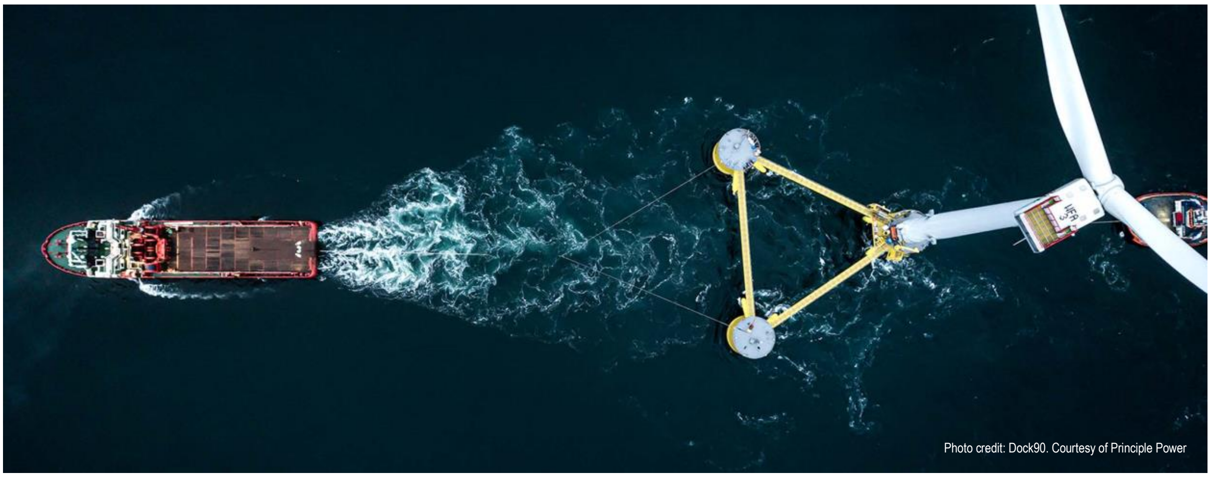

Project Erebus Environmental Statement
Chapter 7: Marine Sediment and Water Quality

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Acronyms

Term	Definition
AA	Annual Average
CCME	Canadian Council of Ministers of the Environment
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CoCP	Code of Construction Practice
DCO	Development Consent Order
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EMMP	Environmental Monitoring and Mitigation Plan
EQS	Environmental Quality Standard
EQSD	Environmental Quality Standards Directive
GEP	Good Ecological Potential
GES	Good Ecological Status
HDD	Horizontal Directional Drill
HRA	Habitats Regulations Assessment
ISQG	Interim Marine Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
LOD	Limit of Detection
MAC	Maximum Allowable Concentration
META	Marine Energy Test Area
MFE	Mass Flow Excavator
MPCP	Marine Pollution Contingency Plan
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDE	Project Design Envelope
PEL	Probable Effect Level
PPG	Pollution Prevention Guidelines
RBMP	River Basin Management Plans
SBE	Simply Blue Energy
SPM	Suspended Particulate Matter
SSC	Suspended Sediment Concentration
TBT	Tributyl Tin
TEL	Threshold Effect Level
THC	Total Hydrocarbon
TSHD	Trailing Suction Hopper Dredge

Term	Definition
WFD	Water Framework Directive
WNMP	Welsh National Marine Plan
WTG	Wind Turbine Generator

Chapter 7 Marine Sediment and Water Quality

7.1 Introduction

7.1.1.1 The proposed Project Erebus (the Project) is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The Applicant, Blue Gem Wind, is a joint venture between Simply Blue Energy (SBE) and TotalEnergies, set up to create a new low carbon offshore energy sector in the region; that contributes to climate change targets, supply chain diversification and energy security.

7.1.1.2 This assessment has been carried out by MarineSpace Limited, the lead offshore Environmental Impact Assessment (EIA) Consultants. The Chapter has been authored by Damien Kirby, who has over seven years' experience as a marine professional. He was previously employed at Cefas, during which time he provided advice to UK regulatory bodies on technical reports submitted as part of EIA, Habitats Regulations Assessment (HRA) or Water Framework Directive (WFD) assessments.

7.1.1.3 The array area is located approximately 35 km southwest of the Pembrokeshire coastline, covering an area of 43.5 km^2 in water depths of between 65-85 m. The array area is located outside of the 12 nm limit, but all elements of the Project, array area, offshore export cable corridor and landfall, fall within Welsh territorial waters or the Welsh Zone.

7.1.1.4 The Project comprises six to ten Wind Turbine Generators (WTG) with a total generating capacity up to 100 MW. Each WTG is housed on a semi-submersible floating platform with a mooring system comprising a maximum of five catenary mooring lines, up to 870 m in length, and a range of foundation options including drag embedment anchors, driven piles, drilled piles and/or suction piles. Up to 10 dynamic array cables are proposed, with a lazy wave configuration from the semi-submersible floating platform to the seabed. The offshore export cable, up to 49 km in length, links the array area to landfall at West Angle Bay, Pembrokeshire.

7.1.1.5 The Study Area for this assessment is defined in Section 7.4. Project-specific water and sediment quality samples were collected during offshore surveys in summer 2020. The data from these, along with desk-based review of available data/literature as described in Section 7.4.3, have been used to define the baseline environment and inform this assessment - see Section 7.4.

7.1.1.6 This chapter provides a description of the existing baseline environment with regard to marine water and sediment quality. Additional assessment is provided for potential effects of the Proposed Development during the construction, operation and decommissioning phases. Where the potential for significant effects is identified, mitigation measures are presented.

7.1.1.7 This chapter utilises and builds upon the information presented in the Project Erebus EIA Scoping Report (MarineSpace, 2019) and in the formal EIA Scoping Opinion (NRW, 2020). Copies of the Scoping Opinion Request (the Scoping Report) and Natural Resource Wales's (NRW's) Scoping Opinion are provided in Volume 3, Technical Appendices 2.1 and 2.2, respectively.

7.1.1.8 This chapter has drawn upon information provided in:

- Chapter 6: Marine and Coastal Processes;
- Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment;
- Volume 3, Technical Appendix 7.1: Water Framework Directive Assessment;

- Volume 3, Technical Appendix 9.1: Integrated report (Geophys and Habitat Assessment);
- Volume 3, Technical Appendix 9.2: Environmental Baseline Report; and
- Volume 3, Technical Appendix 9.3: Intertidal Report.

7.1.1.9 The potential impacts on water and sediment quality have been assessed conservatively using realistic worst case scenarios for the Project, summarised in Table 7.11. The Project Design Envelope (PDE) is provided in full in Chapter 4: Proposed Development Description.

7.1.1.10 This chapter should also be read in conjunction with Chapter 6: Marine and Coastal Processes.

7.2 Legislation, Policy and Guidelines

7.2.1.1 The principal European and International policy and legislation documents or standards and guidelines used to inform the assessment of potential impact on marine water and sediment quality include:

- European Commission (EC) Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (the Water Framework Directive), which has been transposed into UK law by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- EC Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC (the Bathing Waters Directive), which is transposed into UK law by The Bathing Water Regulations 2013;
- EC Directive 2008/105/EC on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC;
- EC Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive), transposed into UK law by The Marine Strategy Regulations 2010;
- The International Convention for the Prevention of Marine Pollution by Ships (MARPOL Convention) 73/78;
- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment, 2002); and
- Cefas Action Levels for the disposal of dredged material.

7.2.2 The Water Framework Directive

7.2.2.1 The Water Framework Directive (WFD) sets out legal requirements intended to encourage the sustainable use of water and to protect and improve surface waters (including rivers, lakes, transitional and coastal waters, and man-made water bodies), and groundwater bodies. The Directive commits EU member states to achieve good quantitative and qualitative status of all water bodies.

7.2.2.2 Even though the UK has now exited the EU, the WFD remains transposed into UK law through the Water Environment Regulations, which require that all UK waterbodies must achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by 2027, with interim targets in 2015 and 2021. It also requires that environmental objectives be set for all waterbodies to either maintain Good Status, or to move towards Good Status if a waterbody is currently failing its target. Under all conditions, it requires that there should be no deterioration in status.

7.2.2.3 Water body classification is based on two separate categories: ecological and chemical. For a water body to be in overall 'good' status, both ecological and chemical status must be at least 'good'. The ecological status of surface waters is classified using information on the biological, physico-chemical and hydromorphological quality of the body of water.

7.2.2.4 Ecological status is recorded on the scale of high, good, moderate, poor or bad. 'High' denotes largely undisturbed conditions and the other classes represent increasing deviation from this natural condition, otherwise described as a 'reference condition'. Classification under the WFD is determined in accordance with the 'one out, all out' principle, meaning that the worst assessment result for a biological quality element determines the overall assessment result. This means that the condition of a single quality element can cause a water body to fail to reach its WFD classification objectives.

7.2.2.5 Chemical status is assessed by compliance with environmental standards for chemicals that are listed in the EC Environmental Quality Standards Directive (2008/105/EC). These chemicals include priority substances, priority hazardous substances, and eight other pollutants carried over from the Dangerous Substance Daughter Directives. Chemical status is recorded as 'good' or 'fail'. The chemical status classification for the water body is determined by the worst scoring chemical.

7.2.2.6 The WFD seeks to reduce Priority Substances (there are 20 Priority Substances and 13 Priority Hazardous Substances = 33 in total) in the marine environment through the use of the Environmental Quality Standards Directive (EQSD) for discharges and outfalls. In addition, there are a further eight pollutants, which fall under the scope of Directive 86/280/EEC and which are included in List I of the Annex to Directive 76/464/EEC, but are not in the Priority Substances list. Environmental quality standards for these substances are, however, included in the Environmental Quality Standards Directive 2008/105/EC.

7.2.2.7 Where the hydromorphology of a surface water body has been significantly altered for anthropogenic purposes, it can be designated as an Artificial or Heavily Modified Water Body (A/HMWB). An alternative environmental objective, GEP applies in these cases.

7.2.2.8 River Basin Management Plans (RBMPs) developed for each River Basin District (RBD) set out the current status classification of all waterbodies, as well as the objectives and actions required to maintain or improve the current Status of each waterbody.

7.2.2.9 The Project offshore Export Cable Corridor (ECC) passes through Milford Haven Outer coastal water body (GB641008220000), which is at Moderate Ecological Status because of high concentrations of dissolved inorganic nitrogen, mercury, and mercury-containing compounds; and Pembrokeshire South coastal water body (GB611008590003), which is at Good Ecological Status.

7.2.3 Shellfish Waters Directive

7.2.3.1 The WFD has repealed 'Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the Quality Required of Shellfish Waters', also known as the Shellfish Waters Directive. This Directive was in place to protect and improve water quality and support the growth of healthy shellfish (bivalve and gastropod molluscs) and contribute to good quality edible shellfish. These requirements are now included within the WFD to ensure that historic designated Shellfish Waters (now recognised as Shellfish Water Protected Areas under the WFD) retain at least the same level of protection as they had under the Shellfish Waters Directive.

7.2.3.2 The Shellfish Waters Directive established parameters applicable to designated

Shellfish Waters, as well as indicative values, mandatory values, reference methods of analysis and the minimum frequency for taking samples and measurements. These parameters are set for pH, temperature, colouration, suspended solids, salinity, faecal coliforms, saxitoxin, substances affecting shellfish taste and the presence or concentration of certain substances (dissolved oxygen, hydrocarbons, metals, organohalogenated substances etc.).

7.2.3.3 The competent authorities for each Member State (even though the UK has now exited the EU, in this case, it is still NRW) must take samples from the waters to verify their conformity with the criteria set by the Directive. The following proportions of samples must conform to the established values:

- 100% of the samples for the parameters 'organohalogenated substances' and 'metals';
- 95% of the samples for the parameters 'salinity' and 'dissolved oxygen';
- 75% of the samples for the other parameters; and
- No evidence of harm to the shellfish from organohalogenated compounds.

7.2.3.4 Additionally, the Directive stipulated that a discharge should not cause increase of suspended solids to exceed 30% above background levels, as shellfish can be adversely affected by the smothering effects of sediment settling.

7.2.4 The Bathing Waters Directive

7.2.4.1 The Bathing Waters Directive is implemented through the Bathing Waters Regulations 2013 and subsequent amendments (2014, 2016, 2017 and 2020). This requires that bathing waters are monitored every year and the monitoring calendar should provide for at least four samples to be taken per season (except where the season is very short or where there are special geographic constraints). The sampling interval should not be longer than one month. From the point that three years of monitoring results are available, assessment of bathing waters should be completed at the end of every season. A shorter period may be acceptable in some cases.

7.2.4.2 NRW monitors and assesses bathing water quality at each designated bathing water site in Wales between May and September.

7.2.4.3 Under the revised Bathing Waters Directive (2006/7/EC) more stringent water quality standards have been set, and a stronger emphasis placed on beach management. The bacterial parameters are updated to constitute tests for:

- *Escherichia coli*; and
- Intestinal enterococci.

7.2.4.4 NRW must also undertake appropriate monitoring for cyanobacteria, must undertake investigations for macro-algae and marine phytoplankton and must undertake visual inspections for waste, including tarry residues, glass, plastic or rubber.

7.2.4.5 Assessment of potential impacts on designated Bathing Waters is made in Section 7.6.5.

7.2.5 Marine Strategy Framework Directive

7.2.5.1 The objective of the Marine Strategy Framework Directive (MSFD) is to achieve 'good environmental status' in Europe's seas by 2020, and to protect the resources upon which marine-related economic and social activities depend.

7.2.5.2 The MSFD enshrines, in a legislative framework, the ecosystem approach to the management of human activities having an impact on the marine environment, in order to enable the sustainable use of the marine environment and to safeguard its use for future generations.

7.2.5.3 The MSFD establishes European marine regions and sub-regions on the basis of geographical and environmental criteria and requires each Member State to develop a strategy for its marine waters (or Marine Strategy). In addition, because the MSFD follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every six years.

7.2.5.4 In coastal waters out to 1 nm, both the WFD and the MSFD apply, however, inside WFD coastal waters the MSFD only applies for aspects of good environmental status that are not already addressed by the WFD.

7.2.6 MARPOL Convention

7.2.6.1 The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78) was developed by the International Maritime Organization in an effort to minimise pollution of the oceans and seas, including dumping, oil and air pollution. The UK is a signatory to the MARPOL Convention 73/78.

7.2.6.2 All ships flagged under countries that are signatories to MARPOL are subject to its requirements, regardless of where they sail; and member nations are responsible for vessels registered on their national ship registry.

7.2.6.3 The objective of this convention is to preserve the marine environment in an attempt to completely eliminate pollution by oil and other harmful substances and to minimise accidental spillage of such substances.

7.2.7 Cefas Action Levels for the Disposal of Dredged Material

7.2.7.1 One means of assessing the pollution potential associated with marine sediment is to compare their analysed contaminant levels with the ‘Action Levels’ for contaminants as defined by Centre for Environment, Fisheries and Aquaculture Science (Cefas). However, it should be noted that these are not statutory standards.

