thus, any additional records over the short term are unlikely to result in any significant change to what is considered to be a 1 in 50 year wave climate.

Furthermore, it is important to note that the marine processes assessment is effectively a comparative assessment. Therefore, any small changes to tide, wave, or sediment conditions over the near future would be common to both pre and post construction scenarios and in effect cancel one another out.

In terms of water quality the baseline has been established from the WFD and MSFD monitoring programmes and the most current status for the WFD water bodies and MSFD indicators of GES have been used.

7.8 Key parameters for assessment

7.8.1 Project design parameters

The project description is provided in volume 2A, chapter 5: Project Description. Table 7-13 outlines the project design parameters that have been used to inform the assessment of potential impacts of the construction, operation and maintenance and decommissioning phases of the Project on marine processes and marine water quality.

Due to the potential for unexpected ground conditions and obstructions, the final route and length of the offshore export cable and offshore inter array cables will be confirmed during construction (see design flexibility details in chapter 5: Project Description (volume 2A). For the purposes of the assessment presented in section 7.10, the maximum length of cables has been considered to ensure the potential for maximum impact is assessed. Should the lengths of cables be less than those specified, then the potential for effects will not change the assessment outlined in section 7.10. An alternative route within the offshore wind farm area or offshore cable corridor will also not change the assessment in section 7.10.

Table 7-13: Project design parameters considered for the assessment of potential impacts on marine processes.

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
Increased suspended sediment concentrations and associated deposition	✓	✓	✓	**Construction Phase** **Subtidal** Site preparation activities will require sand wave clearance as follows • Inter-array cables clearance of 10% of inter-array cable route with a clearance width 15 m; and • Offshore cables clearance of 10% of offshore cable corridor with a clearance width 15 m. Wind Turbine Generators (WTGs) and Offshore Substation (OSS) installed on monopile foundations: • Drilled installation of 9.6 m diameter pile at 0.25 m/h to full depth of 35 m assuming 26 foundations require to be drilled (25 x WTG and 1 x OSS); and • Modelled at representative locations across the offshore wind farm area. Foundation installation duration of six months. Maximum drilling duration of 150 days. Installation of inter-array cables and offshore cable:	This operation is to be undertaken by plough dredging / jetting which mobilises a small amount of sediment into suspension at the seabed; sediment plume concentrations and extents are reduced compared to other types of dredging activities. Drilling or augured operations tend to jet/release all material to the vicinity. Volume of native material is limited but drilling presents the greater volume. Partial drilling or fully hammered piles releases far less material. In reality ploughing (and to a certain extent jetting) moves material rather than bringing it fully into suspension therefore the assumption that the seabed is fluidised was used for modelled simulations. Cable routes include areas of gravel, sand and muddy sand along with exposed rock. Sections of the routes which mobilise material that has the potential to move beyond the immediate vicinity has been examined (see appendix 7-1: Marine Processes Technical Report). It is proposed that installation in the intertidal zone will be undertaken using land-based

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
				• Inter-array cable length 41 km; Disturbance of seabed material from a 1 m wide and 3 m deep trench; and • Offshore cable length 16 km; and Disturbance of seabed material from a 3 m wide and 3 m deep trench. Inter-array and offshore cable installation duration over a period of up to fifteen months. Modelling assumes that the cable routes extend over areas of sand and muddy sand which mobilised the greatest volume of sediment. **Intertidal** Cable installation at the landfall via open trenching: • Modelling assumes sediment release along the full 16 km length of the offshore cable route, through the intertidal zone to the HWM. **Operational and Maintenance Phase** Cable repair/reburial activities: Inter-array cables: 7 repair events and 7 reburial events; Offshore cable: three repair events and three reburial events for subtidal and intertidal region; Disturbance of seabed material from a 3 m wide and 3 m deep trench; and Operational phase of 40 years. **Decommissioning Phase** WTGs and OSS on monopile foundations: • Cutting and removal of monopile foundations to approximately 2 m below seabed. Removal of inter-array and offshore cables: • Disturbance of seabed material from a 3 m wide and 3 m deep trench.	techniques with smaller trenches with a reduction in sediment release.
Presence of infrastructure may lead to changes to tidal currents	✗	✓	✗	**Operational and Maintenance Phase** **Subtidal** WTGs and OSS installed on monopile foundations: • Presence of 25 WTG foundations and one OSS foundation of 9.6 m diameter throughout the water column; • Minimum spacing 944 m; and • Operational phase of 40 years.	The presence of constructed monopile foundations creates an obstruction to flow in the water column, with the potential to effect tidal currents.
Presence of infrastructure may lead to changes to wave climate	✗	✓	✗	**Operational and Maintenance Phase** **Subtidal** WTGs and OSS installed on monopile foundations:	In the case of the wave climate, the obstruction created by the structure at the water surface has the potential to exhibit localised influence on the magnitude, speed, and direction of waves.

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
and littoral currents				• Presence of 25 WTG foundations and one OSS foundation of 9.6 m diameter throughout the water column; and • Minimum spacing 944 m. Operational phase of 40 years.	
Presence of infrastructure may lead to changes to waves and tidal currents, leading to changes in sediment transport	×	✓	×	**Operational and Maintenance Phase** **Subtidal** WTGs and OSS installed on monopile foundations: Presence of 25 WTG foundations and one OSS foundation of 9.6 m diameter throughout the water column; Minimum spacing 944 m; Inclusion of scour protection for each foundation with a radius of 24 m (from the centre of the foundations); and • Operational phase of 40 years.	The scour protection was defined as the largest dimension described within volume 2A, chapter 5: Project Description, i.e. extending 19.2 m beyond the monopile structure.
Impact of pollution caused by accidental spills/ contaminants	✓	✓	✓	**Construction Phase** • 475 vessel round trips during the construction phase. Offshore construction phase duration of 15 months. **Operational and Maintenance Phase** • 352 vessel round trips per year during the operational and maintenance phase; • Presence of 25 WTG foundations and one OSS. Operational phase of 40 years. **Decommissioning Phase** • 475 vessel round trips during the decommissioning phase.	The main source of pollution and contaminant spills will be from hydrocarbons associated with the Project including Marine Gas Oil (MGO) or Intermediate Fuel Oil (IFO), lubricant oil and hydraulic oil from marine construction vessels. The potential worst-case spill scenario associated with the Project would be a complete loss of fuel inventory from two large vessels as a result of collision, or where a passing vessel collides with a wind farm vessel or structure. It must be noted that for larger vessels, even following a significant collision, it is unlikely that all fuel onboard would enter the water due to location of bunker tanks. Once spilled in the marine environment, oil immediately begins to undergo weathering, a term used to describe many natural, physical, chemical, and biological changes. The changes that the oil undergoes will often influence the effectiveness of response options. Prevailing meteorological and oceanographic conditions, as well as the type of oil spilled, will determine its ultimate fate. Each wind turbine will contain components that require lubricating oils, hydraulic oils and coolants and other chemicals (e.g. paints for operation and maintenance). The offshore substation will include a diesel power generator and storage as well as coolant for the transformers. The wind turbines and offshore substation will have full containment to ensure there is no leakages or discharges to the marine environment from equipment containing environmental damaging fluids or compounds. As outlined in volume 2A chapter 5: Project Description the design of the wind turbines

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
					and offshore substation includes a drainage system that will collect and contain any leakages from equipment containing environmentally damaging fluids.

7.8.2 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 marine processes (see Table 7-14). 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 7.10 below (i.e., the determination of magnitude assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 7-14: Measures included in the Project.

Measures included in the Project	Justification
Scour protection	In the absence of scour protection, there is potential for scour pits to develop around foundations. This may result in the release of sediment into the water column and a change to seabed habitat in the vicinity of the foundation. Where required, scour protection will be installed as described in volume 2A, chapter 5: Project Description.
Burial and protection of cables	The cables will be buried below the seabed wherever possible, to a minimum burial depth of 0.5 m and a maximum burial depth of up to 3 m. The appointed contractor will be required prior to the construction phase to submit details on the cable specification and installation methodology. This will include details on the cable laying, including geotechnical data, cable laying techniques and a cable burial risk assessment. Also, in advance of any cable repair, the contractor will be required to submit details on the parameters of the repair or reburial activities and the proposed methodology.
Use of trench reinstatement in the intertidal zone	The offshore cable will be installed through the intertidal zone using open cut trenching methods. The trench will be backfilled immediately after cable installation to reduce mobilisation of sediments into the wider area. The material will be excavated and reinstated on a layer-by-layer basis to minimise impacts on sediment structure and profile.
An Environmental Management Plan (EMP) (see volume 2A, appendix 5-2: Environmental Management Plan) will be implemented during the construction, operation and maintenance and decommissioning phases of the Project.	The EMP includes Project specific measures and commitments and a Marine Pollution Contingency Plan (MPCP (see volume 2A, appendix 5-2 (Annex 2)). Measures also include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds within the Project Infrastructure, i.e. WTG and offshore sub-station to ensure that the potential for release of pollutants from construction, operational and maintenance, and decommissioning is minimised. In this manner, accidental release of contaminants from vessels and Project infrastructure will be strictly controlled, thus providing protection for marine life across all phases of the Project development.
A Marine Invasive Non-Indigenous Species Management Plan (volume 2A, appendix 5-3 Marine Invasive Non-Native Species Management Plan) will be implemented.	The plan outline measures to ensure vessels comply with the International Maritime Organisation (IMO) ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as measures to be adopted in the event that a high alert species is recorded. To manage and minimise the risk of potential introduction and spread of Invasive Non-Indigenous Species. The plan outline measures to ensure vessels comply with the International Maritime Organisation (IMO) ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as measures to be adopted *in the event that a high alert species is recorded.*

