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Morlais Project
Environmental Statement

Chapter 8: Marine Water and Sediment Quality

Volume I

Applicant: Menter Môn Morlais Limited

Document Reference: PB5034-ES-008

Chapter 8: Marine Water and Sediment Quality

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MarineSpace
Making Sense of the Marine Environment ™

Morlais Document No.: MOR/RHDHV/DOC/0011	Status: Final	Version No: F3.0	Date: July 2019

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GLOSSARY OF ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
BGS	British Geological Survey
BOD	Biological Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EA	Environment Agency
EIA	Environmental Impact Assessment
EQS	Environmental Quality Standards
ES	Environmental Statement
HDD	Horizontal Directional Drilling
IPPC	Integrated Pollution and Prevention Control
JLDP	Joint Local Development Plan
MDZ	Morlais Demonstration Zone
MSFD	Marine Strategy Framework Directive
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
ORP	Oxidation-Reduction Potential
PDA	Project Development Area
PEL	Probable Effect Level
PPMP	Pollution Prevention and Management Plan
RBD	River Basin District
RBMP	River Basin Management Plan
SEA	Strategic Environmental Assessment
TEL	Threshold Effect Level
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
WFD	Water Framework Directive

GLOSSARY OF TERMINOLOGY

Bathymetry	Topography of the sea bed
Beach	A deposit of non-cohesive sediment (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively 'worked' by present-day hydrodynamic processes (i.e. waves, tides and currents) and sometimes by winds
Contaminant	A polluting substance within the sediment or water column
Current	Flow of water generated by a variety of forcing mechanisms (e.g. waves, tides, wind)
Ebb tide	The falling tide, immediately following the period of high water and preceding the period of low water
Fetch	The distance travelled by wind or waves across open water
Flood tide	The rising tide, immediately following the period of low water and preceding the period of high water
Gravel	Loose, rounded fragments of rock larger than sand but smaller than cobbles. Sediment larger than 2 mm (as classified by the Wentworth scale used in sedimentology)
Habitat	The environment of an organism and the place where it is usually found
Intertidal	Area on a shore that lies between Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT)
Megaripples	Bedforms with a wavelength of 0.6 to 10.0m and a height of 0.1 to 1.0m. These features are smaller than sand waves but larger than ripples
Neap tide	A tide that occurs when the tide-generating forces of the sun and moon are acting at right angles to each other, so the tidal range is lower than average
Nearshore	The zone which extends from the swash zone to the position marking the start of the offshore zone (~20m)
Numerical modelling	Refers to the analysis of coastal processes using computational models
Offshore	Area to seaward of nearshore in which the transport of sediment is not caused by wave activity
Sand	Sediment particles, mainly of quartz with a diameter of between 0.063mm and 2mm. Sand is generally classified as fine, medium or coarse
Scour	The erosion of sediment away from tan area as a result of the flow of water.
Sediment	Particulate matter derived from rock, minerals or bioclastic matter
Sediment transport	The movement of a mass of sediment by the forces of currents and waves
Semi-diurnal	Where two high and two low tides of approximately equal size occur every lunar day

Shallow water	Commonly, water of such depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than half the surface wave length as shallow water
Significant wave height	The average height of the highest of one third of the waves in a given sea state
Spring tide	A tide that occurs when the tide-generating forces of the sun and moon are acting in the same directions, so the tidal range is higher than average
Surge	Changes in water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and the astronomical tide predicted using harmonic analysis
Suspended sediment	The sediment moving in suspension in a fluid kept up by the upward components of the turbulent currents or by the colloidal suspension
Tidal current	The alternating horizontal movement of water associated with the rise and fall of the tide
Tidal range	Difference in height between high and low water levels at a point
Tide	The periodic rise and fall of the water that results from the gravitational attraction of the moon and sun acting upon the rotating earth
Water catchment	An area where water is collected by the natural landscape, eventually flowing to a river, lake, ocean or groundwater system
Wave height	The vertical distance between the crest and the trough

8. MARINE WATER AND SEDIMENT QUALITY

8.1. INTRODUCTION

1. Menter Môn Morlais Limited (Menter Môn) proposes the development of 240 MW of tidal generating capacity within the Morlais Demonstration Zone (MDZ). The development of the Morlais Project (the Project) will support the development of renewable energy technology objectives of the Anglesey and Gwynedd Joint Local Development Plan (JLDP), providing a consented tidal technology commercial demonstration zone. The Project will also provide opportunities for the local communities via direct employment and support of the local supply chain.

2. The development of the Project will provide a demonstration zone, specifically designed for the installation and commercial demonstration of multiple arrays of tidal energy devices. The Project will include communal infrastructure for tidal technology developers which provides a shared route to the cable landfall point via nine export cables, an onshore landfall substation, and an onshore electrical cable route to the existing electricity network via a grid connection substation (see **Chapter 4, Project Description**).

3. This chapter provides a summary description of key aspects relating to existing marine water and sediment quality, followed by an assessment of the magnitude and significance of the effects on the baseline conditions resulting from the construction, operation and decommissioning of the Project, as well as those effects resulting from cumulative interactions with other existing or planned projects.

4. This chapter has been prepared by MarineSpace Ltd on behalf of Menter Môn.

8.2. POLICY, LEGISLATION AND GUIDANCE

5. The principal European and International policy and legislation documents used to inform the assessment of potential impact on marine water and sediment quality include:

   - 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);
   - Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive);
   - Directive 76/464/EEC Water pollution by discharges of certain dangerous substances (Dangerous Substances Directive) and Priority Substances Directive (2008/105/EC);
   - Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC (the Bathing Waters Directive);
   - Directive 2006/113/EC on the quality required of shellfish waters (The Shellfish Waters Directive);
   - 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.