7.2.7.2 Action Levels are used by Cefas as part of a ‘weight of evidence’ approach to assessing sediment contamination, and the suitability for the disposal at sea of such sediment. For Cefas’ decision making process, these values are used in conjunction with a range of other assessment methods, including bioassays, the disposal site characteristics and other relevant data.

7.2.7.3 In general, contaminant levels in sediment below Action Level 1 are of no concern to Cefas and unlikely to influence the licensing decision, while sediment with contaminant levels above Action Level 2 is generally considered unsuitable for sea disposal. Where contaminant levels lie between Action Levels 1 and 2, further consideration must be made before disposal. However, there is no prohibition that sediment exceeding Action Level 1 for contaminants is unsuitable for further use or disposal at sea. Fine (muddy) sediments have a higher risk of containing contaminants (due to a relatively large surface area and greater cation exchange capacity) than coarser sediments, such as sand and gravel.

7.2.7.4 Selected current Action Levels are set out in Table 7.1.

Table 7.1 – Cefas Action Levels (from MMO, 2018)

	Action Level 1	Action Level 2
Contaminant / Compound	**mg/kg Dry Weight (ppm)**	**mg/kg Dry Weight (ppm)**
Arsenic	20	100
Mercury	0.3	3
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Lead	50	500
Zinc	130	800
Organotins; TBT DBT MBT	0.1	1
PCBs, sum of ICES 7	0.01	None
PCBs, sum of 25 congeners	0.02	0.2
PAHs	0.1	None
Total Hydrocarbons	100	None
DDT	0.001	None
Dieldrin	0.005	None

7.2.8 Canadian Sediment Quality Guidelines for the Protection of Aquatic Life

7.2.8.1 Canadian sediment guidelines for the protection of aquatic life were developed under the auspices of the Canadian Council of Ministers of the Environment (CCME) to help set targets for sediment quality that would sustain long-term aquatic ecosystem health. The guidelines were developed from the available scientific information on the biological effects of sediment associated chemicals.

7.2.8.2 The sediment quality guidelines are numerical concentrations or narrative statements that, unless otherwise specified, refer to the total concentration of a substance in surficial sediments (i.e. the upper few centimetres) on a dry weight basis (e.g. mg/kg dry weight).

7.2.8.3 These standards are not statutory and are based on the protection of pristine environments. There are two assessment levels, the Threshold Effect Level (TEL) is the lower of the levels and represents the concentration below which adverse biological effects are expected to occur only rarely.

7.2.8.4 The higher level, the Probable Effect Level (PEL), defines a concentration above which adverse effects may be expected in a wider range of organisms. Selected Canadian guidelines are presented in Table 7.2.

Table 7.2 – Canadian Council of Ministers of the Environment (CCME) Interim Marine Sediment Quality Guidelines/threshold effect values (ISQGs/TELs; dry weight) and probable effect levels (PELs; dry weight)

Contaminant		Units	TEL	PEL
Arsenic		mg/kg	7.24	41.6
Cadmium		mg/kg	0.7	4.2
Chromium		mg/kg	52.3	160
Copper		mg/kg	18.7	108
Lead		mg/kg	30.2	112
Mercury		mg/kg	0.13	0.7
Zinc		mg/kg	124	247
Total Polychlorinated Biphenols (PCBs)		mg/kg	0.0215	0.189
Polycyclic aromatic hydrocarbons (PAHs)	Acenaphthene	mg/kg	0.00671	0.0889
	Acenaphthylene	mg/kg	0.00587	0.128
	Anthracene	mg/kg	0.0469	0.245
	Benz(a)anthracene	mg/kg	0.0748	0.693
	Benzo(a)pyrene	mg/kg	0.0888	0.763
	Chrysene	mg/kg	0.108	0.846
	Dibenz(a,h)anthracene	mg/kg	0.00622	0.135
	Fluoranthene	mg/kg	0.113	0.494
	Fluorene	mg/kg	0.0212	0.144
	2-Methylnaphthalene	mg/kg	0.0202	0.201
	Naphthalene	mg/kg	0.0346	0.391
	Phenanthrene	mg/kg	0.0867	0.544
	Pyrene	mg/kg	0.153	1.398

7.2.9 National Policy Statements

7.2.9.1 Although this Project is seeking Section 36 consent under the Electricity Act 1989 and a Marine Licence under the Marine and Coastal Access Act (MCAA) 2009, as opposed to a Development Consent Order (DCO), its size (up to 100 MW) is similar to the minimum threshold (100 MW) for Nationally Significant Infrastructure Projects (NSIPs). As such, guidance relevant to NSIPs is considered relevant to use for this Project. National Policy Statements (NPSs) were developed to provide guidance in the determination of NSIPs. Those relevant for the assessment of impacts on marine water and sediment quality include[1]:

- Overarching NPS for Energy (EN-1) (DECC, 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3), July 2011 (DECC, 2011b).

7.2.9.2 Table 7.3 identifies sections of EN-1 and EN-3 most relevant to this assessment. These highlight specific assessment requirements for marine water and sediment quality, with reference to where this information is contained within the respective NPS. The planning policy described has been reviewed and taken into account as part of this assessment.

Table 7.3 – NPS EN-1 and EN-3 Assessment Provisions Relevant to Marine Sediment and Water Quality

NPS Requirement	NPS Reference	ES Reference
Infrastructure development can have adverse effects on the water environment, including groundwater, inland surface waters, transitional waters and coastal waters. During the construction, operation and decommissioning phases, discharges would occur. There may also be an increased risk of spills and leaks of pollutants to the water environment. These effects could lead to adverse impacts on health or on protected species and habitats and could, in particular, result in surface waters, ground waters of protected areas failing to meet environmental objectives established under the Water Framework Directive	EN1, Section 5.15.1	Predictions for changes to the wider water environment are presented throughout Section 7.6.
Where the project is likely to have adverse effects on the water environment, the application should undertake an assessment of the existing status of, and impacts of the proposed project, on water quality, water resources and physical characteristics of the water environment as part of the Environmental Statement or equivalent	EN1, Section 5.15.2	Predictions for changes to the wider water environment are presented throughout Section 7.6.
The existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges. Existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics; and any impacts of the proposed project on waterbodies or	EN1, Section 5.15.3	Predictions for changes to the wider water environment, including specific reference to WFD protected areas are presented throughout Section 7.6 and within

[1] A period of consultation on a set of revised energy NPS's, managed by the Department of Business, Energy and Industrial Strategy (BEIS), ended on 29th November 2021.

protected areas under the Water Framework Directive		Volume 3, Technical Appendix 7.1: WFD Assessment
Where the project is likely to have effects on water quality or resources the applicant should undertake an assessment as required in EN-1, Section 5.15.	EN3, Section 2.5.85	Assessment of likely impacts is provided in Section 7.6. Additional reference should be made to Volume 3, Technical Appendix 7.1: WFD Assessment
The construction, operation and decommissioning of offshore energy infrastructure can affect marine water quality through the disturbance of seabed sediments or the release of contaminants with subsequent indirect effects on habitats, biodiversity and fish stocks	EN3, Section 2.6.189	Assessment of potential for adverse effects caused by mobilisation of contaminated sediments is provided in paragraphs 7.6.2.37 onwards.

7.2.10 Marine Policy Statement

7.2.10.1 The Marine Policy Statement (MPS) provides the policy framework for the preparation of marine plans and establishes how decisions affecting the marine area should be made in order to enable sustainable development. The MPS was adopted by all UK administrations in March 2011. The MPS sets out a vision of having "*clean, healthy, safe, productive and biologically diverse oceans and seas*" by supporting the development of Marine Plans. It also sets out the framework for environmental, social and economic considerations that need to be considered in marine planning.

7.2.10.2 The MPS was updated in 2020 to incorporate changes associated with the UK's exit from the EU. Section 2.6.4 of the MPS states:

"*Developments and other activities at the coast and at sea can have adverse effects on transitional waters, coastal waters and marine waters. During the construction, operation and decommissioning phases of developments, there can be increased demand for water, discharges to water and adverse ecological effects resulting from physical modifications to the water environment. There may also be an increased risk of spills and leaks of pollutants into the water environment and the likelihood of transmission of invasive non-native species, for example through construction equipment, and their impacts on ecological water quality need to be considered.*"

7.2.11 Welsh National Marine Plan

7.2.11.1 The Welsh Government published its first marine plan for Welsh inshore and offshore waters, the Welsh National Marine Plan (WNMP), in November 2019. The WNMP was developed in accordance with the MCAA 2009 and the UK MPS. The WNMP covers a 20-year period from its adoption in 2019. The publishing of the WNMP in November 2019 followed a period of consultation from 7 December 2017 to 29 March 2018. The WNMP is discussed further in Chapter 5: Policy and Legislation.

7.2.11.2 The following key objectives of the WNMP are of direct relevance to marine sediment and water quality:

- Objective 4: "*Provide space to support existing and future economic activity through* *managing multiple uses, encouraging the coexistence of compatible activities, the mitigation of conflicts between users and, where possible, by reducing the displacement of existing activities*";

- Objective 11: "Maintain and enhance the resilience of marine ecosystems and the benefits they provide in order to meet the needs of present and future generations"; and
- Objective 13: *"Develop a shared, accessible marine evidence base to support use of sound evidence and provide a mechanism for the unique characteristics and opportunities of the Welsh Marine Area to be better understood".*

7.2.11.3 Also of relevance to this chapter is WNMP policy GOV_01, which pertains to the assessment of cumulative impacts and GOV_02 which relates to cross-border issues. Requirements relevant to the Project from the WNMP are outlined in Table 7.4.

Table 7.4 – National and Regional Policy Requirements from the WNMP relevant to Marine Sediment and Water Quality

Policy Description	Reference	ES Reference
Proposals should demonstrate that they: avoid the deliberate introduction of litter into the marine plan area; and minimise the risk of accidental release.	ENV_04: Marine Litter	Impacts through accidental spillage are assessed in Section 7.6.2.8 onwards, Section 7.6.3.1 onwards and Section 7.6.4.3 onwards.
Proposals should demonstrate that they have considered their potential air and water quality impacts and should, in order of preference: a) avoid adverse impacts; and/or b) minimise adverse impacts where they cannot be avoided; and/or c) mitigate adverse impacts where they cannot be minimised.	ENV_06: Air and water quality	An assessment of potential impacts arising from the construction, operation and decommissioning of the Project is located in Section 7.6.
Proposals should minimise their risk of marine pollution incidents.	SOC_03: Marine pollution incidents	Impacts through accidental spillage are assessed in Section 7.6.2.8 onwards, Section 7.6.3.1 onwards and Section 7.6.4.3 onwards.
Proposals should demonstrate that they have assessed potential cumulative effects and, in order of preference: a) avoid adverse effects; and/or b) minimise effects where they cannot be avoided; and/or c) mitigate effects where they cannot be minimised. If significant adverse effects cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding. Proposals that contribute to positive cumulative effects are encouraged	GOV_01: Cumulative effects	Cumulative impacts are assessed in Section 7.10.

7.3 Consultation and Scoping

7.3.1.1 As part of the EIA process, consultation with key stakeholders has been undertaken at all stages of the Project, to date, and will continue in the future.

7.3.1.2 An EIA Scoping Report (MarineSpace, 2019) was produced and submitted to the regulators, who consulted with the statutory bodies and key stakeholders upon the contents. A formal Scoping Opinion was issued by NRW in January 2020 (NRW, 2020b). Copies of the Scoping Opinion Request (the Scoping Report) and NRW's Scoping Opinion are provided in Volume 3, Technical Appendices 2.1 and 2.2, respectively.

7.3.1.3 Ongoing consultation has taken place with NRW and the Joint Nature Conservation Committee (JNCC) to discuss and agree the suitability of available evidence, assessment methodologies, and forthcoming guidance where appropriate.

7.3.1.4 Responses and feedback relating to marine sediment and water quality are addressed throughout this chapter. Table 7.5 provides a summary of key points raised and describes how they have been addressed

Table 7.5 – Consultation Responses Pertaining to Marine Sediment and Water Quality where Concerns were Raised

Consultee	Response	Applicant Action
NRW (Scoping Opinion) January 2020	The first paragraph of section 5.2.3.1 (page 5-15) discusses seabed sediment types off the west coast of Wales. However, sediment types from Milford Haven are omitted. We advise this information, and assessment of impacts of cable installation, will be required should the cable be routed through this location.	Assessment of seabed sediments within the EIA Scoping Report was based on publicly available information. This has subsequently been supplemented by Project-specific survey data intended to characterise the specific seabed conditions within the area of the Proposed Development. These Project-specific data are used within this chapter.
NRW (Scoping Opinion) January 2020	The WFD waterbodies have been omitted from consideration within the water quality chapter. We would recommend you consider these in the water and sediment quality section and feed through to the WFD assessment; however, we note that WFD waterbodies are included in the WFD chapter. For information, the website Water Watch Wales can be used to find up to date information on the WFD waterbodies. Water quality information and data within WFD waterbodies will be available from NRW Advisory to help inform a baseline.	Details of WFD water bodies are included within the baseline environment description and reference to WFD standards and receptors is made where appropriate. Outcomes from the present chapter are used to inform Volume 3, Technical Appendix 7.1: WFD Assessment.

Consultee	Response	Applicant Action
NRW (Scoping Opinion) January 2020	We agree that background Suspended Sediment Concentration (SSC) and sediment properties should be considered (page 5-17 5.2.6. para 1). However, no further information is provided so no further comment can be made at this stage. We would recommend that you engage with NRW advisory at an early stage to discuss how baseline conditions will be characterised.	The Applicant contacted NRW (09.04.21) with details of the proposed approach to baseline characterisation. NRW confirmed that the information provided was "*sufficient to resolve the issues raised*" (19/05/2021). Baseline characterisation is discussed further in Section 7.4.4.
NRW (Scoping Opinion) January 2020	No information is provided on how the potential effects on marine water and sediment quality will be assessed (page 5-17 section 5.2.6. para 2). We would recommend that you engage with NRW advisory at an early stage in order to discuss how the assessment will be conducted.	The Applicant contacted NRW (09.04.21) with details of the proposed approach to assessment for use in the ES chapter. NRW confirmed that the information provided was "*sufficient to resolve the issues raised*" (19/05/2021). The assessment methodology is discussed further in Section 7.4.
NRW (Scoping Opinion) January 2020	On page 5-17 section 5.2.6. para 3, no further data collection on marine sediment and water quality is being proposed due to low risk of contamination. We advise of the need for data collection to understand impacts the SAC / WFD / BW sites inshore. NRW advisory query how an assessment against existing baseline will be made if that baseline is not available. Should no further data be collected sufficient justification must be provided, we would recommend early engagement with NRW advisory to support this consideration.	NRW feedback on this point was noted and site-specific sediment and water quality data have been collected and used in characterisation of baseline conditions, see Section 7.4.4.
NRW (Scoping Opinion) January 2020	You must ensure that both offshore and near-shore impacts on water and sediment quality are assessed within the submitted ES. This should include consideration of the potential impacts of heated cables on temperature responsive bacterial growth and potential impacts on bathing waters from all impact pathways (including suspended sediment and bacterial growth).	The Applicant has endeavoured to make full consideration of both offshore and near-shore impacts. In recognition of NRW feedback, an additional pressure pathway has been included for assessment of potential for impacts of heated cables on temperature responsive bacterial growth, see Section 7.6.3.10. Designated bathing waters are included as a receptor within assessment of effects on human environment and considered within this assessment, see Section 7.6.5.
NRW	We (NRW advisory) can confirm that the	Assessment presented in this

Consultee	Response	Applicant Action
(technical consultation on approach to assessment) May 2021	Marine Sediment and Water Quality information provided in your emails is sufficient to resolve the issues raised	chapter is in line with the approach provided to NRW in April 2021 and approved via email responses dated 19 May 2021 (see left).