Measures included in the Project	Justification
Marine Pollution Contingency Plan (MPCP) (see volume 2A, appendix 5-2 (Annex 2)):	This Marine Pollution Contingency Plan (MPCP) provides the pollution response arrangements for the Oriel Wind Farm Project (hereafter referred to as the 'Project') during both the construction and operational and maintenance, and decommissioning phases of the offshore infrastructure. The overall objective of the MPCP is to outline procedures to safeguard the marine environment and respond to an accidental pollution event during the construction and operation of the Project.
Emergency Response Co-operation Plan (see volume 2A, appendix 5-7: Emergency Response Co-operation Plan)	The ERCoP addresses emergency response and coordination arrangements for the construction and operational and maintenance of the offshore infrastructure of the Project (i.e., all infrastructure below the High-Water Mark including the Wind Turbine Generators (WTGs), the offshore substation and offshore cable). This plan describes the actions to be taken in an emergency during both construction and operation, details the resources available to support those actions, and provides emergency contact details.
Construction Environmental Management Plan (see volume 2A, appendix 5-1: Construction Environmental Management Plan)	The remit of the CEMP is for the Project activities taking place landward of the High-Water Mark (HWM). The CEMP is applicable to all OWL personnel, contractors and subcontractors carrying out construction and operational and maintenance activities associated with the Project. The principal objective of this document is to detail appropriate measures in the avoidance, minimisation and control of adverse environmental impacts associated with construction of the onshore infrastructure of the Project. Furthermore, this document defines good practice as well as detailing specific commitments relating to environmental protection as identified in the Environmental Impact Assessment Report (EIAR) and the Natura Impact Statement (NIS) and a future version of this document will detail any planning conditions associated with a future planning consent, when they are known.

7.8.3 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 for Marine Processes. These impacts are outlined, together with a justification for the scoping out decision, in Table 7-15.

Table 7-15: Impacts scoped out of the assessment for marine processes.

Potential impact	Justification
Changes to seabed morphology due to depressions left by jack-up vessels.	The potential for jack-up vessel spud-cans to affect the sediment regime has been scoped out of the assessment. Jack-up footprint depressions would not persist after jack-up operations have been completed as these would infill over time. Jack-up vessel footprints will not have implications for the sediment regime due to both their very limited extent and temporary nature.
Installation of offshore cable through intertidal zone may lead to changes in sediment transport during installation.	The construction phase of the Project will result in disturbance to intertidal features at the landfall. However, the intertidal zone at the landfall location experiences a high rate of natural morphological change from mudslides and cliff collapses. Furthermore, the period of disruption during the trenching will be short and the beach will be reinstated, as described in section 7.10. The landfall location overlaps with Dunany Point pNHA at the beach and the sea cliffs. Potential impacts to the ecological features of interest at Dunany Point pNHA are addressed in chapter 8: Benthic and Intertidal Ecology and volume 2C chapter 19: Onshore Biodiversity.
Scour of seabed sediments	The potential for scour of seabed sediments around the WTG and OSS foundations has been scoped out of the assessment on the basis of the project design which includes for scour protection (see volume 2A chapter 5: Project Description).
Wake effects	Wind turbines operate by converting kinetic energy from the wind into electricity with a generator. This process results in less kinetic energy in the atmosphere and a localised reduction in wind speed behind the turbine rotor. This reduction in wind speed is known as a

	"wake." A recent study funded by the European Union Horizon 2020 project found this reduction of downstream wind speeds was in the regions of 2-10% at 10 m above mean sea level with average wakes persisting for 20-40 km (Owda & Badger, 2022). As would be expected, these wakes vary in both intensity and dimensions, and are highly dependent on a variety of factors, such as wind speed, turbine size, and layout (i.e. direction and spacing) of the wind turbine array (e.g. Barthelmie et al. 2010). Regarding impacts on hydrodynamics modeling studies in the North Sea have shown wind speed reductions at the surface due to these wakes on the order of 0.1 to 0.5 m/s, depending on a range of factors including but not limited to the season and density of wind turbines (Akhtar et al. 2021; Christiansen et al. 2022a). Importantly, these studies noted that "as a result of constantly changing wind directions, pronounced wake patterns disappear when averaging over time". In context of prevailing coastal processes at the Project, the speed reductions of 0.1 to 0.5 m/s within the surface layer are considered to be insignificant in context of magnitude and effect, particularly given that these patterns would likely disappear when averaging overtime owing to naturally varying wind speeds and directions across the site. For these reasons, potential impacts arising from wake effects have been scoped out.

7.9 Impact assessment methodology

7.9.1 Overview

The assessment on marine processes has followed the methodology set out in volume 2A, chapter 3: Environmental Impact Assessment Methodology. Specific to the marine processes assessment, the following guidance documents have also been considered:

- EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2022);
- Guidelines in the use of metocean data through the lifecycle of a marine renewables development, CIRIA C666 (Cooper *et al*., 2008);
- Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects (Department of Communications, Climate Action and Environment (DCCAE), 2017);
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2 April 2018 (DCCAE, 2018);
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments. Natural Resource Wales (NRW) Report No 208 (Pye *et al*., 2017); and
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects, NRW Report No: 243 (Brooks *et al*., 2018).

7.9.2 Impact assessment criteria

As described in section 7.1, marine processes are not receptors in themselves; however, they are the pathway for indirect impacts on other receptors. For example, increases in suspended sediments during the construction phase may lead to the deposit of these sediments and smothering of benthic habitats. For this impact, the magnitude of the potential changes has been assessed, with the sensitivity of the receptors to these changes and the significance of effects assessed within chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology, chapter 10: Marine Mammals and Megafauna, chapter 15: Marine Archaeology and chapter 16: Infrastructure, Marine Recreation and Other Users.

A full impact assessment has however been provided for the hydrodynamic regime and the sediment transport regime, both of which have been identified as potentially sensitive marine processes receptors.

A full impact assessment for marine water quality as a receptor has considered the following impacts:

- Increased suspended sediment concentrations and associated deposition;
- Presence of infrastructure may lead to changes to tidal currents and supporting hydromorphological conditions of water bodies;
- Presence of infrastructure may lead to changes to wave climate and littoral currents and supporting hydromorphological conditions of water bodies;
- Presence of infrastructure may lead to changes to waves and tidal currents, leading to changes in sediment transport supporting hydromorphological conditions of water bodies;
- Impact of pollution caused by accidental spills/contaminants;
- Impact of Invasive non-native species (INNS); and
- Electromagnetic Fields EMFs from cabling during the operational phase.

Determining the significance of effects is a 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 are based on those which are described in further detail in volume 2A, chapter 3: Environmental Assessment Methodology.

The criteria for defining impact magnitude in this chapter are outlined in Table 7-16 below.

Table 7-16: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
High	**Marine Processes**
	Change in marine processes which results in the loss of a coastal feature, (e.g., blockage of sediment pathway resulting in loss of spit (Adverse))
	Change in marine processes which results in the creation of a coastal feature, (e.g., reduction in wave climate giving rise to dune formation (Beneficial))
	Water Quality
	Loss or extensive change to a water body or water dependent habitat
	Potential high risk of pollution to water body from routine run-off
	Extensive reduction in amenity value
Medium	**Marine Processes**
	Alteration of marine processes which effects the rate at which a coastal feature is maintained (e.g., reduction in accretion rate (Adverse))
	Alteration of marine processes which effects the rate at which a coastal feature is developing (e.g., reduction in erosion rate (Beneficial))
	Water Quality
	Partial change in character of a water body or water dependent habitat.
	Potential medium risk of pollution to water body from routine run-off
	Partial reduction in amenity value
Low	**Marine Processes**
	Variation in marine processes which maintains the coastal feature (e.g., localised change in sediment pathway which does not destabilise bank)
	Water Quality - Results in minor impact on integrity of attribute or loss of small part of attribute
	Minor change in character of a water body or water dependent habitat
	Potential low risk of pollution to water body from routine run-off
	Slight reduction in amenity value
Negligible	**Marine Processes**
	Imperceptible variation in marine process (e.g., in the order of natural variability)
	Water Quality - Results in an impact on attribute but of insufficient magnitude to affect either use or integrity
	Negligible change in character of a water body or water dependent habitat, negligible loss of amenity value

The criteria for defining receptor sensitivity in this chapter are outlined in Table 7-17 below.

Table 7-17: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
High	**Marine Processes**
	Feature forms part of a wider scale system and non-recoverable
	Water Quality
	High importance and rarity, international scale and very limited potential for substitution. Examples: water body protected area interests are of international importance and have been designated under the Habitats, Birds, Shellfish, Bathing Water. High or good status water bodies.
Medium	**Marine Processes**
	Feature has limited potential for re-creation
	Water Quality
	Water Quality feature medium importance and rarity, national/regional scale, limited potential for substitution. Examples: moderate ecological status with an objective of good status by 2027, regionally important resource in terms of ecology or fisheries interest.
Low	**Marine process**
	Features of local scale and recoverable
	Water Quality
	Low importance and rarity, local scale Examples: locally important amenity site for small range of leisure activities; Quality Class D water bodies, Poor ecological status.
Negligible	Marine Process - Feature adaptable to changes in Marine Processes
	Water Quality – Feature of negligible importance for water quality or is not water dependent

The significance of the effect upon marine processes and water quality is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 7-18. Where a range of significance of effect is presented in, the final assessment for each effect is based on calculated assessment and professional judgement. 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 7-18: Matrix used for the assessment of the significance of the effect.

		Magnitude of impact			
		Negligible	**Low**	**Medium**	**High**
Sensitivity of receptor	**Negligible**	Imperceptible	Imperceptible or slight	Imperceptible or slight	Slight
	Low	Imperceptible or slight	Imperceptible or slight	Slight	Slight or moderate
	Medium	Imperceptible or slight	Slight	Moderate	Moderate or major
	High	Imperceptible to slight	Slight or moderate	Moderate or major	Major or Profound

7.9.3 Designated sites

Where Natura 2000 sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the QIs of internationally designated sites as described within section 7.7.2 of this chapter (with the assessment on the site itself deferred to the Natura Impact Statement (NIS) (RPS, 2023) for the Project).

With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site and where notified QIs of the Natura site are also QIs of the nationally designated sites (e.g. natural heritage areas (NHAs) which underpin a Natura site), only the international site has been taken forward for assessment This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken). There are no nationally designated sites identified in the Marine Processes Study Area that fall outside the boundary of an internationally designated site. However, one proposed nationally designated site, Dunany Point pNHA, has been identified within the Marine Processes Study Area (see section 7.7.2) that is not part of an internationally designated site.

7.10 Assessment of significance

The potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Project are listed in Table 7-13 along with the project design parameters against which each impact has been assessed. The marine processes assessment was supported by numerical modelling, details of which are provided in appendix 7-1: Marine Processes Technical Report.

A description of the potential effect on marine processes and water quality caused by each identified impact is given below.

7.10.1 Increased suspended sediment concentrations and associated deposition

Increased suspended sediment concentrations and associated deposition may arise due to the installation of the WTG and OSS foundations, the installation and/or maintenance of inter-array cables and the offshore cable and associated decommissioning activities. This impact is relevant to the construction, operation and maintenance and decommissioning phases of the Project and may cause indirect impacts to receptors.

The following scenarios were investigated by means of numerical modelling:

- Site preparation activities – sand wave clearance to facilitate cable installation;
- Drilled pile installation – across the range of hydrodynamic conditions;
- Inter-array cable installation – for a zone of sandy seabed sediment; and
- Offshore cable installation – through sandy seabed sediment.

Scenarios 3 and 4 were considered to be reflective of potential impacts which may arise during the operational and maintenance phase activities of cable repair and reburial.

Modelling was undertaken for the project design parameters listed in Table 7-13. A detailed description of this modelling assessment is provided in appendix 7-1: Marine Processes Technical Report.

Construction phase

Magnitude of impact

The installation of Project infrastructure within the offshore wind farm area and offshore cable corridor may lead to increased suspended sediment concentrations and associated deposition. The project design parameters include for the installation of 26 x 9.6 m diameter monopiles (25 x WTG and 1 x OSS) to a depth of 35 m and for the installation of inter-array cables and offshore cable in a trench 3 m in depth and of 1 m and 3 m in width respectively.

The modelled scenarios used a drilling depth of 35 m as described in volume 2A, chapter 5: Project Description and examined a range of locations across the offshore wind farm area. The drilled pile installations are anticipated to generate plumes with a maximum suspended sediment level of 100 mg/l. These levels would be localised and only persist for a short period. Average plume concentrations are much lower, typically one tenth of peak values. Following the cessation of drilling the turbidity levels reduce within a few hours. Some of the finer material associated with the drilling process is re-suspended during successive tides as it is redistributed but turbidity levels remain low. The sedimentation beyond the immediate drilling location is indiscernible. This is due to the relatively slow drilling rate (0.25 m/hour), allowing the fines to be widely dispersed while the larger material settles at the release point due to the limited current speed.

For the inter-array cable installation, the sediment plumes are much smaller than those seen for the pile installation. The reason for this is twofold, firstly there is no fine bentonite material associated with the cable installation activities (i.e. which is utilised in the drilling process); and secondly the material is mobilised at the seabed where current speeds are lower. Maximum plume concentrations are higher at around 2,000 mg/l, but these sediment levels are not sustained, as average plume concentrations are less than 3 mg/l which is comparable to background levels. The sediment plume will only persist for a maximum period of two to three hours in any location as the installation moves on and the tide turns.

Following the completion of the works, turbidity returns to baseline level within a couple of tidal cycles. It would however be anticipated that spring tides following the works may mobilise and redistribute unconsolidated seabed material deposited at the end of the construction phase; this material with therefore be incorporated into the existing transport regime. Following installation, the native seabed material settles close to where it is mobilised and remains in situ. This would be expected as the baseline modelling indicated that sediment transport potential is limited across the offshore wind farm area. The sedimentation is concentrated along the installation route as material effectively returns to the site from where it is was disturbed. Beyond 50 m the sedimentation levels are in the order of 1 mm in depth and at the offshore wind farm area boundary <1 mm and therefore indiscernible from the existing seabed sediment.

Offshore cable installation shows a higher variability in suspended sediment concentration due to the change in hydrography along the offshore cable corridor. As described in Table 7-13 the modelled release continued through the intertidal zone to the HWM. Generally, peak values are around 300 mg/l which is akin to turbidity levels experienced during storm conditions. Towards the landfall these peaks increase due to the limited depth into which the material is dispersed, however, these areas are localised towards landfall and average concentrations along the offshore cable corridor are less than 50 mg/l. As with the inter-array cable scenario the plume does not remain stationary, and these elevated levels do not persist for more than three to four hours as material settles and the tide turns. Following completion of the work, material would be re-suspended on successive tides and be drawn into the existing transport regime in nearshore regions. Modelling demonstrated the influence of the eddy south of Dunany Head and how material will be incorporated into the existing transport patterns. The distribution of the sediment which is released during the installation of the offshore cable is typically less than 20 mm in depth. Most material settles in the vicinity of the site of the offshore cable trench, within 200 m either side of the works, with final settled depth being less than 5 mm beyond the offshore cable corridor.

The offshore cable installation modelling provided a worst-case scenario in terms of suspended sediment concentration particularly within the intertidal zone at landfall. Firstly, it was assumed that the material was comprised of the finest most easily mobilised material encountered in the area. In reality seabed mapping shows areas of cobbly boulders which would both reduce the mobility of the trenched material, as coarser material would settle adjacent to the trench, it would also inhibit the dispersion of material which is brought into suspension near the bed. The modelling also assumed that landfall trenching activities would be undertaken using the same technique as further offshore. However, it is likely that, the offshore cable would be installed through the intertidal zone by open cut trenching. The material would be excavated and reinstated immediately after installation on a layer-by-layer basis to minimise impacts on sediment structure and profile with little or no suspended sediment release.

Site preparation of sand wave clearance activities have the potential to increase suspended sediment concentrations in the construction phase with associated sedimentation. These activities are proposed along 10% of the offshore cable and inter-array cable lengths using a subsea plough. A clearance width of 15 m to facilitate cable installation with an average depth of approximately 0.5 m for inter-array cables and offshore cable would result in a volume of approximately 7.3 m^3 being displaced per metre of levelling along the route.

This operation is to be undertaken using plough dredging which mobilises a much smaller amount of sediment into suspension at the seabed and has reduced sediment plume concentrations and extents compared to other types of dredging activities, such as those modelled for trenched cable installation. The trenching modelled a release of 5.025 m^3 of material per metre of cable laid which was assumed to be fully mobilised.