7.4 Assessment Methodology and Significance Criteria

7.4.1.1 Detailed discussion on the EIA methodology can be found in Chapter 2: Overview of EIA Methodology. Impacts on marine sediment and water quality are based on the impacts identified within the EIA Scoping Report, and any additional potential impacts which have been identified via consultation with key stakeholders.

7.4.1.2 This assessment has been based on the existing baseline environment, as described in Section 7.5 (see also Volume 3, Technical Appendix 9.1: Integrated report (Geophys and Habitat Assessment); Volume 3, Technical Appendix 9.2: Environmental Baseline Report; and Volume 3, Technical Appendix 9.3: Intertidal Report.) and the PDE as detailed in Chapter 4: Proposed Development Description. Specific parameters that have been the basis of this assessment are provided in Table 7.11.

7.4.1.3 Impacts have been assessed for the following three distinct phases of the proposed project:

- Construction;
- Operation (and maintenance); and
- Decommissioning.

7.4.1.4 Assessment of marine sediment and water quality impacts is made based on predicted variations from the baseline environment, or based on WFD standards. Additional detail is provided below specifying how this will be applied to the assessment of the potential effects on marine water and sediment quality.

7.4.1.5 Details of contaminant levels in sediments present within the Project array area or ECC will be contextualised against established guidelines and action levels:

- Cefas Action Levels for the disposal of dredged material; and
- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life.

7.4.1.6 Cefas' guideline Action Levels were established for assessment of suitability of dredged material for disposal at sea. The thresholds are not statutory contaminant concentrations but should be used as part of a 'weight of evidence' approach. The action levels are presented in Table 7.1.

7.4.1.7 Sediments containing chemicals at concentrations below Action Level 1 can generally be considered acceptable for disposal at sea (subject to other considerations such as physical suitability for the respective disposal site and potential for beneficial uses). Disposal at sea would not normally be accepted for sediments containing contaminants at concentrations above Action Level 2. However, this may be permitted where special handling and/or containment measures are applied. There is currently no guidance or protocols for sediments which fall between Action Levels 1 and 2; decisions are made on a case by case basis with consideration of all available evidence (MMO, 2015; Mason *et al.*, 2020).

7.4.1.8 The Canadian Sediment Quality Guidelines were developed by the Canadian Council of Ministers of the Environment as a means of protecting, supporting and maintaining healthy and functional aquatic ecosystems (CCME, 2001). The guidelines are based on field and laboratory-based studies, monitoring associations between chemicals released into the environment and biological effects on specific organisms. As such, these can be used to predict likelihood of impact upon ecological receptors from known contamination levels.

7.4.1.9 The guidelines provide TELs and PELs. Values below the TEL correspond with contaminant concentrations that rarely result in adverse effects. Values above the PEL frequently result in adverse effects, and chemical concentration values between the TEL and PEL are considered to occasionally result in adverse effects.

7.4.1.10 It should be noted that the Canadian Sediment Quality Guidelines were produced for Canadian waters as opposed to being international standards. They are based on the protection of pristine environments and should therefore be considered as highly precautionary when applied to UK waters. However, in the absence of suitable alternatives, these thresholds are commonly applied within the UK within a 'weight of evidence' approach.

7.4.1.11 Table 7.2 provides details of current sediment quality guidelines for a selection of key parameters. This shows the interim marine sediment quality guidelines (ISQGs) / TELs and probable effect levels PELs.

7.4.2 Study Area

7.4.2.1 Assessment of impacts of marine sediment and water quality will consider effects within two study areas:

- The Project array area, inclusive of anchor points, mooring lines, wind turbine generators (WTGs), semi-submersible floating platforms and array cables; and
- The offshore ECC. Further detail of these cables is provided Table 7.11 and in Chapter 4: Proposed Development Description.

7.4.2.2 Assessment will also consider more distant (far-field) impacts on the surrounding marine environment and costal habitats, due to the potential for far-reaching environmental impacts.

7.4.2.3 It is important to note that assessment of water quality will be made with full consideration of WFD requirements, WFD water bodies, and references to the WFD compliance assessment (Volume 3, Technical Appendix 7.1: Water Framework Directive Assessment) where appropriate. It is acknowledged that there is a degree of crossover between these two assessments and a coordinated approach will be adopted to ensure alignment where there are receptors with overlapping geographic remit.

7.4.3 Desk Study

7.4.3.1 Information available in publicly available scientific literature has been used to characterise the wider marine environment. In addition, data collected by NRW in regular water quality monitoring survey programmes have been used to provide a complimentary source of longer-term localised water quality data. This information is used to inform the assessment, together with site-specific survey data as described below.

7.4.4 Site Visit / Surveys

7.4.4.1 Project -specific monitoring surveys of the Project array area and ECC were completed between September and November 2020. Grab samples (*n*=107) were collected within the array area and ECC and analysed to provide details of sediment contamination by hydrocarbons and metals (Volume 2, Figure 7.1).

7.4.4.2 Sampling stations were generally selected at approximately 1 km intervals along the offshore export cable route[2], although each was micro-sited to ensure sedimentary habitats evident in the geophysical data coverage were targeted and, where relevant, bedforms and other features of interest were investigated. Sampling within the array area targeted stations at approximately 1 km spacing, to provide an even spatial coverage of sampling across the survey area.

7.4.4.3 Eight heavy and trace metals were analysed from sediments taken at each of the 107 stations. These were Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).

7.4.4.4 All sediment samples were also analysed for the full range of Polycyclic Aromatic Hydrocarbons (PAHs) as specified in the Department of Trade and Industry (DTI) regulations (1993) as well as by the EPA.

7.4.4.5 In addition to marine sediment, water samples were collected from 26 sample stations across the portion of the ECC that intersects WFD waterbodies[3]. Samples were analysed to assess concentrations of chlorophyll, suspended solids, dissolved oxygen, nutrients, hydrocarbons and metals. Sampling stations were positioned along the centre of the proposed cable routes at approximately 500 m intervals and three water samples were collected at each station: 2 m above the seabed; mid-water depth; and 2 m below the surface (Volume 2, Figure 7.2).

7.4.5 Assessment of Potential Effect Significance

7.4.5.1 Determination of whether predicted effects are likely to be significant is made by relating receptor sensitivity to magnitude of environmental effects.

7.4.6 Sensitivity

7.4.6.1 The overall receptor sensitivity is determined through consideration of the receptor value, adaptability, tolerance and recoverability.

7.4.6.2 Table 7.6 sets out the criteria used in defining the sensitivity of marine sediment and water quality receptors.

Table 7.6 – Sensitivity Levels for Receptors (Marine Sediment and Water Quality)

Sensitivity	Description
High	The marine sediment or water quality receptor provides key supportive contribution to the designation or nationally important feature(s); and/or has limited capacity for change to current status relative to the baseline.

[2] Stations 1-8 are situated outside the ECC but within the footprint of alternative route options presented as Project alternatives. Data from these stations have been included and used within the assessment to provide additional characterisation of the surrounding environmental conditions.

[3] Stations 1-10 are situated outside the ECC but within the footprint of alternative route options presented as Project alternatives. Data from these stations have been included and used within the assessment to provide additional characterisation of the surrounding environmental conditions.

Sensitivity	Description
Medium	The marine sediment or water quality receptor supports high biodiversity; and/or has limited capacity for change to water quality status.
Low	The marine sediment or water quality receptor has reasonable capacity for change to status, due, for example, to fast current speeds or relatively large size of the receiving water body leading to increased capacity for dilution and flushing.
Negligible	The marine sediment or water quality receptor has high tolerance for the expected change with little or no impact upon baseline conditions.

7.4.7 Magnitude

7.4.7.1 Assessment of effect magnitude is based on expected effects specific sediment or water quality receptors from Project activities. Potential impacts are described in terms of persistence (permanent or temporary) and effect type (adverse or beneficial).

7.4.7.2 Table 7.7 sets out the criteria used in defining the magnitude of marine sediment and water quality receptors.

Table 7.7 – Magnitude of Impact

Magnitude	Description
High	Extensive alterations to key characteristics of the marine sediment or water quality status; water or sediment quality status degraded to a level that caused permanent or long term change.
Medium	Medium scale alterations to key characteristics of the marine sediment or water quality status. Associated expectation that marine sediment or water quality status likely to require extensive time for recovery to baseline conditions.
Low	Alterations to marine sediment or water quality status expected to be measurable above background concentrations, but not considered to be substantial changes. Activity not likely lead to compromise of water or sediment Environmental Quality Standard (EQS).
Negligible	Any changes to marine sediment or water quality will extend for short periods of time and are expected to be quickly reversed once activity ceases.

7.4.8 Effect Significance

7.4.8.1 The significance of the effect upon marine sediment and water quality is determined by correlating the magnitude of the impact and the sensitivity of the receptor, as presented in Table 7.8. On this basis potential effects are assessed as of negligible, minor, moderate and major significance (definitions are provided in Chapter 2: Overview of EIA Methodology).

7.4.8.2 For the purposes of this assessment, any effects with a significance level of major and/or moderate have been deemed significant in EIA terms, while those of minor or negligible are deemed non-significant.

Table 7.8 – Effect Assessment Matrix

		Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Magnitude	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Minor	Negligible	Negligible

7.4.8.3 Within the context of marine sediment and water quality, the terms used in Table 7.8 to describe the predicted level of effect are defined as:

- **Major beneficial or adverse effect** – large change in marine sediment or water quality, either beneficial or adverse. Such changes would likely result in regional or district level implications through contribution to achieving national, regional or local objectives, or, through the exceedance of statutory objectives and / or breaches in legislation;
- **Moderate beneficial or adverse effect** – where the Proposed Development would result in a noticeable improvement (or deterioration) in water quality, which is likely to be an important consideration at a regional level;
- **Minor beneficial or adverse effect** – where the Proposed Development would result in a small improvement (or deterioration) in water quality. This effect may be noticeable at a regional level, but is unlikely to be a concern with regards to environmental plans or targets;
- **Negligible** – where the Proposed Development would result in no discernible improvement (or deterioration) to marine sediment or water quality.

7.4.9 Standard Mitigation

7.4.9.1 A range of standard mitigation measures have already been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives and Chapter 4: Proposed Development Description). These have been introduced to prevent, reduce and offset potential impacts of the Project on any affected receptors.

7.4.9.2 With respect to this EIA topic, best practice techniques will be employed throughout all construction, operation, maintenance and decommissioning activities. Construction practices will comply with appropriate Pollution Prevention Guidelines (PPG) and good practice guidelines will be followed.

7.4.9.3 A Construction Environment Management Plan (CEMP) will be produced post-consent in accordance with the Marine Outline CEMPs for each of the relevant parts of the Project. Each CEMP would explain how the activities of contractors and sub-contractors would be required to comply with its requirements, including where necessary the production of subsidiary plans in relation to specific construction matters. This would include the following measures embedded into the design:

- Oils in the WTGs shall be biodegradable where possible;
- All work practices and vessels will adhere to the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL)73/78; specifically Annex 1 Regulations for the prevention of pollution by oil concerning machine waters, bilge waters and deck drainage and Annex IV Regulations for the prevention of pollution by sewage from ships concerning black and grey waters; and
- All oils and fluids will be contained within the WTG in case of a spill.

7.4.9.4 Best practice procedures would be put in place when handling oil or fuel. Appropriate spill plan procedures would be implemented to in the case of any unexpected spillage into the marine environment. Full details of these measures will be provided in the Marine Pollution Contingency Plan (MPCP), which will form part of the CEMP, to be agreed post-consent.

7.4.9.5 All measures for control of drilling fluid breakout would also be detailed in the MPCP in a Drilling Fluid Detection and Response Plan. This plan will include details of:

- Proposed measures to monitor for and identify breakouts;
- Response procedure, i.e. ensuring drilling is stopped immediately following identification of breakout, measures for breakout containment;
- On-site emergency equipment requirements for use in containment and removal of spilled fluids; and
- Communication and documentation procedure for reporting any incident.

7.4.10 Additional Mitigation and Assessment for Residual Effect Significance

7.4.10.1 The impact assessments and conclusions on significance of effect presented in Section 7.6 assume that these standard mitigation measures listed above have been successfully implemented. Where significant environmental impacts remain even after these standard measures have been factored in, then project-specific mitigation measures are detailed and the residual significance of effect presented.

7.4.11 Limitations to Assessment

7.4.11.1 Collection of Project-specific survey data provides a valuable basis for characterisation of present baseline marine sediment and water quality conditions. However, particularly for water quality, the use of a single time point may not fully capture any temporal variability.

7.5 Baseline Conditions

7.5.1 Marine Sediment Quality

7.5.1.1 Seabed sediments off the southwest coast of Wales predominantly consist of sandy gravel with nearshore areas of sand (DECC 2016). The inshore seabed around the south Pembrokeshire coast is characterised by rocky reef, shoals and sandbanks.

Site-specific grab sample data show that sediment type within the Project footprint (array and ECC) are typically dominated by sand. Mud contents is highest close to land and towards the main array, and gravel content was low within the array area, but higher at intermittent locations within the landward half of the ECC. Full details of benthic sediments within the array area and ECC are provided in Chapter 6: Marine and Coastal Processes. The physical properties of the sediments are important because fine muddy sediments have a higher risk of containing / taking up contaminants (due to a relatively large surface area and greater cation exchange capacity) than coarser sediments, such as sand and gravel.

7.5.1.2 Reviews of historic sediment sample analyses reveal that Milford Haven waterway has shown consistent background levels of levels of PAHs, metals and other contaminants. This is linked to various factors such as the use of Milford Haven port by the oil and gas industry; and specific pollution events in 1996 and 2007 (Little *et al.*, 2015).

7.5.1.3 Data collected for other nearby developments have shown that chemical contamination in regional seabed sediments is low. The ES for the Atlantic Array Offshore Wind Farm (RWE, 2013) reported no sediment samples exceeded the Cefas Action Level values for metal or Total Hydrocarbon Content (THC). Concentrations of hydrocarbons such as PAH in offshore samples and from the south coast of Pembrokeshire were also found to be below Maximum Allowable Concentrations (MACs) (Intertek, 2018).

7.5.1.4 These conclusions are supported by site-specific monitoring data within the Project array area and ECC. Grab samples (*n*=107) collected during Project-specific surveys of the array area and export ECC between September and November 2020 (see Volume 2, Figure 7.1 for locations) have been analysed to provide details of sediment contamination by hydrocarbons and metals (see Sections 7.5.2, 7.5.3, and 7.5.4 below for details).