The volume of material relocated per metre of bed preparation is therefore of the same order of magnitude as the trenching, however the mobilisation into suspension would be less significant as the trenching lifts material off the bed whilst plough dredging would move material along it. The bed preparation constitutes 10% of the cable lengths in total and at discrete locations. Therefore, the activity would be less extensive. It may therefore be concluded that the magnitude of impacts arising from seabed clearance would be less than for cable trenching.

The trenching modelling showed that, for the cable installation, the sediment plume will only persist for a maximum period of two to three hours in any location as the cable is continuously installed along its length; site preparation activities would be expected to have a similar duration. Offshore cable installation shows a higher variability in suspended sediment concentration due to the change in hydrography along the offshore cable corridor. This would also be the case for site clearance and suspended sediment concentrations would vary depending on the location of the activity but still remain less than those experienced during trenching. Following the completion of the clearance works the turbidity levels return to baseline within two to three tidal cycles.

During levelling, the coarser native seabed material would remain close to the bed where it is ploughed and remain *in situ*. It is anticipated that the finest unconsolidated seabed material deposited at the end of the operation may be redistributed on successive spring tides and drawn into the existing transport regimes particularly if works are undertaken in nearshore regions.

Seabed disturbance leading to the potential release of sediment contaminants may occur during the construction and decommissioning phases as a result of the installation/removal of foundations and the installation/removal of inter-array and offshore cables. Seabed disturbance leading to the potential release of sediment contaminants may occur during the operational and maintenance phases due to inter-array and offshore cable repair and reburial events.

The benchmarks for the relevant MarESA pressures which have been used to inform this impact assessment are as follows:

- Transition elements and organo-metal contamination: The benchmark is compliance with all average annual environmental quality standards (AA EQS), conformance with Permissible Exposure Limits (PELs), Environment Assessment Criteria (EACs) and Effects Range Lows (ER-Ls);

- Hydrocarbon and Polycyclic Aromatic Hydrocarbons (PAH) contamination: The benchmark is compliance with all AA EQS, conformance with PELs, EACs, ER-Ls; and

- Synthetic compound contamination: The benchmark is compliance with all AA EQS, conformance with PELs, EACs, ER-Ls.

Site specific sediment sampling for contaminants will be carried out at the detailed design phase for the Project. Although site specific sediment contamination levels are unknown at this time, it is considered unlikely that transition elements, organo-metals, hydrocarbons, PAH compounds and synthetic compounds will be present in any greater concentrations than trace amounts. They are very likely to all be in compliance with the Marine Institute sediment quality guidance levels which are similar to the levels in the MarESA benchmark listed above (Cronin et al., 2006). It is therefore likely that any contaminants will be below the MarESA benchmark levels. There are few large infrastructure projects and no oil and gas exploration activities in this part of the western Irish Sea, with activities further limited in the immediate vicinity of the offshore wind farm area and offshore cable corridor. Therefore, there is currently no identified source of contamination. In addition, sediments within large parts of the offshore wind farm area and offshore cable corridor are composed of sand and coarse sediment, with low levels of fine sediments (i.e. muds) onto which contaminants would adhere. This further reduces the risk of contamination in these areas.

The impact of increased suspended sediment concentration and associated sedimentation is predicted to be of local spatial extent, short term duration and intermittent. It is predicted that the impact will affect the receptor indirectly. The nature of the sediments and the absence of a contaminant source in this area means that the potential for the disturbance of sediment contaminants is very low. The magnitude of the impact from increased suspended sediment concentrations and associated deposition is therefore, considered to be negligible.

Sensitivity of the receptor

The shoreline within Dundalk Bay is characterised by saltmarshes and intertidal sand/mudflats. Mudflats and sandflats have been designated as QIs of the Dundalk Bay SAC and pNHA whilst it is also a designated SPA under the EU Birds Directive and RAMSAR (see Table 7-12). Although there are not many coastal features similar to this in Ireland, these areas are extensive and would recover from the predicted magnitude of the changes in marine processes as outlined above. The sensitivity of the receptor to changes in suspended sediment concentration and sedimentation is therefore considered to be low.

Much of Clogher Head SAC and pNHA lies above the HWM with the designated QIs being vegetated sea cliffs and dry heaths. Therefore, these QIs are not impacted by or classified as coastal QIs in the sense of marine processes. The sensitivity of the receptor to changes in suspended sediment concentration and sedimentation is therefore considered to be negligible.

Carlingford Shore SAC and pNHA is designated by shoreline vegetation but the site also has intertidal sand and mudflats with patches of saltmarsh. Carlingford Lough SPA and RAMSAR is designated for wetland and water birds and extends to mean low water. Therefore, the assessment of marine processes is applicable to the intertidal zone. The sensitivity of the receptor to changes in suspended sediment concentration and sedimentation is considered to be low as it is of local scale and recoverable.

Dunany Point pNHA is proposed to be designated by stony shoreline and clay cliffs. The stony shoreline indicates that the area is adapted to the natural variations in marine processes but the clay cliff may be vulnerable to coastal erosion. The sensitivity of the receptor to changes in suspended sediment concentration and sedimentation is considered to be negligible as these parameters would not contribute to cliff erosion.

The marine waters in the Western Irish Sea are currently achieving their objectives under the WFD and the MSFD. Outer Dundalk Bay and the Louth Coast coastal water bodies are currently classified to be at high ecological status and the marine waters across Ireland are currently achieving GES for the qualitative descriptor “contaminants in water and biota” under the MSFD. On this basis the sensitivity of the marine water quality to changes in suspended sediment concentration and sedimentation is considered to be high.

Sensitivity and significance of effect where increased suspended sediment concentrations and associated deposition represents an impact pathway are assessed for the relevant receptor in chapter 8: Benthic Subtidal and Intertidal Ecology, chapter 9: Fish and Shellfish Ecology, chapter 15: Marine Archaeology and chapter 16: Infrastructure, Marine Recreation and Other Users.

Significance of the effect

During the course of the installation of wind turbine structures, increases in suspended sediment concentrations do not extend to the designated areas of Dundalk, Clogher Head or Dunany Point. Installation of drilled structures in the north of the site indicate that on occasion sediment plumes extend to the mouth of Carlingford Lough. However, maximum concentrations are <5 mg/l and do not persist or result in discernible sedimentation.

Sediment plumes originating from inter-array trenching activities do not extend to any of the designated sites. Similarly, the offshore cable installation does not affect Clogher Head and Carlingford designations or the Dundalk Bay SAC. Plumes may reach the outer extent of Dundalk Bay SPA at the southern end of Dundalk Bay and peak concentrations may reach 300 mg/l on occasion, but typical values are one hundredth of this and no discernible sedimentation persists following the installation.

The offshore cable trenching route passes through the Dunany Point pNHA however the increased suspended sediment concentrations will have little significance as this area is designated for the stony shoreline and clay cliffs which are not sensitive to these impacts. Sedimentation thickness may reach 0.02 m however this a native material settling back to the site of the trenching.

In terms of marine water quality, the coastal water bodies, protected bathing waters and nutrient sensitive areas the sensitivity of the water bodies, water dependent protected areas and marine water quality is considered high however the magnitude of the impact is deemed to be negligible given the localised temporary nature of the impact, the nature of the sediments and the absence of a contaminant source in this area.

Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be low (and high for marine water quality). The effect will, therefore, be of **imperceptible and slight (for marine water quality) adverse significance**, which is not significant in EIA terms.

Operational and maintenance phase

Magnitude of impact

Operational and maintenance activities within the offshore wind farm area and offshore cable corridor may lead to increases in suspended sediment concentrations and associated sediment deposition. The Project design parameters include for one inter-array cable repair and one reburial event every five years and three offshore cable repairs and reburial events over the 40-year Project lifetime (see Table 7-13). This work would be undertaken using similar methods as those for cable installation activities (i.e. trenching/jetting, with trench width of 3 m and trench depth of 3 m).

In each case the length of the repair or reburial activity may be up to 2 km; therefore, the magnitude of the impacts would be a fraction of those quantified for the construction phase. In the case of the offshore cable the total length of works would be approximately 35% of the length assessed for the construction phase with events being undertaken over the course of the Project lifetime. Whilst the sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired, the entire length has been quantified under the construction phase scenario discussed above.

The impact is predicted to be of local spatial extent, short term duration and intermittent. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor and significance of the effect

The sensitivity of receptors to changes in suspended sediment concentrations and sedimentation remains the same for all project phases. The significance of the effects will however be reduced as the works are limited to intermittent, discrete repair activities.

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low (and high due to the current classification of the water bodies affected and the fact that the study area is achieving its objectives in terms of the WFD and the MSFD. The effect will, therefore, be of **imperceptible and slight (for marine water quality) adverse significance**, which is not significant in EIA terms.

Decommissioning phase

Decommissioning will involve cutting and removal of monopile foundations below seabed whilst the removal of inter-array and offshore cables would involve disturbance of seabed material from a trench with the same dimension as that into which they were installed. As such, the significance of effect from decommissioning activities are expected to be the same or similar to the effects from construction.

7.10.2 Presence of infrastructure may lead to changes in tidal currents

The presence of infrastructure may lead to changes to tidal currents during the operational and maintenance phase of the Project. Modelling was undertaken using the project design parameters as outlined in Table 7-20. The detail of the modelling assessment is provided in appendix 7-1: Marine Processes Technical Report.

The magnitude of the impact is detailed in this section whilst the assessment of the combined effect of changes to marine processes to relevant receptors is detailed in section 7.10.4.

Operational and maintenance phase

Magnitude of impact

The presence of Project infrastructure may lead to changes in tidal currents. The project design parameters as described in volume 2A, chapter 5: Project Description includes for 26 monopile foundations of 9.6 m in diameter throughout the water column, with a minimum spacing of 944 m between the centre of each foundation.

The results of the modelling indicated that tidal flow is accelerated in the immediate vicinity of each structure as it is redirected around the structure, with a zone of reduced speed in the lee of the structure. These alterations in current speed are generally <4 mm/s which constitutes less than 2% at the peak flows. These changes are also limited to the immediate offshore wind farm area. These changes may have a direct impact on the hydrodynamic regime and persist for the entire lifecycle of the Project. However, they would be imperceptible beyond the immediate vicinity of the offshore wind farm area and would be reversible on decommissioning.

The hydrodynamic regime is highly variable through tidal cycles and due to meteorological conditions, with the scale of the impact being well within the natural variation. The changes to the tidal currents are insignificant in terms of the hydrodynamic regime and will not significantly impact on the supporting hydromorphological conditions in the coastal water bodies within the Marine Processes Study Area ensuring that the ecological status of the Outer Dundalk Bay and the Louth Coast coastal water bodies will remain unaffected.

The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be negligible.

Sensitivity of the receptor and significance of the effect

No assessment of sensitivity of receptor or significance of effect is provided for changes in tidal currents, as this does not represent an impact pathway.

The assessment of the combined effect of changes to marine processes to relevant receptors is assessed in section 7.10.4.

7.10.3 Presence of infrastructure may lead to changes to wave climate and littoral currents

The presence of infrastructure may lead to changes in wave climate and littoral currents (the current resulting from tidal and wave induced currents) during the operational and maintenance phase of the Project. Modelling was undertaken to quantify this using the project design parameters as outlined in Table 7-20, with the detail of the assessment provided in appendix 7-1: Marine Processes Technical Report. The magnitude of the impact is detailed in this section along with the assessment of the effect of changes to marine processes on relevant receptors.

Operational and maintenance phase

Magnitude of impact

The presence of project infrastructure may lead to changes in wave climate and littoral currents. The project design parameters as described in volume 2A, chapter 5 include for 26 monopile foundations of 9.6 m in diameter, with a minimum spacing of 944 m between the centre of each foundation. As with the tidal modelling, these project design parameters were used to quantify potential changes to wave climate and littoral currents.

Examination of the 1 in 2 year wave climate showed a reduction in significant wave heights of around 40 mm which is typically less than 2%. This is limited to the immediate vicinity of the structures. For a more severe 1 in 50 year storm the reduction was seen to be of a similar 40 mm magnitude. For the 1 in 50 year wave climate, the change is less pronounced as the baseline wave height has increased.

The potential effect of the Project on the littoral current (i.e. the combined effect of wave and tidal currents) was also studied. During the flood tide the tidal flow is in concert with the wave climate and the difference in littoral currents from the baseline is both limited in magnitude (to around 30 mm/s) and also spatially, with the alteration in flows limited to the offshore wind farm area. During ebb tide the tidal flow is in opposition to the wave direction and the resulting flow field is more unsteady. The changes in littoral currents due to the structures were found to be imperceptible from the background levels within the modelling.

The hydrodynamic regime is highly variable through tidal cycles and due to meteorological conditions, with the scale of the impact being well with the natural variation. The changes to the wave climate and littoral current are insignificant in terms of the hydrodynamic regime and effects would be reversible on decommissioning (i.e. following removal of the structures).

The impact is predicted to be of local spatial extent, long term duration, continuous and high 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 shoreline within Dundalk Bay is characterised by saltmarshes and intertidal sand/mudflats. Mudflats and sandflats have been designated as features of the Dundalk Bay SAC and pNHA whilst it is also a designated SPA under the EU Birds Directive and RAMSAR (see Table 7-17). Although there are not many coastal features similar to this in Ireland, the areas present in Dundalk Bay are extensive and would recover from the magnitude of the changes in marine processes assessed above. The sensitivity of the receptor to changes in tides, waves and littoral currents is therefore considered to be low.

Much of Clogher Head SAC and pNHA lies above the HWM with the QIs being vegetated sea cliffs and dry heaths therefore these features cannot be directly impacted by any changes in wave climate or littoral currents resulting from the Project. The sensitivity of the receptor to changes in tides, waves and littoral currents is therefore considered to be negligible.

Carlingford Shore SAC and pNHA is designated by shoreline vegetation but the site also has intertidal sand and mudflats with patches of saltmarsh. Carlingford Lough SPA and RAMSAR is designated by wetland and water birds and extends to mean low water therefore assessment of marine processes is applicable in the intertidal zone. The sensitivity of the receptor to changes in tides, waves and littoral currents is considered to be low.

Dunany Point pNHA is proposed to be designated for stony shoreline and clay cliffs. The stony shoreline indicates that the area is adapted to the natural variations in marine processes, but the clay cliff may be vulnerable to coastal erosion. The sensitivity of the receptor to changes in tides, waves and littoral currents is considered to be medium due to the presence of clay cliffs.

Given the assessment of the sensitivity of the above designations and their water dependent habitats the sensitivity of Outer Dundalk Bay and Louth Coast coastal water bodies, within which many of these designations are located, to changes in tides, waves and littoral currents and therefore the supporting hydromorphological conditions are also considered to be low.

Significance of the effect

Changes to tides, waves, and littoral currents due to the presence of the infrastructure do not extend to the Clogher, Carlingford or Dunany designations or to the Outer Dundalk Bay and Louth Coast coastal water bodies and therefore there is no pathway and potential for impacts to these sites. During 1 in 50-year storms from the east, the wave climate is marginally altered at the eastern boundary of the Dundalk Bay SPA and within the Outer Dundalk Bay coastal water body. The reduction in wave height is <0.5% and would be indiscernible from natural variation.

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

7.10.4 Presence of infrastructure may lead to changes in waves and littoral currents, leading to changes in sediment transport

The previous two sections considered the impact of the Project on waves and tidal currents separately. This section considers the potential impact on residual currents (these can be expressed as the mean littoral current flow over the course of a full tidal cycle) and sediment transport. The presence of infrastructure may lead to changes to residual currents (arising from the combination of waves and tides) and sediment transport during the operational and maintenance phase of the Project. Modelling was undertaken using the project design parameters as outlined in Table 7-20, with the detail of the assessment provided in appendix 7-1: Marine Processes Technical Report.

Operational and maintenance phase

Magnitude of impact

The presence of project infrastructure may lead to changes to residual currents and sediment transport. The project design parameters include for 26 monopile base foundations of 9.6 m in diameter and associated scour protection extending 19.2 m in radius beyond the foundation, with a minimum spacing of 944 m between the centre of each foundation.

Residual currents are effectively the driver of sediment transport and therefore any changes to residual currents would have a direct impact on sediment transport which would persist for the lifecycle of the Project. However, if the presence of the foundation structures does not have a significant influence on either tide or wave conditions (see impact assessments presented above for changes in tidal currents and changes to wave climate and littoral current) they cannot therefore have a significant effect on the sediment transport regime. For completeness, the residual current and sediment transport was simulated with the foundations in place, with the increased number of structures. The changes due to the presence of the foundations are very small (often in the order of the model convergence criteria) beyond the immediate vicinity of the structure. During both calm and storm conditions the variation in residual currents and therefore sediment transport processes is limited both in magnitude and spatially. The post-construction regime showed virtually no difference from the baseline scenario.

Cable installation will comprise the burial of both the inter-array and offshore cables. The cables will be buried to a maximum depth of 3 m, with a minimum depth of 0.5 m. In some areas where sufficient burial depth cannot be achieved cable protection may be required depending on the specific ground conditions. Due to the limited nature of the tidal current magnitude the protection required is modest with inter-array protection of 2 m in height and 10 m wide and offshore cable protection being 2 m in height and 10 m wide.