7.5.1.5 Intertek (2018) also indicates that polychlorinated biphenyls (PCBs) concentrations are decreasing across the Celtic and Irish Sea but are highest in industrialised regions such as harbours. Tributyltin (TBT) is a widespread contaminant of coastal waters and sediments due to its use an antifoulant on marine structures and shipping. OSPAR (2010) reports suggest that levels of TBT are acceptable across the Celtic Sea but there are still areas of high concentrations such as harbours and shipping lanes (UKMMAS 2010).

7.5.1.6 It is important to note that the ECC intersects the footprint of the Milford Haven historic dredge disposal site (LU170, used until 1994; see Volume 2, Figure 7.2). Although details are not available of contamination levels in material disposed at this site, the site was used for spoil dredged from Milford Haven Port and would be expected to contain contaminants typically associated with shipping and transport hubs, such as TBT, hydrocarbons, and heavy and trace metals.

7.5.2 Heavy and Trace Metals

7.5.2.1 Eight heavy and trace metals were analysed from sediments taken at each of the 107 stations. These were Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).

7.5.2.2 As detailed in Sections 7.2.7 and 7.2.8, sediment contamination levels are described with respect to Cefas Action Levels and Canadian Sediment Quality Guidelines for the Protection of Aquatic Life.

7.5.2.3 Arsenic was the most common contaminant, being recorded in excess of Cefas Action Level 1 at 18 stations, although there were no instances where arsenic was found in excess of Cefas Action Level 2. Samples with high levels of arsenic were primarily found at the eastern edge of the array area and at sites within the southwest extent of the ECC, close to where this met the array area. Nickel was found in excess of Cefas Action Level

1 at 6 stations; Stations 8 and 13 were located around the mouth of Milford Haven Estuary, Station 22 is within the ECC, approximately 8 km offshore, and Stations 79, 91 and 114 are located within the array area.

7.5.2.4 The Cefas Action Level 1 for chromium was exceeded in 4 instances, Stations 10 and 13 around the mouth of Milford Haven estuary, and Stations 51 and 114, at the southwest end of the ECC and within the array area respectively. Cefas Action Levels have been used in this instance to provide an indication of contamination distribution, rather than as a direct indication of locations of concern. It is apparent that where contamination does occur, it is not in discrete isolated areas, but is widely distributed.

Table 7.9 – Summary of 8 number of stations with records of elevated heavy and trace metals levels in comparison with Cefas and Canadian/International Sediment Quality Guidelines.

Analyte	Cefas		Canadian SQG	
	AL1	AL2	TEL	PEL
Arsenic	18	0	102	0
Cadmium	1	0	0	0
Chromium	4	0	2	0
Copper	0	0	2	0
Lead	0	0	1	0
Mercury	0	0	0	0
Nickel	6	0	-	-
Zinc	0	0	0	0

7.5.2.5 Volume 3, Technical Appendix 9.2: Environmental Baseline Report provides full detailed results of heavy and trace metal contamination levels at each sample station. Typically, concentrations of all metals are higher at nearshore stations than at offshore stations. However, in contrast, As was found in higher average (±SD) concentrations at offshore stations (15.66 ± 5.61 mg/kg) than at nearshore stations (11.3 ± 6.28 mg/kg).

7.5.3 Polycyclic Aromatic Hydrocarbons (PAHs)

7.5.3.1 Analysis results for determination of PAH levels in sediment samples are described in relation to CSQG TEL and PEL. Although all PAHs were generally recorded at relatively low concentrations, higher concentrations were recorded at the nearshore stations compared to the offshore stations. The most abundant (fluoranthene; max. concentration 182 µg/kg) exceeded TEL at only 3 stations. Other notably high values were recorded for phenanthrene (maximum concentration 142 µg/kg) and pyrene (maximum concentration 137 µg/kg). However, phenanthrene and pyrene exceeded TEL at 2 and 0 stations respectively. In addition, naphthalene, although only recorded at concentrations ≤83.5 µg/kg, was shown to exceed TEL at 3 stations.

7.5.3.2 Although concentrations of naphthalene, acenaphthene, phenanthrene, fluoranthene, benzo[a]anthracene, chrysene, benzo[a]pyrene and dibenzo[a,h]anthracene exceeded TELs at some stations, no samples were found to exceed PELs.

7.5.4 Total Hydrocarbons

7.5.4.1 Total Hydrocarbon Content (THC) in sediment samples ranged from 0.68 mg/kg at ST086 (array area) to 49.5 mg/kg at ST03 (Milford Haven), with an average value (± SD) for the whole of the survey area of 5.72 ± 7.86 mg/kg. There were no instances of THC in excess of Cefas Action Level 1 (100 mg/kg). THC was higher, on average, in nearshore stations than at offshore stations, which is most likely due to the proximity of the nearshore stations to urban settings and, therefore, to potential additional sources of hydrocarbons.

7.5.5 Marine Water Quality

7.5.5.1 The ECC intersects both the Pembrokeshire South (GB611008590003) water body, which is currently classified as ‘good’ status, and the Milford Haven Outer (GB641008220000) water body, currently classified as ‘moderate’ status. Milford Haven Outer is failing to achieve good status because of high concentrations of dissolved inorganic nitrogen, mercury, and mercury-containing compounds. Coastal waters typically contain higher concentrations of contaminants due to input by contaminated run off from coastal industries; this may explain the contaminant levels within the Milford Haven Outer water body (see Volume 2, Figure 7.3).

7.5.5.2 Water quality, defined in terms of bacterial concentration, is monitored in bathing waters designated under the revised Bathing Water Directive (2007/7/EC) and many of the beaches within the vicinity of the Proposed Development have been assessed as having excellent water quality for the last four years (NRW, 2020). There are five designated bathing waters within 10 km of the landfall location: West Angle (0 km); Dale (3.5 km); Sandy Haven (4 km); Freshwater West (5.5 km); and Marloes Sand (7.5 km). All of these sites were classified as ‘excellent’ during the most recent (2020) Wales Bathing Water Report. It is clear that potential for impacts is greatest at West Angle: the site of the offshore export cable landfall (see Volume 2, Figure 7.3).

7.5.5.3 Water quality monitored for compliance under the WFD also considers shellfish waters, which constitute WFD protected areas. Currently, the nearest shellfish water to the Proposed Development is the Upper Cleddau shellfish waters 13 km to the northeast, upstream within Milford Haven Estuary.

7.5.5.4 Pembrokeshire coastal waters have a dynamic hydrological regime with a varied wave regime and a strong tidal regime that provides the area with high levels of mixing and dispersal, increasing likelihood off good water quality offshore. Intertek (2019), in the Environmental Statement for the Greenlink interconnector, reports that dissolved contaminants in the Celtic Sea, and off the Pembrokeshire coast, are low or below the level of detection for current analytical tools.

7.5.5.5 In addition to marine sediment, Project-specific water samples have been collected from 26 sample stations across the portion of the ECC that intersects WFD waterbodies[4] (see Volume 2, Figure 7.2). Samples were analysed to assess concentrations of chlorophyll,

[4] Stations 1-10 are situated outside the ECC but within the footprint of alternative route options presented as Project alternatives. Data from these stations have been included and used within the assessment to provide additional characterisation of the surrounding environmental conditions.

suspended solids, dissolved oxygen, nutrients, hydrocarbons and metals. Sampling stations were positioned along the centre of the proposed cable routes at approximately 500 m intervals and water samples were taken at: 2 m above the seabed; mid-water depth; and 2 m below the surface. The following text relates to results from these water samples, and therefore differs from the analysis of sediment samples presented in Sections 7.5.1 to 7.5.4.

7.5.6 Chlorophyll

7.5.6.1 Chlorophyll *a* concentrations were below the limit of detection (<7.00 μg/l) in water samples collected at all stations but one (top of the water column at ST22: 7.82 μg/l).

7.5.7 Suspended Particulate Matter (SPM)

7.5.7.1 Suspended sediments within marine environments can be divided into organic and inorganic components. Organic Suspended Particulate Matter (SPM) occurs due to biological activity within the aquatic environment and includes material from animal waste or decomposition, planktonic material, algae and bacteria. Inorganic material is derived from rivers (i.e. eroded material, products of chemical reactions within rivers of estuarine environments etc.), coastal erosion, and mobilisation of existing seabed sediments.

7.5.7.2 The assessment of the Pembrokeshire Marine / Sir Benfro Forol SAC NRW (2018) provides the following assessment of SPM within the Pembrokeshire coastal environment:

"*Suspended particulate concentrations are highly variable with season, wave action, tidal conditions and freshwater discharge. As a consequence, water clarity and seabed and water column light intensity are also highly spatially and seasonally variable*."

7.5.7.3 Measurements of marine SPM are available from various sources but primarily *in situ* field data or satellite imagery. Cefas (2016) provides SPM data for UK waters 1998-2015. Within Pembrokeshire coastal waters the average values during this time are approximately 5-10mg/l. In terms of temporal variation, concentrations are highest during autumn and winter. However it should be noted that satellite imagery data are limited to near-surface data collected under non-storm / cloud-free conditions. Similarly, due to logistical limitations in data collection there is little field data on SPM during storm events. As such, it is expected that SPM levels under natural conditions would regularly exceed the upper limits provided herein. (Cefas, 2016).

7.5.7.4 Suspended solid concentrations in Project-specific water samples were low to moderate across all sample stations and depths (range <5 mg/l - 23 mg/l). The WFD (Standards and Classifications) Directions (EA, 2015) provides criteria for classifying turbidity of marine waters (for use in determining compliance of inorganic nitrogen levels with WFD standards). Coastal or transitional waters are considered to be clear at suspended solid concentrations <10 mg/l and intermediate turbidity at 10-100 mg/l.

7.5.7.5 Based on these criteria, all water samples can be classified as 'clear' with the exception of 9 samples, which are 'intermediate turbidity' (ST01 (middle and bottom samples both 20 mg/l), ST02 (bottom: 15 mg/l), ST11 (bottom: 23 mg/l), ST16 (bottom: 22 mg/l), ST15 (middle: 15 mg/l) and ST22 (middle: 10 mg/l), ST18 (top: 11 mg/l) and ST23 (top: 11 mg/l))

7.5.8 Dissolved Oxygen

7.5.8.1 Levels of dissolved oxygen were recorded at all sample stations. Concentrations were consistently above the standard that would correspond to a classification of 'high' under WFD classification (5.7mg/l).

7.5.9 Nutrients

7.5.9.1 Nutrients analysed in water samples included nitrogen, nitrates, nitrites and phosphate. Details of mean, maximum and minimum values are provided in Table 7.10. The WFD (Standards and Classifications) Directions (EA, 2015) provide standards for inorganic nitrogen within coastal and transitional waters, which vary depending on turbidity. Values for ammoniacal nitrogen in water samples collected would correspond to a classification of 'high' (<1.4 mg/l) for both clear and intermediate turbidity transitional or coastal waters.

Table 7.10 – Summary of nutrient concentrations in survey water samples

	Mean (±SD) (mg/l)	Maximum (mg/l)	Minimum (mg/l)
Ammoniacal nitrogen	0.38 ±0.09	0.55	0.20
Nitrate	N/A*	0.4	<0.2
Nitrite	N/A*	<0.01	N/A
Phosphate	N/A*	0.13	<0.01 †

*Mean value not provided due to high proportion of results below limit of detection.
†*77 of 78 samples were recorded as <0.01 mg/l*

7.5.10 Heavy and Trace Metals

7.5.10.1 Eight heavy and trace metals were analysed from water samples collected at 3 depths (bottom, mid-depth, surface) at each of the 26 sample stations. These were arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). Full raw results data is provided in Volume 3, Technical Appendix 9.1: Integrated report (Geophys and Habitat Assessment).

7.5.10.2 Heavy and trace metal concentrations were consistently low and below the limit of detection in most instances. However, zinc levels were found to exceed the WFD EQS (long term mean 0.0068 mg/l) within 3 of 78 samples (ST01: middle; ST02: bottom; ST12: middle). Cadmium was found to exceed WFD EQS (long term mean 0.00002 mg/l) in one sample (ST18: middle).

7.5.11 Polycyclic Aromatic Hydrocarbons (PAHs)

7.5.11.1 All water samples were analysed for the full range of PAHs as specified in the DTI regulations (1993) as well as by the EPA. Results were below the limit of detection for all determinands.

7.5.12 Summary

7.5.12.1 Based on the sample analysis data and other information presented above it is concluded that baseline marine sediment and water and quality is good within the Project array area and ECC, with low levels of chemical contamination. These conclusions concur with assessments for other nearby projects such as the Greenlink Interconnector and Atlantic Array, which report that dissolved contaminants in the Celtic Sea, and off the Pembrokeshire coast, are low or below the level of detection for current analytical tools (RWE, 2013; Intertek, 2018).

7.5.13 NRW Water Quality Data

7.5.13.1 NRW carries out regular water quality monitoring, and data for the Pembrokeshire coastal and transitional water bodies have been obtained from NRW on request. The closest sampling stations to the Project site are Station 39683 (approximately 700 m from the ECC, at the mouth Milford Haven Estuary) and Station 39684 (approximately 2 km from the landfall site upstream within Milford Haven estuary). Data have been provided for samples collected 2007-2020 and these were compared against results of Project-specific water quality sample analysis to confirm that Project data are representative of the local water environment.

7.5.13.2 Determinands which were recorded at below the limit of detection (LOD) for >95% of Project water samples (chromium, mercury, nickel, zinc and chlorophyll-*a*) were considered of low concern excluded from comparison. The remaining parameters (arsenic, cadmium, copper, lead, and ammoniacal nitrogen) are discussed below.

7.5.13.3 The mean value for arsenic in Project water samples (1.77 µg/l) was elevated slightly above that of the NRW values (1.31 µg/l). However, 22 of the 46 arsenic values are recorded as below the LOD. Given that the NRW LOD value (2 µg/l) is above the means for both datasets, there is a degree of uncertainty in comparison of results. However, given the magnitude of headroom between the maximum concentration of arsenic reported in Project water samples (3.2 µg/l; Station 16, (top)) and the WFD EQS (long term mean 25 µg/l), and the relatively small, localised increases in arsenic levels that may occur following sediment mobilisation, it is considered that there is minimal risk that Project activities would result in elevation of contaminant levels above excess of acceptable limits.

7.5.13.4 Levels of cadmium reported for NRW water sample analysis were consistently low, with concentrations ranging 0.03-0.04 µg/l. This consistency was not matched by Project-specific sample data. Although in most instances, levels of cadmium reported for Project water samples were below the LOD, in a small number of records, concentrations were elevated. Most (77 of 78) results for analysis of Project samples did not exceed the Annual Average (AA) EQS for cadmium. Given that this standard is intended for long term average results, this single exceedance is not considered to be of concern.

7.5.13.5 Concentrations of copper in water samples were ≤1 µg/l in 76 of 78 samples, broadly corresponding with levels for long term NRW monitoring data (range 0.2-0.71 µg/l). The remaining two samples (Station 14 (top) and Station 17 (bottom): both 2 µg/l) were below the EQS value for marine waters (≥3.76 µg/l, dependent on ambient dissolved organic carbon concentration).