The cable protection will be provided by suitable rock placement or mattressing which allows for low profile protection and features tapering to minimise disruption to flow patterns and scour. The locations where cable protection may be required would be rocky outcrops which are located in areas offshore; mid-way along the offshore cable corridor and at various locations across the offshore wind farm area as shown in Figure 7-5. These outcrops have more limited sediment transport potential. No material will be placed in the intertidal area and landfall location; the cable will be installed by trenching through the intertidal zone to the depth required. Impacts on sediments transport pathways would be negligible due to both the scale and the locations of the cable protection.

The magnitude of the impact on sediment transport is predicted to be of local spatial extent, long term duration, continuous and high reversibility. The magnitude is therefore, considered to be negligible.

Sensitivity of the receptor

The shoreline within Dundalk Bay is characterised by saltmarshes and intertidal sand/mudflats. Mudflats and sandflats have been designated as features of the Dundalk Bay SAC (see Table 7-17). Although there are not many coastal features similar to this in Ireland, the areas present in Dundalk Bay are extensive and would recover from the magnitude of the changes in marine processes assessed above. The sensitivity of the receptor to changes in tides, waves and littoral currents is therefore considered to be low.

Much of Clogher Head SAC and pNHA lies above the HWM with the designated features being vegetated sea cliffs and dry heaths therefore these features are not directly impacted by or classified as coastal features. The sensitivity of the receptor to changes to changes in sediment transport is therefore considered to be negligible.

Carlingford Shore SAC and pNHA is designated by shoreline vegetation but the site also has intertidal sand and mudflats with patches of saltmarsh. Carlingford Lough SPA and RAMSAR is designated by wetland and water birds and extends to mean low water therefore assessment of marine processes is applicable in the intertidal zone. The sensitivity of the receptor to changes in sediment transport is considered to be low.

Dunany Point pNHA is proposed to be designated owing to the presence of stony shoreline and clay cliffs. The stony shoreline indicates that the area is adapted to the natural variations in coastal processes but the clay cliff may be vulnerable to coastal erosion. The sensitivity of the receptor to changes to changes in sediment transport is considered to be low.

Given the assessment of the sensitivity of the above designations and their water dependent habitats the sensitivity of Outer Dundalk Bay and Louth Coast coastal water bodies, within which many of these designations are located, to changes in sediment transport and therefore the supporting hydromorphological conditions are also considered to be low.

Significance of the effect

Changes to sediment transport due to the presence of the infrastructure will not extend to the Dundalk, Clogher, Carlingford or Dunany designations.

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

7.10.5 Impact of pollution caused by accidental spills/contaminants

Construction phase

Magnitude of impact

The impact of pollution within coastal water bodies traversed by the offshore cable corridor and the offshore wind farm area within which the WTG, inter array cables and offshore substation are located may have an adverse effect on marine water quality. Pollution derived from accidental spills/contaminant release during the construction phase will be addressed by the appropriate measures included in the Project as outlined in Table 7-16. Pollution prevention measures to address the risk from accidental spills and contaminants during construction should they arise are included in the following supporting management plans:

- Construction Environmental Management Plan (volume 2A, appendix 5-1 of the EIAR);
- Marine Pollution Contingency Plan (MPCP) (volume 2A, appendix 5-2 of the EIAR); and
- Emergency Response Co-operation Plan (volume 2A, appendix 5-7 of the EIAR).

Provided these measures are implemented, there should be no risk of the Project causing a deterioration in the overall coastal water body status, water dependent protected areas under the WFD or GES of the marine waters under the MSFD. Therefore, the magnitude of the impact will be low.

Sensitivity of the receptor

The sensitivity of the Louth Coast and Outer Dundalk Bay coastal water bodies and the marine waters within which the WTG and offshore substation are located to pollution caused by accidental spills/contaminants is high as these coastal waterbodies are currently achieving high ecological status and therefore are vulnerable to pollution effects which could result in a deterioration of the ecological and chemical status. In addition the marine waters are currently achieving GES for the qualitative descriptor “contaminants in water and biota” and pollution caused by accidental spills/contaminants could result in a deterioration in the environmental status of this qualitative descriptor which would compromise the achievement of the objectives under the MSFD. On this basis the sensitivity of the marine water quality to pollution caused by accidental spills/contaminants is considered to be high.

Significance of the effect

With the implementation of mitigation measures as outlined in Section 7.8 and Table 7-14, the significance of the impact of pollution caused by accidental spills/contaminants will be low. A low magnitude of impact on a high sensitivity receptor results in a significance of effect of **slight adverse** (based on Table 7-18) which is not significant in EIA terms.

Operational and maintenance phase

Magnitude of impact

Pollution from accidental spills/contaminant release may impact on coastal water bodies and marine waters during the operational and maintenance phases. Routine maintenance and servicing of the offshore infrastructure may have impacts on the supporting elements of coastal water bodies namely physico-chemical and chemical supporting elements of the Louth Coast and Outer Dundalk Bay coastal waterbodies.

The main source of pollution and contaminant spills will be from hydrocarbons associated with the Project including Marine Gas Oil (MGO) or Intermediate Fuel Oil (IFO), lubricant oil and hydraulic oil from marine construction vessels. The potential worst-case spill scenario associated with the Project would be a complete loss of fuel inventory from two large vessels as a result of collision, or where a passing vessel collides with a wind farm vessel or structure. It must be noted that for larger vessels, even following a significant collision, it is unlikely that all fuel onboard would enter the water due to location of bunker tanks. Once spilled in the marine environment, oil immediately begins to undergo weathering, a term used to describe many natural, physical, chemical, and biological changes. The changes that the oil undergoes will often influence the effectiveness of response options. Prevailing meteorological and oceanographic conditions, as well as the type of oil spilled, will determine its ultimate fate.

There will also be lubricating oils, hydraulic oils and chemicals (including transformer coolants, paints, paint thinners, solvents and cleaning fluids) used during the operation and maintenance of the Project. Each wind turbine will contain components that require lubricating oils, hydraulic oils and coolants and other chemicals (e.g. paints for operation and maintenance). The offshore substation will include a diesel power generator and storage as well as coolant for the transformers.

The wind turbines and offshore substation will have full containment to ensure there is no leakages or discharges to the marine environment from equipment containing environmental damaging fluids or compounds. As outlined in volume 2A, chapter 5 Project Description the design of the wind turbines and offshore substation includes a drainage system that will collect and contain any leakages from equipment containing environmentally damaging fluids.

When the measures included within the project, as outlined in Section 7.8 and Table 7-14, particularly the Environmental Management Plan (EMP) (see volume 2A, appendix 5-2: Environmental Management Plan), the Marine Pollution Contingency Plan (MPCP) (see volume 2A, appendix 5-2 (Annex 2) and the Emergency Response Co-operation Plan (see volume 2A, appendix 5-7: Emergency Response Co-operation Plan), are taken into consideration the magnitude of the impact form pollution caused by accidental spills/contaminants during the operational and maintenance phase is considered to be low.

Sensitivity of the receptor

The sensitivity of receptors to pollution caused by accidental spills/contaminants remains the same for all project phases. The significance of the effects will however be reduced during the operation and maintenance phase as the works are limited to intermittent, discrete maintenance and repair activities.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high due to the current classification of the water bodies affected and the fact that the study area is achieving its objectives in terms of the WFD and the MSFD. The effect will, therefore, be of slight adverse significance, which is not significant in EIA terms.

Significance of the effect

With the implementation of mitigation measures, the significance of the impact of pollution caused by accidental spills/contaminants will be low. A low magnitude of impact on a high sensitivity receptor results in a significance of effect of **slight adverse** which is not significant in EIA terms.

Decommissioning Phase

Wind turbines and the offshore substation topside will be removed by reversing the methods used to install them for disassembly and reuse, recycling or disposal onshore. Decommissioning of the foundations will involve cutting and removal of monopile foundations below seabed whilst the removal of inter-array and offshore cables would involve disturbance of seabed material from a trench with the same dimension as that into which they were installed. As such, the significance of effect from decommissioning activities are expected to be the same or similar to the effects from construction.

7.10.6 Mitigation and residual effects

The assessment of impacts has concluded that there are no significant effects with the implementation of the measures included in the Project (as outlined in section 7.8.2). Therefore, no measures over those as outlined in section 7.9.2 are required.

With the implementation of the measures included in the Project (section 7.8.2), the residual effects are as outlined in the assessment provided in section 7.10.

7.10.7 Future monitoring

No marine processes monitoring to test the predictions made within the impact assessment is considered necessary.

Compliance monitoring of the Environmental Management Plan (EMP) (see volume 2A, appendix 5-2: Environmental Management Plan) and the mitigation measures therein will be undertaken through the duration of the Project. This is to ensure the measures are being implemented correctly and to provide an evidence base to demonstrate they are working effectively. Any observations or corrective actions arising from audits and inspections will be addressed, with procedures updated in this EMP as required.