7.5.13.6 Levels of lead within Project water samples (<LOD – 1 µg/l) were low compared to levels reported in NRW data for local waters (0.04-2.67 µg/l) and were below both the AA and MAC EQS as set out in the WFD standards and classification directions (1.3 µg/l and 14 µg/l respectively; EA, 2015).

7.5.13.7 Ammoniacal nitrogen levels in NRW monitoring data (range: 0.007-0.072 µg/l) were below the values reported from the Project survey data (range: 0.20-0.55 µg/l). However, it should be noted that values reported for the Project samples would correspond to a classification of ‘high’ (< 1.4 mg/l) for the corresponding water turbidity categories.

7.6 Potential Environmental Effects

7.6.1.1 The following assessment provides a summary of all impacts identified during Scoping, and those which have been noted as the EIA has progressed. Each impact is not necessarily relevant to all stages of the Project, and thus impacts have been assessed within the stage of the Project at which they will occur (construction, operation and maintenance, and decommissioning). Further information on the EIA process and methodology is outlined in Section 7.4 and Chapter 2: Overview of EIA methodology.

7.6.1.2 The impacts have been assessed on the current baseline, as defined in Section 7.5.

7.6.1.3 The worst case parameters assumed for each individual potential impact on marine sediment and water quality are detailed below in Table 7.11. Further information on the PDE is described in Chapter 4: Proposed Development Description.

Table 7.11 - Project Design Envelope Parameters Relevant to Marine Sediment and Water Quality

Potential Pathway Change / Impact	**Realistic Worst-Case Scenario**	**Justification**
Construction		
Impact on water quality via drilling and disposal of drill arisings	• Maximum number of pile anchors: 35 • Maximum dimensions of drilled pile section: 2.5 m diameter, 55 m length • Maximum volume of material per pile: 270 m^3 • Maximum volume of material all piles: 11,340 m^3	Corresponds to (a combination of) the greatest amount of material disturbed, the largest dimensions and number of pile anchors. Other anchor types (embedment anchors, driven piled and suction pile anchors) will cause a lesser rate and duration of sediment disturbance than drilling.
Accidental release of fluids into the environment during the construction phase.	<u>Vessel presence</u> • 6 at any one time	Corresponds to the maximum number of vessels that would realistically be expected to be operating simultaneously. Each vessel contributes additional risk of accidental pollution incident.
Cable installation works may cause changes to water quality through sediment re suspension.	<u>Array cable installation</u> • Maximum total length of trenches: 23.9 km • Trench dimensions: 1.2 m wide; 3 m deep; ‘U’ shape profile • Excavation method: Trenching by jetting or mass flow excavator (MFE) <u>Offshore export cable installation</u> • Maximum number of trenches: 1 • Maximum total length of trench: 49 km • Trench dimensions: 1 m wide; 3 m deep; ‘U’ shape profile • Excavation method: Trenching by jetting or MFE	Corresponds to (a combination of) the greatest amount of material disturbed, the largest dimensions of trenching, the greatest depth of seabed lowering / levelling and the greatest geographical extent of the impact. The fastest rate of progress is used to assess the greatest rate of sediment disturbance or release. The installation of scour protection will cause a lesser rate and duration of sediment disturbance than cable installation (trenching).

Potential Pathway Change / Impact	Realistic Worst-Case Scenario	Justification
	Sandwave levelling – array area • Maximum volume (array cables) of material that will be subject to levelling / temporary removal: 160,600 m^3 • Maximum depth of levelling: half height of sandwave. [Max sandwave height in array area is 4.0 m] • Levelling method: Trailing Suction Hopper Dredger (TSHD) or MFE Sandwave levelling – offshore export cable • Maximum volume (offshore export cable) of material that will be subject to levelling / temporary removal: 403,000m^3 • Maximum depth of levelling: half height of sandwave. [Max sandwave height along ECC is 6.0m] • Levelling method: Trailing Suction Hopper Dredger (TSHD) or MFE HDD / Drilling fluid release (at landfall) • Number of HDD exit/release events: 6 • Maximum volume of drilling fluid: 2,210 m^3. • Maximum concentration of bentonite in drilling fluid: 80,000 mg/l. Open cut trenching • Trench dimensions: 650 m (length); 3 m wide; 10 m total width of disturbance); 3 m (depth).	
Water quality may be altered through the mobilisation of contaminated sediments.	Notes for Impacts 1 and 4 (above) are applicable here.	The worst case scenario relates to activities that involve the most re-suspension of sediment

Potential Pathway Change / Impact	Realistic Worst-Case Scenario	Justification
Operation and Maintenance		
Accidental release of fluids into the environment during the operation phase.	Vessel presence • No more than 2 O&M vessel present in the array area at one time	Corresponds to the maximum number of vessels that would realistically be expected to be operating simultaneously. Each vessel contributes additional risk of accidental pollution incident.
Changes to water quality through sediment re suspension via cable repair and/or remediation events	Cable Repair • Maximum number of events (offshore export cable): 5 • Maximum length per repair (offshore export cable): 1 km • Maximum number of events (array): 5 • Maximum length per repair (array): 6 km Cable Remediation • Maximum number of events: 12 • Maximum seabed disturbance footprint (total for 12 events): 600,000 m^2	Corresponds to (a combination of) the maximum number of events, the greatest length and greatest amount of material disturbed
Benthic sediments may be mobilised through scouring effects caused by installation of turbine foundations, anchor points and cable protection. Sediment re-suspension could lead to deterioration in water quality through increased SSC.	Mooring system and electrical cables • Maximum number of moorings (35) and array cables (10) present in the water column : 45 • Dimensions of mooring chain: links 0.81 m long x 0.67 m wide x 0.2 m diameter. • Total swept area for mooring chains: (assuming 50 m lateral motion at touchdown and 37,234 m^2 swept area per line): 1,303,194 m^2 • Total footprint of clump weights (x35 lines): 3,500 m^2 • Diameter of electrical cable: 0.30 m • Dimensions of suction	See above for justification of number of moorings and electrical cables. Embedment anchors will be completely buried and will not interact at all with waves or currents. Drilled piles may also extend up to 3 m above the seabed but have a smaller diameter (up to 2.5 m).

Potential Pathway Change / Impact	Realistic Worst-Case Scenario	Justification
	pile anchors once installed: 6.5 m diameter, 3 m above seabed. Cable protection • Applied to up to 16% (7.5 km) of the total offshore export cable length • Applied to up to 100% (22.5 km) of the total array cable length in contact with the seabed • Rock protection berm or mattress • Maximum offshore export cable protection dimensions: 13 m base width x 2 m height (2 m berm crest width). • Typical array cable protection dimensions 5 m base width x 1 m height, (rock bags).	
The introduction of transmission assets may heat surrounding sediments and cause increase bacterial growth.	• Transmission assets for the Proposed Development are predicted to result in a maximum localised temperature change of 2.5°c. • Target cable burial depth of 3.0 m • Any elevations in surface temperature are expected to be limited to within 50 cm from the cable.	Corresponds to (a combination of) the maximum localised temperature change and the deepest burial depths
Decommissioning		
Removal of piles drilled into hard rock seabed during decommissioning may produce additional suspended particles which may become part of the local sediment transport regime.	Values are expected to be similar to those for installation.	Parameters are expected to be similar to those for installation.

Potential Pathway Change / Impact	Realistic Worst-Case Scenario	Justification
Accidental release of fluids into the environment during decommissioning activities.	Values are expected to be similar to those for installation.	Parameters are expected to be similar to those for installation.
Removal of array, and export cabling may cause changes to water quality through sediment re-suspension.		

7.6.2 Construction

Impact on water quality via drilling and disposal of drill arisings from anchor installation

7.6.2.1 Although drag embedment anchors are still the primary foundation solution, there may be a need to install both driven and drilled piles in certain parts of the array area. Where drilling is required, this will cause drill cuttings to be brought to the seabed and introduced into the marine environment via reposition onto the seabed adjacent to the pile location. The semi-submersible floating platforms may be secured in place by up to 35 drilled anchor piles (worst case scenario is 5 piles each for 7 WTG. 10 WTGs of smaller dimensions would only require 3 piles per WTG). It is expected that drilled pile sediment will be left *in situ* in close proximity to the location of extraction and that each pile will be a maximum volume of 270 m^3. Installation of 2.5 m diameter piles would require removal of up to 11,340 m^3 of seabed sediment (270 m^3 x 35 pile anchors + 20% contingency). It is assumed that sediment is released at or above the water surface in an area approximately equal to the area of the drilled hole (2.5 m diameter).

7.6.2.2 The particle size distribution of drill arisings for individual anchor locations is not currently known; Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment Technical Report provides details of predicted changes in SSC separately for scenarios where 100% of the material is assumed to be either fines, (medium) sand or (coarse) gravel sized.

7.6.2.3 In practice, sediment is likely to be mixed, and changes to SSC will fall somewhere within this range.

7.6.2.4 Following drilling activities SSC is expected to increase by thousands to hundreds of thousands of mg/l in the immediate vicinity of sediment release (<50 m). It is assumed that sediment is released at or above the water surface and therefore the greatest SSC increase will occur in the upper water column. Gravels and sands will settle towards the seabed (within approximately 100 or 1000 m, respectively), resulting in a lower change in SSC within the midwater and nearbed environments. Elevated SSC levels are expected to persist for 2-30 minutes after cessation of drilling activities, as sands and gravels settle to the seabed and suspended fines disperse into the water column.

7.6.2.5 Suspended fine sediments are expected to result in a small elevation in SSC (low tens of mg/l) across a narrow plume (tens to a few hundreds of metres wide) up to one tidal excursion in length (up to ~10 km on spring tides in the array area and ~5 km on neap tides) aligned to the tidal stream downstream from the source. However, it should be noted that if drilling occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions.

7.6.2.6 Some fine sediments may persist in suspension for hours to days or longer but will become diluted to background levels within less than one day. In view of the small level by which SSC may increase, short duration of effect and the highly localised spatial extent, it is not expected that these changes will have any measurable effect on WFD designated features such as shellfish waters or designated bathing waters.

7.6.2.7 Overall, the marine area in which the Project array area is located, is considered to be of low sensitivity to changes in suspended sediments due to large volume of the receiving water and the capacity for dilution and flushing. The magnitude of impact is considered to be negligible due to the low predicted elevation in SSC and the short residency duration. Conditions are expected to return to baseline following cessation of activities and so any impact would only be present during the installation process. Therefore, based on the above, it is considered to result in a **negligible** effect, which is not significant in EIA terms.

Accidental release of fluids into the environment.

7.6.2.8 The presence of numerous works vessels in and around the Proposed Development area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to potential for pollution by construction materials accidently released into the marine environment.

7.6.2.9 It is anticipated that up to six vessels will be present at any one time within the array area during the construction phase. Overall offshore construction may take up to 8 months to complete. In addition, offshore export cable installation works will be associated with regular vessels presence and may continue for up to 8 months. Each instance of vessel presence at the Project site introduces a degree of risk of accidental release of fluids to the environment.

7.6.2.10 The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

7.6.2.11 Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A MPCP will be produced and agreed with stakeholders post-consent.

7.6.2.12 This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

7.6.2.13 Overall, the marine area in which the main array is located is considered to be of low sensitivity to changes in suspended sediments due to large volume of the receiving water and the capacity for dilution and flushing. The magnitude of impact is considered to be negligible due to the control measures that will be put in place to avoid accidental chemical contamination events, or address one should it occur. Therefore, based on the above, it is considered to result in a **negligible** effect, which is not significant in EIA terms.

Cable installation works may cause changes to water quality through sediment re-suspension.

7.6.2.14 The installation of array cables and the offshore export cable using a plough, jetting or MFE tool(s) at the seabed, or cutting tools within the intertidal environment, will lead to sediment disturbance. The associated sediment disturbance has the potential to affect water quality through changes in turbidity. It should be noted that sediment disturbance may also result in mobilisation of contaminated sediments, however this is assessed in Section 7.6.2.37 onwards. In addition, sediment re-suspension may result from sandwave levelling / clearance, if this is required prior to cable installation to ensure that the cable does not become exposed post installation.

7.6.2.15 In recognition of this, the following assessment considers plume effects from the following activities:

- Sandwave levelling in array area and along ECC with MFE or TSHD;
- Cable installation through use of plough, trenching or MFE; and
- Works at landfall utilising HDD or open-cut trenching.

7.6.2.16 Assessment within this section is based on the realistic worst-case parameters laid out in Table 7.11. The potential changes to SSC and associated sediment deposition caused by these activities have been assessed using numerical spreadsheet models. The full details and results of each assessment are set out in Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment Technical Report.

7.6.2.17 If required, sandwave levelling/clearance is expected to be achieved through MFE, however trailing suction hopper dredging is also included as a potential methodology. Although MFE would be associated with a greater level of sediment re-suspension initially, any material removed by trailing suction hopper dredging would be returned to the seabed by the dredger, resulting in a sudden elevation in SSC at this location.

7.6.2.18 As detailed in Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment Technical Report elevated SSC caused by extensive sediment disturbance (such as drilling, dredging overspill, pre-lay cable trenching, or cable installation using a jetting or MFE tool) will be in the order of thousands to hundreds of thousands of mg/l within small distances (<50 m) of the activity, reducing rapidly with time and distance (through settlement and dispersion) to the order of hundreds or tens of mg/l.

7.6.2.19 Where initial height of sediment suspension is low (i.e. <3 m) (e.g. drilling, pre-lay cable trenching, or cable installation using a jetting or MFE tool), SSC is unlikely to exceed 150 mg/l beyond approximately 5 m away for (mainly) gravels, 30 m for coarse sand, 90 m for medium sand, and ~250 to 300 m for finer sands. The time required for redeposition of sands and gravels following low height disturbance is in the order of seconds to a few minutes.

7.6.2.20 Where sediment is released at the water surface (e.g. during dredge spoil disposal), SSC is unlikely to exceed 150 mg/l beyond approximately 100 m away for gravels, 500 m for coarse sand, 1.5 to 2 km for medium sand, and approximately 5 km for finer sands. The time required for redeposition of sands and gravels following release at the water surface is in the order of a few minutes to 1.5 hours.

7.6.2.21 Only finer (silt and mud) sized sediments are likely to persist in suspension for long enough to cause any effect in SSC beyond the above distances. SSC due to the limited quantity of fines present is expected to be up to 50 mg/l, up to approximately 2 km downstream of the activity; decreasing to 1 to 5 mg/l within 1 to 3 days through progressive dilution and dispersion.

7.6.2.22 Sediment plume extent is generally limited to the tidal excursion distance: the approximate distance over which water (or a section of plume with elevated SSC) is advected during one flood or ebb tide. Under mean spring conditions, this is approximately:

- 10 km around the array area;
- 14-15 km around the middle of the ECC (approximately KP20);
- 18-19 km in the nearshore approaches to Milford Haven (approximately KP10); and
- 4 km within Milford Haven.

7.6.2.23 Areas beyond the tidal excursion distance and footprint are unlikely to experience any measurable change in SSC from a sediment plume.

7.6.2.24 Excavation of the open cut trench with a plough will likely result in the formation of sediment berms either side of the trench. The displaced material is expected to be predominantly sandy in nature and is expected to form sediment berms approximately 1.1 m in height and approximately 10 m total trench width. It is possible that whilst the trenches are open (potentially up to 3 months), the material in the berms could be mobilised and locally redistributed by the combined action of tidal currents and waves. Although this will result in a degree of SSC uplift, this will be localised and small in magnitude. Any changes to marine water quality due to sediment re-suspension will be no greater than that identified for cable installation trenching works (see Section 7.6.2.12 onwards) and therefore is not considered further here.

7.6.2.25 These worst case changes in SSC due to seabed preparation are expected to be low in magnitude due to the limited spatial and temporal extent of predicted sediment plumes. Ambient SSC within receiving water bodies is expected to return to baseline conditions rapidly following cessation of activities.

7.6.2.26 Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. As such, the impacts of changes to water quality through sediment re-suspension during offshore export cable installation is predicted to result in a **minor adverse** effect, which is not significant in EIA terms.

Water quality may be affected by HDD works

7.6.2.27 Use of HDD requires drilling fluids. This may be released into the marine environment either at the HDD punchout near landfall, or through accidental release resulting from breakout along the HDD route. The potential impact on water environment from such releases is provided herein.

7.6.2.28 Bentonite is a natural, non-toxic material, with a neutral pH level (8-9) and grain size less than 60 microns. Drilling fluids typically comprise 5% bentonite and 95% water. Given the low concentration, non-toxic nature and neutral pH, the release of this material is considered unlikely to result in a degradation in the chemical quality of receiving waters. However, the small grain size mean that this fluid will be transported in suspension and may affect turbidity.

7.6.2.29 The release of bentonite and drill cuttings in the form of drilling fluid from the planned HDD operations will result in a localised and temporary plume of elevated SSC. Where the plume has measurable SSC that might be of concern (e.g. to bathing water quality), the plume is expected to be limited to tens to low hundreds of mg/l over footprints less than 500 m for up to one hour and <10 mg/l for a period of days at distances >500 m.

7.6.2.30 The northern HDD exit point is proposed to be located approximately 374 m offshore of the beach at West Angle Bay (374 m from mean low water springs, 603 m from mean high water springs). The southern HDD exit point would be located a similar distance offshore of the beach (approximately 315 m from mean low water springs and 358 m from mean high water springs). The locations, in or near to the main channel, ensures that the majority of the plume will be advected in the direction of the ambient tidal currents. The direction of transport (into or out of the estuary) will depend on the state of the tide (flood or ebb) at the time of the release. Plumes that are initially advected into the estuary may disperse more widely but may otherwise remain within the estuary. Plumes that are initially advected out of the estuary are likely to be rapidly advected and dispersed alongshore and are unlikely to fully re-enter the estuary on subsequent tides. It is expected that the plume would be dispersed to relatively low concentrations within hours of release and to background concentrations within a few tidal cycles.

7.6.2.31 The bentonite in the drilling fluid is expected to remain in suspension for hours or days and be widely dispersed before settling. More detailed quantitative assessment can is provided in Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment Technical Report.

7.6.2.32 With respect to risk of breakout along the HDD route, industry best practice will be incorporated into HDD methodology to reduce the risk of drilling fluid breakout. The primary means to achieve this involves assessment of ground investigation data and consideration in relation to requirements for specific drill design (bit diameter, length, etc.). This information will be used to determine optimal drill alignment and profile to minimise likelihood of breakout. In addition, proactive removal of cuttings is a key means of preventing breakout. If left within boreholes, cuttings form an obstacle to drill progression, increasing risk of breakout.

7.6.2.33 The methods detailed above will reduce likelihood of drilling fluid breakout, but do not provide guarantee of prevention. In recognition of this, the following measures will be implemented to monitor for accidental release, and direct the response should an incident occur.

7.6.2.34 Drilling fluid volumes will be monitored by HDD operators to identify any unanticipated losses. The HDD contractor will also monitor surface conditions in person to identify any breakout that may occur during operation. In such instances drilling will be stopped immediately and the spill contained by creating a small excavation pit or placement of sandbags. Fluid can then be removed using a submersible pump connected with a settling tank or other suitable container.

7.6.2.35 Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. Considering the industry standard mitigation measures that will be put in place to avoid accidental release and respond to any that do occur (see Section 7.4.9.5), and expectation that bentonite release at the HDD punchout would not result in a degradation in the chemical quality of receiving waters, it is concluded that the magnitude of any impact will be low.

7.6.2.36 As such, the impacts of changes to water quality through sediment re-suspension during offshore export cable installation is predicted to result in a **minor adverse** effect, which is not significant in EIA terms.

Water quality may be altered through the mobilisation of contaminated sediments.

7.6.2.37 Disturbance of seabed sediments, as discussed above, introduces potential for deterioration of water quality where seabed sediments contain chemical contaminants. However, sediment contamination across the Project array area and ECC is low (see Section 7.5.1 onwards).

7.6.2.38 Arsenic was the most common contaminant, being recorded in excess of Cefas Action Level 1 at 18 stations. Nickel, chromium and cadmium were recorded in excess of Cefas Action Level 1 at six, four, and one station respectively. These limited number of instances where concentrations of metals exceeded standard thresholds showed no clear pattern of distribution and were found within the array area, along the ECC and closer to Milford Haven. It is apparent that where contamination does occur, it is not concentrated in broad regions, but intermittently distributed throughout the footprint of the Proposed Development.

7.6.2.39 Only one of these elevated results was recorded for a sample station close to the historic dredge disposal site. The Milford Haven disposal site corresponded with stations 16, 17 and 18. Nickel was found in excess of Cefas Action Level 1 at Station 22, located >4 km from the historic disposal site. The absence of elevated contaminant levels in sediments collected close to the historic Milford Haven disposal site indicates that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. This disposal site has not been in use since 1994 and, as such, there has been considerable opportunity for dispersal and dilution of dredge spoil through natural processes. In view of the analysis results for sediments collected in this area, works within the footprint of the historic disposal ground are not considered to pose in increased risk to marine sediment and water quality relative to other areas of the ECC.

7.6.2.40 Although all PAHs were, in general, recorded at relatively low concentrations, higher concentrations were recorded at the nearshore stations compared to the offshore stations. As detailed in Section 7.5.3 TEL was exceeded at a limited number of stations for various PAHs, but no samples were found to exceed PELs.

7.6.2.41 THC, on average, was higher in nearshore stations than at offshore stations, which is most likely due to the proximity of the nearshore stations to urban settings and therefore to potential additional sources of hydrocarbons. However, there were no instances of THC in excess of Cefas Action Level 1.

7.6.2.42 Given the low level of chemical contaminants present in seabed sediments, there is a low risk that sediment mobilisation will result in significant contamination of the marine environment. As a result, the magnitude of this impact is considered to be low. Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. The low levels of chemical contaminants in Project water samples indicate that any contaminants that are mobilised from benthic sediments are unlikely to lead to failure relative to water quality EQS.

7.6.2.43 Based on this low magnitude of impact and low receptor sensitivity, it is considered to result in a **minor adverse** effect, which is not significant in EIA terms.

7.6.3 Operation and Maintenance

Accidental release of fluids into the environment.

7.6.3.1 Various operation and maintenance (O&M) activities will be required during the Project operational phase. These may include mooring and sub-structure inspection and repair activities, cable repair or remediation activities, hull repair, and other offshore maintenance. The presence of vessels at site to complete these tasks introduces risk of spillage or chemical contamination from works vessels. It is expected that vessel presence for O&M activities will not exceed 2 x 12h periods per year per WTG. Accidental spillage of lubricants, oils or chemicals may occur directly from WTGs themselves or from vessels present on site during maintenance activities.

7.6.3.2 As noted in paragraph 7.6.2.11, best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A MPCP will be produced and agreed with stakeholders post-consent prior to the commencement of construction. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

7.6.3.3 Overall, the marine area in which the array area is located is considered to be of low sensitivity to changes in suspended sediments due to large volume of the receiving water and the capacity for dilution and flushing. The magnitude of impact is considered to be negligible due to the control measures that will be put in place to avoid accidental chemical contamination events, or address one should it occur. Therefore, based on the above, it is considered to result in a **negligible** effect, which is not significant in EIA terms.

Benthic sediments may be mobilised through scouring effects caused by installation of turbine foundations, anchor points and cable protection. Sediment re-suspension could lead to deterioration in water quality.

7.6.3.4 Placement of semi-submersible floating platform anchors or cable protection structures on the seabed introduces potential for localised changes to hydrodynamics, potentially causing scour and the re-suspension of seabed sediments. Associated increased in suspended sediment concentration may lead to an increase in SSC (decreased water clarity), or mobilisation of contaminated benthic sediments into the water column.

7.6.3.5 Changes in local field flow may cause a ‘ploughing’ or ‘sweeping’ of sediment, redistributing sediment volume locally into accumulations. However, it is expected that any sediment movement will involve limited movement at the seabed and will not cause elevations in SSC detectable above natural variation. Any changes to bedforms will stabilise gradually over time, further reducing potential for sediment suspension.

7.6.3.6 The potential for mobilisation of contaminated sediments will be no greater than that identified for the construction phase (see Section 7.6.2.37) and therefore is not considered further here.

7.6.3.7 Given this small associated increase in SSC, the magnitude of impact is determined to be negligible. Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. As such, the impact of changes to water quality through sediment re-suspension during offshore export cable installation is considered to result in a **negligible** effect, which is not significant in EIA terms.

Changes to water quality through sediment re-suspension via cable repair and/or remediation events.

7.6.3.8 The consent seeks allowance for a certain number of repair events as well as cable remediation works, if re-burial of cable is required in any locations. De-burial, and re-burial works associated with cable repairs, and cable remediation events (most likely via MFE) would be associated with elevations to SSC due to sediment disturbance.

7.6.3.9 Any changes to marine water quality due to sediment re-suspension will be no greater than that identified for cable installation during the initial construction phase (see paragraph 7.6.2.14 onwards) and, therefore, is not considered further here.

The introduction of transmission assets may heat surrounding sediments and cause increased bacterial growth.

7.6.3.10 Electricity transmission within the marine environment will cause cables to become heated relative to the ambient environment. These heating effects may result in increased growth of temperature sensitive bacteria and, thereby, cause a deterioration in water quality.

7.6.3.11 Cables that are laid on the sea floor are expected to have minimal effects on surrounding water temperatures as consistent water flow will dissipates excess heat energy (Worzyk, 2009). However, surface laid cables may result in heating of the seabed upon which they are placed. Similarly, thermal energy from cables that are buried below the surface is likely to be retained within surrounding sediments. These heating effects on benthic substrata introduces risk of impacts on benthic receptors.

7.6.3.12 Any demersal, pelagic or epibenthic species will not be impacted by thermal effects due to the high heat capacity of water and the water flow around the cable. However, the potential of heat effects may exist for burrowing fauna. The effect of heat loss from the cables is small increases in temperature within a few centimetres of the cable (Boehlert and Gill, 2010). BirdNed interconnector cable found that the immediate sediment in summer may increase by 0.5-5.5˚C when the cable is buried at a depth of 1 m. At a burial depth of 3 m the temperature was calculated to be between 0.5-1.8˚C (Moray Offshore Windfarm Ltd, 2018; National Grid and Energinet, 2017). The temperature increase from the cables will be extremely low and very localised (within the first couple of centimetres of the cable) as it is likely to dissipate quickly.

7.6.3.13 This assessment will be based on a maximum of 2.5˚C change as was observed in the field experiment for Nysted offshore windfarm within the first 50 cm of the cable. The mean difference in temperature observed at this site was 0.8˚C (Meißbner *et al.*, 2006).

7.6.3.14 In most instances cables will be buried to target depth of 3.0 m however, on occasion, these may be surface laid with cable protection. Any elevations in surface temperature are expected to be limited to within tens of centimetres of the cable. Given this highly limited spatial extent it is expected that any increase in bacterial growth will be of a negligible magnitude.

7.6.3.15 Any bacterial growth will be associated with strains already present within the baseline environment, as opposed to novel bacteria brought to site by Project activities. In view of this, the baseline environment should be considered to have a natural level tolerance through historic exposure to these bacteria. In view of this, sensitivity of the surrounding environment is considered to be low.

7.6.3.16 Based on these assessments the impacts of changes to water quality through increased growth of temperature sensitive bacteria is considered to result in a **negligible** effect, which is not significant in EIA terms.

7.6.4 Decommissioning

Removal of piles drilled into hard rock seabed during decommissioning may produce additional suspended particles which may become part of the local sediment transport regime.

7.6.4.1 Following decommissioning, anchors will be removed from the seabed. Extraction of anchors drilled into hard rock seabed may cause the suspension of sediment into the water column, which could lead to deterioration in water quality. It is assumed that drilled anchors will be cut at or below surface level. Embedded material will be left *in situ* and emergent structures will be removed from site.

7.6.4.2 Cutting of anchors may lead to release of a small volume of fragmented material. However, this is expected to consist of relatively heavy particles that will settle rapidly. The limited volume of material released mean that the magnitude of any change to local sediment transport regime will be low. Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. As such, the impacts of changes to water quality through is predicted to result in a **minor adverse** effect, which is not significant in EIA terms.

Accidental release of fluids into the environment.

7.6.4.3 Any fluids or contaminants contained within the structures have the potential to leak into the marine environment on decommissioning, where they may lead to chemical contamination of marine sediments. Prior to decommissioning, a decommissioning plan will be agreed with Regulators. The plan will provide details of proposed decommissioning activities, and measures that will be put in place to reduce the likelihood of releasing chemical contaminants into the marine environment.

7.6.4.4 Overall, the marine area in which the array area is located is considered to be of low sensitivity to changes in suspended sediments due to large volume of the receiving water and the capacity for dilution and flushing. The magnitude of impact is considered to be negligible due to the control measures that will be put in place to avoid accidental chemical contamination events, or address one should it occur. Therefore, based on the above, it is considered to result in a **negligible** effect, which is not significant in EIA terms.

Removal of array and export cables may cause changes to water quality through sediment re-suspension.

7.6.4.5 Removal of offshore export cable and array cables that are buried in the seabed has potential to result in localised increases in SSC, which may lead to deterioration of water quality. It is expected that equipment similar to that used to install the offshore transmission assets could be used to reverse the burial process and expose the offshore cables. Accordingly, the area of seabed impacted during the removal would be similar to the area impacted during the installation.

7.6.4.6 For all of the above, the changes in SSC and accompanying changes to bed levels associated with decommissioning activities are expected to be no greater than that associated with the construction phase. Further information is provided in the construction phase assessment (paragraph 7.6.2.14 onwards).

7.6.4.7 Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. As such, the changes to water quality through sediment re-suspension during offshore export cable installation is predicted to result in a **minor adverse** effect, which is not significant in EIA terms.