7.11 Cumulative Impact Assessment (CIA)

7.11.1 Methodology

The CIA considers the impact associated with the Project together with other projects within the Marine Processes and Water Quality Study Area. 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). 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 Marine Processes Study Area (20 km buffer from the offshore wind farm area):

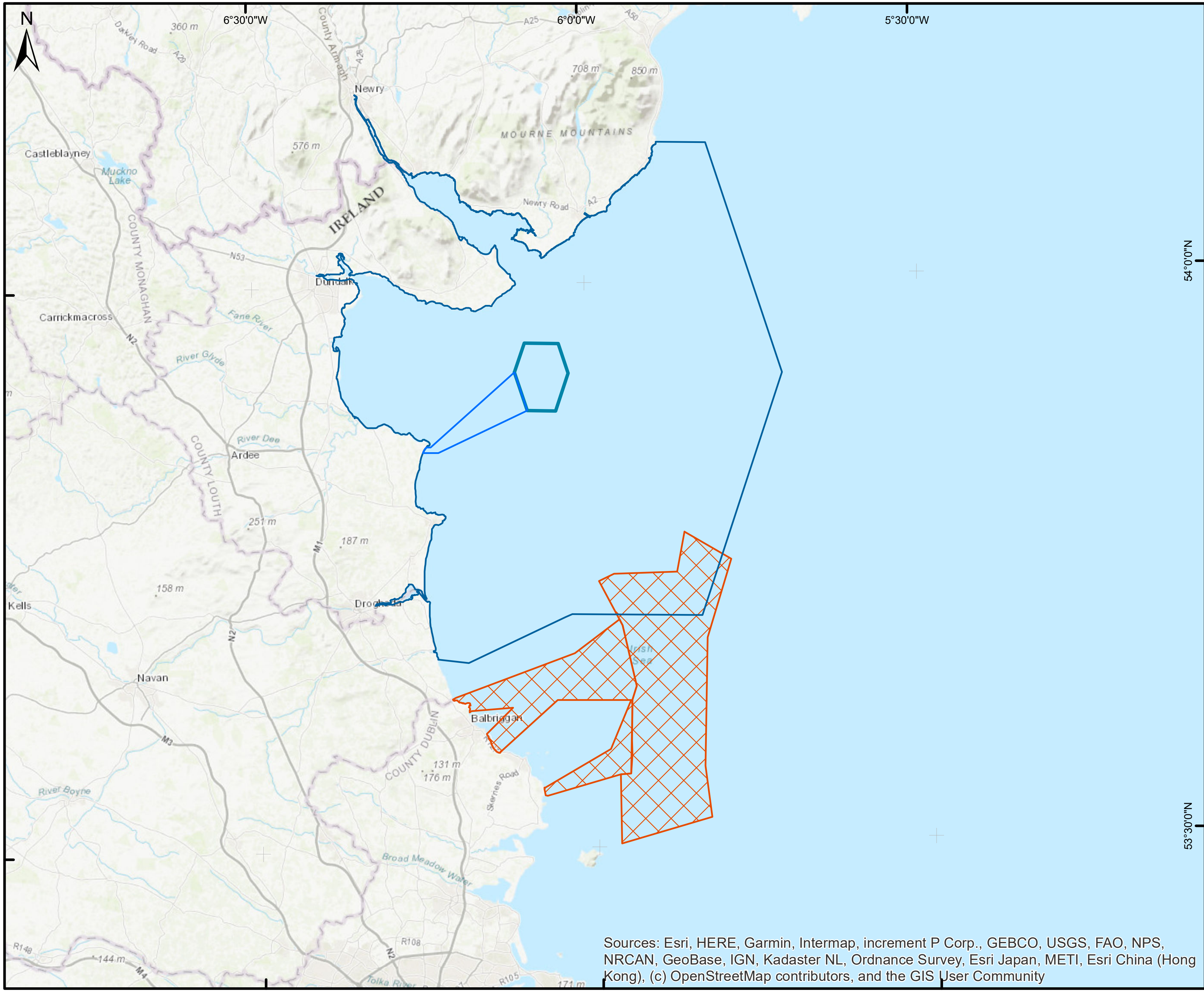
- Other projects with consent but not yet constructed/construction not completed:
- Other projects in a consent application process but not yet determined (including planning applications, foreshore lease/licence applications, EPA Dumping at Sea Permit applications);
- Other projects currently operational 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).

The specific projects screened into this CIA are outlined in Table 7-19.

Table 7-19: List of other projects considered within the CIA.

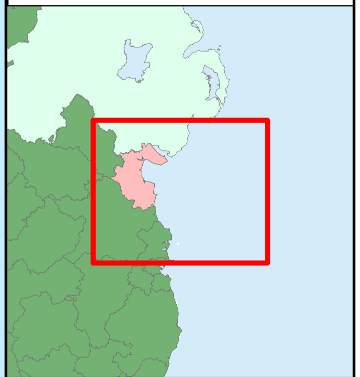
Project/Plan	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project/Plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Renewables							
North Irish Sea Array (NISA)	Maritime Area Consent	16.2 km	18.1 km	EIA Scoping Report (2021) refers to the construction of an offshore wind farm of up to 500 MW, consisting of 36 turbines with a maximum height of 320 m and rotor diameter of up to 290 m. Offshore substation platforms may be required.	Unknown	Unknown (Design life minimum 35 years)	Screened in due to potential for construction and operational phase to coincide with the construction and/or operational and maintenance phases of the Project. Potential cumulative impact to sediment concentration/transport and pollution from accidental spills/contaminants.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Cumulative Benthic Subtidal and Intertidal Ecology Study Area
- Statkraft North Irish Sea Array (NISA)

Data Sources: Client, Ordnance Survey Ireland, RPS



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title **Figure 7-9**

Other projects screened into the Cumulative Impact Assessment

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Issue Details

Drawn By: NG	**Project No.** EOR0822 (MDR1520B)
Checked By: NG	**File Ref:**
Approved By: AOS	EOR0822_BEN_E_1108_FINAL
Scale: 1:500,000 @ A4	**Projection:** ITM (IRENET95)
Date: 12/03/2024	Geographic Co-ordinates: ETRS89

Table 7-20 presents the relevant project design parameters from Table 7-13 which are used to assess the potential cumulative impact of the Project with the other projects identified in Table 7-20 (where information is available).

Table 7-20: Project design parameters considered for the assessment of potential cumulative impacts on marine processes.

Potential impact	Phase			Project design parameters	Justification
	C	O	D		
Increased suspended sediment concentrations and associated deposition	✓	✓	✓	Project design parameters as described for the Project (see Table 7-13) assessed cumulatively with NISA.	Potential overlap of sediment plumes from Project construction, operation, maintenance and decommissioning activities with those from other project activities.
Impact of pollution caused by accidental spills/contaminants	✓	✓	✓	Project design parameters as described for the Project (see Table 7-13) assessed cumulatively with NISA.	Potential overlap of pollution risk from Project construction, operation, maintenance and decommissioning activities with those from other project activities.

7.11.2 Assessment of significance

A description of the significance of cumulative effects upon marine processes and water quality arising from the identified impact is given below.

Increased suspended sediment concentrations and associated deposition

Increased suspended sediment concentrations and associated deposition may arise due to the installation of the WTG and OSS foundations, the installation and/or maintenance of inter-array cables and the offshore cable and associated decommissioning activities. Should NISA take place concurrently with Project construction, operation and maintenance or decommissioning activities, there is potential for cumulative increased turbidity levels.

Magnitude of impact

The magnitude of the increase in suspended sediment concentrations and associated deposition arising from Project activities has been assessed as negligible for the project alone, as described in section 7.10 for the construction, operational and maintenance and decommissioning phases.

NISA is proposed south/southeast of the Project and may see the construction of up to 46 turbines, subject to planning decision. Although the exact method of turbine installation is unknown, it has been assumed that there is the potential for sediment plumes to overlap and result in increased sediment plume concentration.

Overall, the cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The nature of the sediments and the absence of a contaminant source in this area means that the potential for the disturbance of sediment contaminants is very low. The magnitude of the impact from increased suspended sediment concentrations and associated deposition is therefore, considered to be negligible.

Sensitivity of receptor and significance of the effect

The sensitivity of the receptor for cumulative effects remains the same as for the effects of increases in suspended sediment concentrations in the construction phase as outline in section 7.10.

Subject to the final design and construction methods of NISA, the potential for sediment plume overlap with the installation of turbines in the southern extents of the offshore area may arise. However, given the distance between the Project and the proposed NISA site, as well as the extents of the Project modelled sediment plumes on the southern boundary of the offshore area, the potential for interaction is likely to be limited. All other receptors are unaffected.

Overall, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be low and high (for marine water quality). The effect will, therefore, be of **imperceptible and slight (for marine water quality) adverse significance**, which is not significant in EIA terms.

Impact of pollution caused by accidental spills/contaminants

Should NISA take place concurrently with Project construction, operation and maintenance or decommissioning activities, there is potential for cumulative increased turbidity levels.