7.6.5 Effects on Human Health and Population

7.6.5.1 Effects on human populations from changes to water quality are expected to be limited to potential for impacts on local bathing water quality. There are five designated bathing waters within 10 km of the proposed landfall location: West Angle (0 km); Dale (3.5 km); Sandy Haven (4 km); Freshwater West (5.5 km); and Marloes Sand (7.5 km). All of these sites were classified as ‘excellent’ during the most recent (2020) Wales Bathing Water Report. It is clear that potential for impacts is greatest at West Angle: the site of proposed landfall.

7.6.5.2 The Bathing Water Directive classifications are based on two microbiological parameters: *Escherichia coli* (*E. coli*) and intestinal enterococci. There is no cause to suspect that the activities proposed for construction, operation or decommissioning of the Proposed Development will cause notable increase in either of these bacteria. Therefore, it is considered there is negligible potential for activities associated with the Proposed Development to cause deterioration in bathing water classification or jeopardise any potential increase in classification at Sandy Haven.

7.6.5.3 In addition to consideration of bathing water classification, activities associated with the Proposed Development may impact public enjoyment of designated bathing waters if there is significant change in water clarity. As described in paragraph 7.6.2.14 onwards there may be small, localised increases in SSC following cable installation and removal, and following HDD punch-out. Although it is expected that sediment plumes will travel into open waters, small amounts may towards the designated bathing waters at West Angle Beach. However, given the small increases in SSC predicted for these activities and the short duration they are expected to remain in suspension, this is not predicted to have a noticeable impact on public enjoyment of the site. Any changes will be small in magnitude and will only occur during and shortly after construction or decommissioning activities. As such, it is considered to result in a **negligible** effect, which is not significant in EIA terms.

7.7 Additional Mitigation

7.7.1.1 No effects have been predicted to result in a moderate or major adverse impact (significant in EIA terms). As such, additional mitigation measures are not required to reduce the significance to non-significant in EIA terms and the significance of residual effects remain as detailed above.

7.8 Additional Monitoring

7.8.1.1 No additional monitoring is proposed for marine seabed and water quality.

7.9 Inter-Related Effects

7.9.1.1 The assessment of effects on marine sediment or water quality within this chapter has taken into account potential for inter-relationships between multiple impacts acting on common receptors. These may include effects that occur throughout more than one phase of the project (construction, O&M, and decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation, or instances where effects of multiple activities affect a common receptor.

7.9.1.2 Various impacts assessed within this chapter, e.g. changes in SSC, or contamination of marine waters or sediments, may affect a variety of receptors such as fish or benthic communities. However, these inter-relationships will be considered within the topic specific chapter. Changes in SSC caused by sediment mobilisation are of particular importance to other topic areas. The transport and residency of mobilised sediments is considered in detail within Chapter 6: Marine and Coastal Processes. In turn this information has been used to inform other EIA topics such as:

- Chapter 8: Offshore Designated Sites;
- Chapter 9: Marine and Coastal Ecology;
- Chapter 10: Fish & Shellfish Ecology;
- Chapter 11: Offshore Ornithology; and
- Chapter 12: Marine Mammals.

7.9.1.3 Receptors specific to marine sediment and water quality are limited to marine water quality and marine sediment quality. The worst-case impacts assessed within this chapter take these interactions between various pathways upon these receptors into account and therefore the impact assessments are considered conservative and robust.

7.9.1.4 It is considered that there is negligible risk of Project lifetime effects on marine sediment and water quality receptors. The durations of all effects considered in Section 7.6 are short. It is expected that the marine waters and sediment receptors will have recovered in the intervening period between the construction operations and initial O&M requirements, and between O&M and decommissioning phases. Therefore, across the project lifetime, the effects marine sediment and water quality are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.

7.10 Cumulative Effects Assessment

7.10.1.1 A Cumulative Effects Assessment (CEA) has been made based on existing and Proposed Developments in the Study Area (Chapter 30: Cumulative Effects). The approach to the CEA is described in Chapter 30: Cumulative Effects. Cumulative effects are defined as those effects on a receptor that may arise when the development is considered together with other reasonably foreseeable projects.

7.10.1.2 As detailed in Section 7.6, the greatest risk of impact to marine sediment and water quality from the Proposed Development is related to elevated SSC from sediment mobilisation and potential for disturbance of contaminated sediments. Accordingly, the greatest risk for cumulative impacts from the Proposed Development and other plans or projects would be expected to relate to these effect pathways.

7.10.1.3 The maximum spatial extent of potential effects on marine sediment and water quality as identified within this chapter are determined by the associated sediment plume and limited to within one spring tidal excursion of the activity. The tidal excursion distance is the approximate distance over which water (or a section of plume with elevated SSC) is advected during one flood or ebb tide. Under mean spring conditions, this is approximately:

- 10 km around the array area;
- 14-15 km around the middle of the ECC (approximately KP20);
- 18-19 km in the nearshore approaches to Milford Haven (approximately KP10); and
- 4 km within Milford Haven.

7.10.1.4 Areas beyond the tidal excursion distance are unlikely to experience any measurable change in SSC from a sediment plume. As such, only plans or projects with potential to overlap spatially will be included in the cumulative assessment.

7.10.1.5 On this basis, the projects considered within this cumulative assessment are the Greenlink Interconnector, the Marine Energy Test Area (META) Phase Two project, the Bombora Wave Energy project, and Project Valorous (Table 7.12). However, it should be noted that other than Project Valorous, all these are >15 km from the Project array area. As such, Project Valorous will be assessed for potential cumulative effects related to activities occurring within the array area and/or ECC/landfall, whereas the remaining four projects will only be assessed for potential cumulative effects related to activities occurring within the ECC/landfall. Further information on these projects is outlined in Chapter 30: Cumulative Effects.

Table 7.12 – Summary of projects relevant for Cumulative Assessment in relation to Marine Sediment and Water Quality

<table>
<tr><th>Project</th><th>Tier</th><th>Distance from array (km)</th><th>Distance from ECC</th><th>Construction Timings</th></tr>
<tr><td>Greenlink Interconnector</td><td>2</td><td>17.8</td><td>0</td><td>2023-2024</td></tr>
<tr><td>META – East Pickard Bay (Bombora)</td><td>1</td><td>40</td><td>3.0</td><td>Summer 2022 for a maximum duration of 18 months including removal.</td></tr>
<tr><td>META – Warrior Way</td><td>2</td><td>51.7</td><td>12.6</td><td rowspan="2">As a test site deployment and recovery will be dictated by client bookings. There is no programme, and activity will be managed by Notice to Mariners and stakeholder updates.</td></tr>
<tr><td>META – Dale Road</td><td>2</td><td>39.6</td><td>2.3</td></tr>
<tr><td>Project Valorous</td><td>2</td><td>3.3</td><td>9.7</td><td>2026 to 2028</td></tr>
<tr><td>Milford Haven Maintenance Dredging</td><td>1</td><td>35.6</td><td>0.5</td><td>Ongoing</td></tr>
<tr><td>Maintenance Dredge Disposal: Milford Haven Two Disposal Site</td><td>1</td><td>24.1</td><td>4.1</td><td>Ongoing</td></tr>
</table>

7.10.1.6 Although localised work on the Pembroke Dock Slipway was identified within the cumulative effects long list, this has been excluded from further assessment as it is expected to be completed before works on the Proposed Development commence, and it is not expected that there will be any additional operational impacts that require consideration within the cumulative assessment.

7.10.1.7 The potential cumulative impacts of the Pembrokeshire Demonstration Zone (PDZ) have not been considered at the time of writing due to the lack of detail with which to assess the effects of the proposed project. An EIA Scoping Report was produced and issued to NRW in 2018 for a proposed wave/floating wind project however based on discussions with Celtic Sea Power (the 3rd party agents for the PDZ) and recent public presentations by members of Celtic Sea Power, it is understood the PDZ will be repurposed as an offshore electrical hub. In the absence of an updated EIA Scoping Report and insufficient project information to allow the effects to be reasonably understood and a cumulative assessment undertaken, it has been omitted from this assessment.

7.10.1.8 For those reasons identified above, including the absence of EIA Scoping Reports, the potential cumulative impacts of the recently announced Llyr 1, Llyr 2 and Whitecross FLOW projects are also omitted from this cumulative assessment.

7.10.1.9 As set out in PINS Guidance Note 17: Cumulative Effects Assessment, the Project proposed an assessment cut-off date of 1 October 2021 to allow the finalisation of the EIA and HRA assessments, even if project information came forward between the cut-off date and submission. This was agreed with NRW Marine Licensing, noting that in the absence of S.36/Marine Licence guidance the Project was drawing upon the best available advice. It is understood that should sufficient detail of these projects come forward following submission the Project may be requested to provide additional information during the determination period.

7.10.1.10 The consideration of projects that could result in potential cumulative impacts is assessed based on the results of the impact assessment, a review of the status of other projects, together with the professional judgement of the specialist consultants.

7.10.2 Construction

Impact on water quality via drilling and disposal of drill arisings.

7.10.2.1 The location of this activity within the array area means that there is only potential for cumulative impacts with Project Valorous (located approximately 5 km from the Proposed Development). Construction operations at the Proposed Development will be completed before works commence for Project Valorous and, as such, cumulative impacts with Project Valorous are not considered for this impact pathway.

Accidental release of fluids into the environment.

7.10.2.2 The potential for release of pollution from leaks or spills of fuels, chemicals or construction materials introduces risk of deterioration of water quality. Such incidents may occur at any location within the Proposed Development and, as such, the assessment of potential cumulative affect must include all of the projects screened into assessment.

7.10.2.3 As detailed in Paragraph 7.6.2.11, best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A MPCP will be produced and agreed with stakeholders post-consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

7.10.2.4 The adoption of construction best practice and utilisation of MPCPs or similar (e.g. shipboard oil pollution emergency plans) is standard within marine developments and will be similarly adopted at the other projects considered. In addition, given the expected low incidence of pollution events during construction, it is considered highly unlikely that any such incidents that did occur would be associated with the temporal and spatial overlap necessary to result in cumulative effects.

7.10.2.5 In view of the control measures that will be put in place to avoid accidental chemical contamination events, or address one should it occur, the risk of adverse effect from this pressure is considered to result in a **negligible** effect, which is not significant in EIA terms.

Cable installation works may cause changes to water quality through sediment re-suspension.

7.10.2.6 The potential for sediment plume interaction will be greatest for activities associated with cable installation. These activities will take place across the full extent of the array area and ECC and as such introduces risk of cumulative effects with include all of the projects screened into assessment.

7.10.2.7 Although the ECC of the Proposed Development intersects the Greenlink Interconnector route and is in within 3 km of the Bombora Wave Energy project, construction of these developments is expected to be complete by 2024. As such, there will be no temporal overlap with construction associated with the Proposed Development. Cumulative effects may occur however, if operational cable reburial works required for these sites occur during construction of the Proposed Development. Effects from such repair or remediation works are expected to be small in scale and highly localised. Any elevations in SSC would be expected to return to baseline levels rapidly.

7.10.2.8 Sediment disturbance from the META Phase Two project may arise during a range of installation activities, such as foundation installation and drilled pin pilling. The largest increases in SSC are predicted for installation of gravity bases or during seabed levelling for bed mounted devices. Sediment plumes are predicted to increase SSC by 70mg/l and return to background levels within 2 hours following cessation of activities (RPS, 2019). Despite the low probability that construction activities associated with the META Phase Two project would proceed at the specific time when cable laying operations for the Proposed Development are within the appropriate section of the ECC, there is theoretical risk that the respective plumes may interact. However, given the small magnitude of increase predicted both within Section 7.6 and for the META Phase Two development, it is considered that any cumulative increase in SSC would be small in magnitude. Elevated SSC will also return to baseline following cessation of activities and so any impact would only be present during the installation process.

7.10.2.9 Specific predictions of sediment plumes expected for the Valorous development are not currently available. However, it is reasonable to assume that these will be similar to those predicted for the Proposed Development. As such, it can be expected that if works occur at both projects locations concurrently there may be interaction between plumes containing finer sands and fines. However, SSC elevation associated with these fine particle plumes will be small in both cases, and the combined effect will be small in magnitude, far below the parameters assessed for the Proposed Development alone. Given that construction of Project Valorous will not commence until after completion of works for the Proposed Development, the worst case scenario would involve construction of Project Valorous concurrently with MFE activities required for repair or remediation activities for the Proposed Development. In such instance there may be interaction between plumes containing finer sands and fines. However, SSC elevation associated with these fine particle plumes will be small in both cases, and the combined effect will be small in magnitude, far below the parameters assessed for the Proposed Development alone.

7.10.2.10 Where cable installation occurs at landfall, it could (theoretically) occur at the same time as maintenance dredging at Milford Haven, around 500 m away. Given the very close proximity of the two activities, it is possible that plume interaction could occur. However, it is noted that in line with UNCLOS (The United Nations Convention on the Law of the Sea) cable installation vessels typically request a 1 nautical mile (c. 1.85 km) vessel safety zone when installing or handling cables. Accordingly, whilst plume interaction may still occur, it is likely over the distance between these actives the relative SSC levels will have reduced towards background levels. As such, it is expected that any cumulative elevation in SSC will remain within the much higher concentration and more persistent plume parameters considered for the project alone (see Section 7.6.2 and Chapter 6: Marine Coastal Processes). It is expected that there is a low probability of the temporal and spatial overlap required for cumulative effects between these projects. However, even if this did occur, these worst case changes in SSC due to seabed preparation are expected to be low in magnitude due to the limited spatial and temporal extent of predicted sediment plumes.

7.10.2.11 Ambient SSC within receiving water bodies is expected to return to baseline conditions rapidly following cessation of activities. Receptor sensitivity is considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. As such, the impacts of changes to water quality through sediment re-suspension during offshore export cable installation is considered to result in a **minor adverse** effect, which is not significant in EIA terms.

Water quality may be altered through the mobilisation of contaminated sediments

7.10.2.12 As outlined above, although the ECC of the Proposed Development intersects the Greenlink Interconnector route and is in within 3 km of the Bombora Wave Energy project, construction of these developments is expected to be complete by 2024. As such there will be no temporal overlap with construction associated with the Proposed Development. However, cumulative effects may occur, if operational cable reburial works required for these sites occur during construction of the proposed development. The Greenlink Interconnector route will pass close to the historic Milford Haven dredge disposal ground, and the ECC for the Proposed Development will intersect the footprint of this disused spoil area. However, as described in Section 7.6.2.39 the absence of elevated contaminant levels in sediments collected close to the historic disposal site suggest that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. However, sediment samples collected by Intertek (2019) demonstrate that contaminant levels in sediments surrounding the Greenlink Interconnector are largely below the limits of detection. The risk associated with disturbance of these sediments is decreased further given the low chance of interaction between, and small SSC increase associated with respective sediment plumes.