Magnitude of impact

Pollution prevention measures to address the risk from accidental spills and contaminants during construction should they arise are included in the following supporting management plans:

- Construction Environmental Management Plan (Volume 2A, appendix 5-1 of the EIAR);
- Marine Pollution Contingency Plan (MPCP) (volume 2A, appendix 5-2 of the EIAR); and
- Emergency Response Co-operation Plan (Volume 2A, appendix 5-7 of the EIAR).

Provided these measures are implemented, there should be no risk of the Project causing a deterioration in the overall coastal water body status, water dependent protected areas under the WFD or GES of the marine waters under the MSFD.

Given the location of the NISA Project within different coastal water bodies and a different part of the Irish Sea and the measures included in the Project the cumulative magnitude of the impact will remain low.

Sensitivity of the receptor

The sensitivity of the Louth Coast and Outer Dundalk Bay coastal water bodies and the marine waters within which the WTG and offshore substation are located to pollution caused by accidental spills/contaminants is remains high as these coastal waterbodies are currently achieving high ecological status and therefore are vulnerable to pollution effects which could result in a deterioration of the ecological and chemical status. In addition the marine waters are currently achieving GES for the qualitative descriptor “contaminants in water and biota” and pollution caused by accidental spills/contaminants could result in a deterioration in the environmental status of this qualitative descriptor which would compromise the achievement of the objectives under the MSFD. On this basis the sensitivity of the marine water quality to pollution caused by accidental spills/contaminants is considered to be high.

Significance of the effect

With the implementation of measures as outlined in Section 7.8 and Table 7-14, the significance of the cumulative impact of pollution caused by accidental spills/contaminants will be low. A low magnitude of impact on a high sensitivity receptor results in a significance of effect of **slight** (based on Table 7-18) which is not significant in EIA terms.

Operational and maintenance phase

Magnitude of impact

Pollution from accidental spills/contaminant release may impact on coastal water bodies and marine waters during the operational and maintenance phases. Routine maintenance and servicing of the offshore infrastructure and have impacts on the supporting elements of coastal water bodies namely physico-chemical and chemical supporting elements of the Louth Coast and Outer Dundalk Bay coastal waterbodies. However given the separation distances between both projects and the industry best practice measures in terms of the drainage design of the WTG and offshore substation and operational pollution prevention plans as outlined in section 7.8 and Table 7-14 the potential for cumulative effects is not considered significant and the magnitude of the cumulative impact form pollution caused by accidental spills/contaminants during the operational and maintenance phase is considered to remain low.

Sensitivity of the receptor

The sensitivity of receptors to pollution caused by accidental spills/contaminants remains the same for all project phases. The significance of the effects will however be reduced during the operation and maintenance phase as the works are limited to intermittent, discrete maintenance and repair activities.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high due to the current classification of the water bodies affected and the fact that the study area is achieving its objectives in terms of the WFD and the MSFD. The effect will, therefore, be of **slight adverse** significance, which is not significant in EIA terms.

Significance of the effect

With the implementation of mitigation measures, the significance of the impact of pollution caused by accidental spills/contaminants will be low. A low magnitude of impact on a high sensitivity receptor results in a significance of effect of slight which is not significant in EIA terms.

Decommissioning Phase

Wind turbines and the offshore substation topside will be removed by reversing the methods used to install them for disassembly and reuse, recycling or disposal onshore. Decommissioning of the foundations will involve cutting and removal of monopile foundations below seabed whilst the removal of inter-array and offshore cables would involve disturbance of seabed material from a trench with the same dimension as that into which they were installed. As such, the significance of cumulative effects from decommissioning activities are expected to be the same or similar to the effects from construction.

7.12 Transboundary effects

The border between Ireland and Northern Ireland (UK) lies within the 20 km Marine Processes Study Area. In relation to transboundary effects, changes to hydrography as a result of the Project do not extend to the border with Northern Ireland and therefore there is minimal potential for transboundary impacts to physical processes, including tidal and littoral currents, wave climate and therefore marine water quality. During installation of structures in the northwest of the offshore array area sediment plumes were noted, on occasion, to cross the border. However, maximum sediment concentrations were <5 mg/l and did not persist or result in any discernible sedimentation (see Figure 3-43 in appendix 7-1: Marine Processes Technical Report). As such, it is considered that any potential transboundary effects of increased suspended sediments and sediment deposition are highly unlikely.

7.13 Interactions

A description of the likely interactions arising from the Project on marine processes is provided in volume 2C, chapter 32: Interactions.

7.14 Summary of impacts, mitigation measures and residual effects

Information on marine processes and marine water quality was established from desk studies, site-specific surveys, and a comprehensive numerical modelling study.

Table 7-21 presents a summary of the potential impacts, mitigation measures and residual effects in respect to marine processes and marine water quality. Table 7-22 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The impacts assessed include:

- Increased suspended sediment concentrations and associated deposition;
- Changes to tidal currents;
- Changes to wave climate and littoral currents;
- Changes to residual current and sediment transport; and

- Impact of pollution caused by accidental spills/contaminants.

Potential changes in suspended sediment concentrations and associated deposition were quantified to inform the associated receptor assessments (i.e. chapter 8: Benthic Subtidal and Intertidal Ecology and chapter 9: Fish and Shellfish Ecology). The magnitude of the changes arising from the Project to tidal currents and wave climate, and therefore the supporting hydromorphological conditions of the water bodies affected, has been assessed to be negligible, with no significant effects predicted on the identified receptors and not significant in EIA terms.

Environmental Management Plan (EMP) (see volume 2A, appendix 5-2: Environmental Management Plan), the Marine Pollution Contingency Plan (MPCP) (see volume 2A, appendix 5-2 (Annex 2) and the Emergency Response Co-operation Plan (see volume 2A, appendix 5-7: Emergency Response Co-operation Plan), are taken into consideration the magnitude of the impact form pollution caused by accidental spills/contaminants during the operational and maintenance phase is considered to be low and the overall significance of effect on a high sensitivity receptor is considered to be slight which is not significant in EIA terms.

The cumulative impacts assessed include: increased suspended sediment concentrations and associated deposition and the impact of pollution caused by accidental spills/contaminants. The magnitude of the cumulative impact has been assessed to be negligible and low respectively with the significance of these effects being negligible and slight which is not significant in EIA terms.

No potential transboundary impacts have been identified in regard to effects of the Project.

Table 7-21: Summary of potential environment effects, mitigation and monitoring.

Description of impact	Phase C	Phase O	Phase D	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Increased suspended sediment concentrations and associated deposition	✓	✓	✓	Scour protection	C: Negligible O: Negligible D: Negligible	Low; High (marine water quality)	C: Imperceptible; Slight (marine water quality) O: Imperceptible; Slight (marine water quality) D: Imperceptible; Slight (marine water quality)	None	C: Imperceptible; Slight (marine water quality) O: Imperceptible; Slight (marine water quality) D: Imperceptible; Slight (marine water quality)	None
Presence of infrastructure may lead to changes to tidal currents	✗	✓	✗	N/A	O: Negligible	No receptor pathway	O: N/A	N/A	N/A	N/A
Presence of infrastructure may lead to changes to wave climate and littoral currents	✗	✓	✗	N/A	O: Negligible	Low	O: Imperceptible	None	O: Imperceptible	None
Presence of infrastructure may lead to changes to waves and tidal currents, leading to changes in sediment transport	✗	✓	✗	N/A	O: Negligible	Low	O: Imperceptible	None	O: Imperceptible	None
Impact of pollution caused by accidental spills/contaminants	✓	✓	✓	Environmental Management Plan (EMP); Marine Pollution Contingency Plan (MPCP); and Emergency Response Co-operation Plan (ERCoP).	C: Low O: Low D: Low	High	C: Slight O: Slight D: Slight	None	C: Slight O: Slight D: Slight	None

Table 7-22: Summary of potential cumulative environment effects, mitigation and monitoring.

Description of impact	Phase C	Phase O	Phase D	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Increased suspended sediment concentrations and associated deposition	✓	✓	✓	Scour protection	C: Negligible O: Negligible D: Negligible	Low; High (marine water quality	C: Imperceptible; Slight (marine water quality) O: Imperceptible; Slight (marine water quality) D: Imperceptible; Slight (marine water quality)	None	C: Imperceptible; Slight (marine water quality) O: Imperceptible; Slight (marine water quality) D: Imperceptible; Slight (marine water quality)	None
Impact of pollution caused by accidental spills/contaminants	✓	✓	✓	Environmental Management Plan (EMP); Marine Pollution Contingency Plan (MPCP); and Emergency Response Co-operation Plan (ERCoP).	C: Low O: Low D: Low	High	C: Slight O: Slight D: Slight	None	C: Slight O: Slight D: Slight	None

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