7.10.2.13 Potential for sediment contamination for META Phase Two project sites is determined to be very low (RPS, 2019). Although Project-specific sediment sample data are not available for Project Valorous project at the time of assessment, give the proximity, they can be assumed to be similar to that of the Proposed Development. Similarly, the ES for the Bombora Wave Energy Development does not provide site specific sediment sample data, but notes that "*Whilst the Milford Haven Waterway has a notable industrial history, with major petrochemical and port development along its banks contributing to sediment contamination, the exposed coastal area to the south of the Angle peninsular, where mWave will be deployed, is remote and undeveloped. As such the potential for significant sediment contamination to be present in this area is highly unlikely*" (BWP, 2019).

7.10.2.14 Disposal of material at Milford Haven 2 dredge spoil site has potential to introduce contaminated material into the marine environment. This presents risk of cumulative increases in contamination together with seabed disturbance at the Proposed Development. However, it is important to note that at sea disposal of dredge material is regulated through OSPAR guidelines; before disposal, sediments must be characterised as part of a weight of evidence approach with consideration of Cefas Action Levels with respect to protection of the marine environment. As such, it is expected that contaminant levels will be low in any material approved for disposal. In addition, disposal to the Milford Haven site occurs only occasionally. As such, it is unlikely that this will occur at the same time as Project activities. Any temporal separation between these events would allow dispersal of contaminants, thereby removing the pathway for cumulative impacts. The Milford Haven 2 disposal site is >4 km from the ECC and therefore concentrations of any chemical contaminants released by the respective projects will become diluted before mixing and cumulative levels are unlikely to exceed the levels associated with each project alone.

7.10.2.15 As previously highlighted, it is considered unlikely that there will be sufficient temporal and spatial overlap for interaction between sediments mobilised during construction activities required for these projects. However, even if this does occur, the low contaminant levels in underlying sediments ensures that the magnitude of any increase would be low. Receptor sensitivity is also considered to be low due to the large volume of the receiving water and the capacity for dilution and flushing. The low levels of chemical contaminants in Project water samples indicate that any contaminants that are mobilised from benthic sediments are unlikely to lead to failure relative to water quality EQS.

7.10.2.16 Based on this low magnitude of impact and low receptor sensitivity, it is considered to result in **minor adverse** effect, which is not significant in EIA terms.

7.10.3 Operation and Maintenance

Accidental release of fluids into the environment.

7.10.3.1 The potential for release of pollution from leaks or spills of fuels, chemicals or construction materials introduces risk of deterioration of water quality. Such incidents may occur at any location within the Proposed Development and, as such, the assessment of potential cumulative affect must include all of the projects screened into assessment.

7.10.3.2 All changes to marine sediment or water quality from accidental pollution events during the O&M phase will be no greater than that identified for the construction phase (see paragraph 7.10.2.2 onwards) and therefore, no associated effect is predicted.

Benthic sediments may be mobilised through scouring effects caused by installation of turbine foundations, anchor points and cable protection. Sediment re-suspension could lead to deterioration in water quality.

7.10.3.3 Placement of semi-submersible floating platform anchors or cable protection structures on the seabed introduces potential for localised changes to hydrodynamics, potentially causing scour and the re-suspension of seabed sediments. Associated increases in suspended sediment concentration may lead to decreased water clarity or introduction of contaminated benthic sediments into the water column.

7.10.3.4 However, due to the negligible magnitude of SSC increase predicted, it is considered that there is no realistic risk of cumulative effects with other projects. As such, no associated effect is predicted.

The introduction of transmission assets may heat surrounding sediments and cause increase bacterial growth.

7.10.3.5 Electricity transmission within the marine environment will cause cables to become heated relative to the ambient environment. These heating effects may result in increased growth of temperature sensitive bacteria and thereby cause a deterioration in water quality.

7.10.3.6 Assessment of this potential impact is not provided in supporting studies for any of the other projects screened into assessment. Accordingly, within this assessment it is assumed that potential increases in growth of temperature sensitive bacteria will be comparable to the Proposed Development. Given the nature of this pressure, related to the operational phase of each project, consideration should be made of all projects as these are all expected to operate concurrently. However, given the negligible spatial extent predicted for potential impacts, it is considered that the overall cumulative magnitude will be medium.

7.10.3.7 Any bacterial growth will be associated with strains already present within the baseline environment, as opposed to novel bacteria brought to site by Project activities. In view of this, the baseline environment should be considered to have a natural level tolerance through historic exposure to these bacteria. In view of this, sensitivity of the surrounding environment is considered to be low.

7.10.3.8 Based on these assessments the impacts of changes to water quality through increased growth of temperature sensitive bacteria is predicted to result in a **minor adverse** effect**,** which is not significant in EIA terms.

7.10.4 Decommissioning

7.10.4.1 Due to level of uncertainty over the likely schedule for decommissioning of both the Proposed Development and other projects considered, it is considered that cumulative effects assessment cannot be realistically completed for this Project phase.

7.11 Transboundary

7.11.1.1 In view of the limited spatial extent of potential impacts on marine sediment and water quality from the Proposed Development, i.e. ≤19 km and the distance to national waters of nearest neighbour state (>60 km) it is considered that there is no potential for transboundary effects.

7.12 Summary

7.12.1.1 This chapter provides an assessment or potential for impacts to marine sediment and water quality receptors due to construction, operation and decommissioning of the Project.

7.12.1.2 Seabed sediments off the southwest coast of Wales predominantly consist of sandy gravel with nearshore areas of sand. Site-specific grab sample data show that sediment type within the Proposed Development (array area and ECC) is typically dominated by sand. Mud content is highest close to land and towards the array area, and gravel content is low within the array area, but higher at intermittent locations within the landward half of the ECC.

7.12.1.3 Project-specific sediment and water sample data support the findings of assessments for other nearby developments and show low levels of chemical contamination in regional seabed sediments. Arsenic was the most common contaminant, being recorded in excess of Cefas Action Level 1 at 18 stations. Nickel, chromium and cadmium were recorded in excess of Cefas Action Level 1 at six, four and one station respectively. This limited number of instances where concentrations of metals exceeded standard thresholds showed no clear pattern of distribution and were found within the array area, along the ECC and closer to Milford Haven. Although all THC and PAHs were in general recorded at relatively low concentrations, higher concentrations were recorded at the nearshore stations compared to the offshore stations. This is considered to relate to due to the proximity of the nearshore stations to industrial settings.

7.12.1.4 The range of potential impacts and associated effects considered has been informed by Scoping responses and from subsequent discussions with stakeholders. It has also drawn upon reference to existing policy and guidance.

7.12.1.5 The assessment has been undertaken in three stages. These are:

(1) The determination of the realistic worst case parameters from the Chapter 4: Proposed Development Description;

(2) The determination of the baseline environment (including potential changes over the Proposed Development lifespan due to natural variation); and

(3) Assessment of changes to marine and coastal processes arising from the realistic worst case both for the Proposed Development on its own and in conjunction with other built and consented projects.

7.12.1.6 A number of different assessments have been undertaken in this chapter, including:

- The extent and duration of sediment plumes associated with construction activities such as mooring system installation;
- Potential for mobilisation of contaminated sediments; and
- Changes in wave, tides and sediment transport arising from the presence of semi-submersible floating platforms and their mooring systems.

7.12.1.7 However, even with realistic worst case assumptions for the project design parameters, no impacts on identified receptors are found to be significant in EIA terms. The assessment also finds that there is very low potential for significant cumulative impacts resulting from interactions with other planned projects. Accordingly, no additional mitigation has been proposed to that already embedded in the existing Proposed Development Design.

Table 7.13 – Summary of Effects

Description of Effect	Significance of Potential Effect (assuming standard mitigation implemented)		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction					
Impact on water quality via drilling and disposal of drill arisings.	Negligible	-	n/a	Negligible	-
Accidental release of fluids into the environment.	Negligible	-	n/a	Negligible	-
Cable installation works may cause changes to water quality through sediment re-suspension.	Minor	Adverse	n/a	Minor	Adverse
Water quality may be altered through the mobilisation of contaminated sediments.	Minor	Adverse	n/a	Minor	Adverse
Operation					
Accidental release of fluids into the environment.	Negligible	-	n/a	Negligible	-
Benthic sediments may be mobilised through scouring effects caused by installation of turbine foundations, anchor points and cable protection. Sediment re-suspension could lead to deterioration in water quality.	Negligible	-	n/a	Negligible	-
The introduction of transmission assets may heat surrounding sediments and cause increase bacterial growth.	Negligible	-	n/a	Negligible	-

Description of Effect	Significance of Potential Effect (assuming standard mitigation implemented)		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Decommissioning					
Removal of piles drilled into hard rock seabed during decommissioning may produce additional suspended particles which may become part of the local sediment transport regime.	Negligible	-	n/a	Negligible	-
Accidental release of fluids into the environment.	Negligible	-	n/a	Negligible	-
Removal of array, and offshore export cables may cause changes to water quality through sediment re-suspension.	n/a		n/a		

Table 7.14 – Summary of Cumulative Effects

Description of Effect	Cumulative Developments	Significance of Potential Effect (assuming standard mitigation implemented)	
		Significance	Beneficial/ Adverse
Construction			
Drilling of piles into hard rock seabed may produce additional suspended particles which may become part of the local sediment transport regime.	N/A	Negligible	-
Accidental release of fluids into the environment.	• Greenlink Interconnector • The Marine Energy Test Area (META) Phase Two project • Bombora Wave Energy project • Project Valorous	Negligible	-
Cable installation works may cause changes to water quality through sediment re-suspension.	• The Marine Energy Test Area (META) Phase Two project • Project Valorous	Minor	Adverse
Water quality may be altered through the mobilisation of contaminated sediments.	• The Marine Energy Test Area (META) Phase Two project • Project Valorous	Minor	Adverse
Operation			
Accidental release of fluids into the environment.	• Greenlink Interconnector • The Marine Energy Test Area (META) Phase Two project • The Bombora Wave Energy project • Project Valorous	Negligible	-
Benthic sediments may be mobilised through scouring effects caused by installation of turbine foundations, anchor points and cable protection. Sediment re-suspension could lead to deterioration in water quality.	n/a	Negligible	-

<table>
<tr><th rowspan="2">Description of Effect</th><th rowspan="2">Cumulative Developments</th><th colspan="2">Significance of Potential Effect (assuming standard mitigation implemented)</th></tr>
<tr><th>Significance</th><th>Beneficial/ Adverse</th></tr>
<tr><td>The introduction of transmission assets may heat surrounding sediments and cause increase bacterial growth.</td><td>Greenlink Interconnector
The Marine Energy Test Area (META) Phase Two project
The Bombora Wave Energy project
Project Valorous</td><td>Minor</td><td>Adverse</td></tr>
<tr><td colspan="4">Decommissioning</td></tr>
<tr><td>Removal of piles drilled into hard rock seabed during decommissioning may produce additional suspended particles which may become part of the local sediment transport regime.</td><td colspan="3" rowspan="4">Due to level of uncertainty over the likely schedule for decommissioning of both the Proposed Development and other projects considered, it is considered that cumulative effects assessment cannot be realistically completed for this Project phase.</td></tr>
<tr><td>Changes to sediment transport system caused by changes in wave and current climate.</td></tr>
<tr><td>Accidental release of fluids into the environment.</td></tr>
<tr><td>Removal of array, platform link, interconnector and export cabling may cause changes to water quality through sediment re-suspension.</td></tr>
</table>

7.13 References

Boehlert GW and Gill AB, 2010. Environmental and ecological effects of ocean renewable energy development: a current synthesis. Oceanography, 23(2), pp.68-81.

BWP (Bombara Wave Power) (2019). mWave Marine Energy Device and Onshore Infrastructure Environmental Statement. Chapter 7 Benthic Subtidal and Intertidal Ecology.

Canadian Council of Ministers of the Environment (CCME) (2001) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Environmental Protection.

Cefas (2016). Suspended Sediment Climatologies around the UK. Report for the UK Department for Business, Energy & Industrial Strategy offshore energy Strategic Environmental Assessment programme

Department of Energy and Climate Change (DECC) (2011a). Overarching National Policy Statement for Energy (EN-1). July 2011

Department of Energy and Climate Change (DECC) (2011b). National Policy Statement (NPS) for Renewable Energy Infrastructure (EN-3). July 2011.

Department of Energy and Climate Change (DECC) (2016). Offshore Energy Strategic Environmental Assessment (SEA): An overview of the SEA process. Available online at: https://www.gov.uk/guidance/offshore-energy-strategic-environmental-assessment-sea-an-overview-of-the-sea-process [Accessed May 2021].

EA (Environment Agency) (2015). The Water Framework Directive (Standards and Classification) Directions (England and Wales). Water Framework Directive.

Intertek Ltd (2018). Greenlink Interconnector Environmental Scoping Report – UK Marine Route. Rev 2. 105pp.

Intertek Ltd (2019). Greenlink Interconnector Marine Environmental Statement – Wales Ref: P1975_R4484_RevF1 558pp.

Little, D.I., Bullimore B., Galperin, Y., and Langston, W.J. (2015). Sediment contaminant surveillance in Milford haven waterway. Environmental monitoring and assessment. 188(1):34 2-27.

Mason, C., Lonsdale, J., Vivian, C., Griffith, A., and Warford, L. (2020). Review of Action Levels used for assessing dredging and disposal marine licences.Meißner K., Schabelon H., Bellebaum J., and Sordyl H., 2006. Impacts of submarine cables on the marine environment: a literature review. Federal Agency of Nature Conservation/ Institute of Applied Ecology Ltd.

MMO (Marine Management Organisation) (2015) High Level Review of Current UK Action Level Guidance. A report produced for the Marine Management Organisation. MMO Project No: 1053.

MMO (Marine Management Organisation) (2018). Guidance; Marine Licensing: sediment analysis and sample plans; Details of sediment and sample analysis for marine licence applications. Available at: https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans. [Accessed May 2021]

Moray Offshore Windfarm (West) Limited, 2018. Moray West Offshore Windfarm Offshore EIA Report, Chapter 1 Introduction. Available at: https://marine.gov.scot/sites/default/files/00538033.pdf [Accessed: March 2021].

National Grid and Energinet, 2017. Appendix I - Cable Heating Effects – Marine Ecological Report, Viking Link. Document No VKL-07-30-J800-016.

NRW (Natural Resources Wales), 2018. Wales Bathing Water Report (2018). Available at: https://cdn.cyfoethnaturiol.cymru/media/688821/wales-bathing-water-report-2018.pdf?mode=pad&rnd=132010877590000000 [Accessed May 2021]

RPS (RPS Energy Limited) (2019). Marine Energy Wales Marine Energy Test Area (META) Environmental Impact Assessment Chapter 5: Coastal Processes. Ref: EOR0730. Available at: https://www.meta.wales/wp-content/uploads/2020/02/Chapter-5-META-Coastal-Processes.pdf [Accessed May 2021]

RWE (2013). Atlantic Array Offshore Wind Farm Environmental Statement Volume 3: Offshore Annexes.

UKMMAS (UK Marine Monitoring and Assessment Strategy) (2010). Charting Progress 2. Feeder Report: Productive Seas. Defra, London. 472pp.

Worzyk T., 2009. Submarine Power Cables: Design, Installation, Repair, Environmental Aspects. Springer Science & Business Media, 11 Aug 2009 Technology & Engineering, pp 313.