8.2.1. National Policy Statements

6. The Project is seeking consent for a Transport and Works Act Order from the Welsh Ministers and a Marine Licence from Natural Resources Wales (NRW). Although this Project is not seeking a Development Consent Order (DCO), its size (240 MW) means it is representative of a Nationally Significant Infrastructure Project (NSIP), therefore guidance relevant to NSIPs is considered appropriate to use for this Project. Guidance that is relevant to assessing impacts on marine water and sediment quality for NSIPs are set out within National Policy Statements (NPSs) which are the principal decision-making documents for NSIPs. Those relevant to marine water and sediment quality include:

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

7. Details of specific policies within EN-1 and EN-3 used to inform this assessment are provided in **Table 8-1** below. The specific assessment requirements for marine water and sediment quality are detailed, together with an indication of the paragraph numbers of the chapter where each is addressed.

Table 8-1 NPS EN-1 and EN-3 Assessment Requirements Relevant to Marine Water and Sediment Quality

NPS Requirement	NPS Reference	ES Reference
Infrastructure development can have adverse effects on the water environment, including 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	EN-1 Paragraph 5.15.1	Potential impacts of the Project on water quality are assessed in **Section 8.6** and in the Water Framework Directive (WFD) Compliance Assessment found in **Appendix 8.1** (**Volume III**). Impacts to habitats and species are assessed in Chapter 10 Benthic and Intertidal Ecology, Chapter 11 Fish and Shellfish Ecology and Chapter 12 Marine Mammals.
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	EN-1 Paragraph 5.15.2	The existing baseline is presented in **Section 8.5** and the baseline for relevant WFD marine bodies is provided in **Appendix 8.1** (**Volume III**).
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	EN-1 Paragraph 5.15.3	The existing baseline is presented in **Section 8.5** and the baseline for relevant WFD marine bodies is

NPS Requirement	NPS Reference	ES Reference
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 protected areas under the Water Framework Directive		provided in **Appendix 8.1** (**Volume III**).
The construction, operation and decommissioning of offshore energy infrastructure can affect marine water quality through the disturbance of sea bed sediments or the release of contaminants with subsequent indirect effects on habitats, biodiversity and fish stocks.	EN-3 Paragraph 2.6.189	Potential impacts during construction are assessed in **Section 8.6.4**.
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.	EN-3 Paragraph 2.5.85	Potential impacts of the project on water quality are assessed in **Section 8.6** and in the Water Framework Directive (WFD) Compliance Assessment found in **Appendix 8.1** (**Volume III**).

8.2.2. Marine Policy Statement

8. The Marine Policy Statement (MPS) adopted by all UK administrations in March 2011 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 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.

8.2.3. Wales National Marine Plan

9. By adopting the MPS, the Welsh Government committed to the requirement to introduce Marine Plans for Wales.

10. The Welsh Government is currently developing the first marine plan for Welsh inshore and offshore waters, the Welsh National Marine Plan (WNMP). The Plan is being developed in accordance with the Marine and Coastal Access Act (MCAA) 2009, the MPS and the Maritime Spatial Planning Directive, a draft version has been issued for consultation (discussed further in **Chapter 2, Policy and Legislation**).

11. Objective 10 of the WNMP, “to maintain and enhance the resilience of marine ecosystems and the benefits they provide in order to meet the needs of present and future generations”, is of relevance to this chapter as this covers policies and commitments on the wider ecosystem, as set out in the MPS including those to do with the Marine Strategy Framework Directive and the Water Framework Directive, as well as other environmental, social and economic considerations.

12. **Table 8-1** sets out national and regional policies which are particularly relevant to the Project.

Table 8-2 National and Regional Policy Requirements Relevant to Marine Water and Sediment Quality

Policy Description	Reference	ES Reference
MPS		
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.	Section 2.6.4.1	An assessment of potential impacts arising from the construction, operation and decommissioning of the Project is located in **Section 8.6.4**, **8.6.5** and **8.6.6**, respectively.
Draft WNMP		
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 Sections **8.6.4.4**., **8.6.5.1** and **8.6.6.2**.
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. If significant adverse impacts cannot be adequately addressed, proposals should present a clear and convincing justification for proceeding.	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 8.6.4**, **8.6.5** and **8.6.6**, respectively.
Proposals should minimise their risk of marine pollution incidents.	SOC_03: Marine pollution incidents	Impacts through accidental spillage are assessed in Sections **8.6.4.4**., **8.6.5.1** and **8.6.6.2**.
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 8.6.7** and in **Chapter 26**
Anglesey and Gwynedd Joint Local Development Plan (JLDP)		
Where appropriate, that the proposal does not have a significant unacceptable effect on the quality and supply of water	AND 3: Other Renewable Energy and Low Carbon Technologies	The impacts to marine water and sediment quality are assessed as minor to negligible and are summarised in **Section 8.7**, **Table 8-17**
It does not cause unacceptable harm to: i. water quality	AMG 4: Coastal Protection	

Policy Description	Reference	ES Reference
Wellbeing of Future Generations (Wales) Act 2015		
A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).	A resilient Wales	The Project is assessed to have minor to negligible impacts on marine water and sediment quality (**Section 8.6**) while providing a source of renewable energy to communities.

8.2.4. The Water Framework Directive (WFD)

13. The WFD commits EU member states to achieve good quantitative and qualitative status of all water bodies. In the UK, an integrated approach to the management of all freshwater bodies, groundwaters, transitional (estuarine) and coastal waters at the river basin level has been adopted.

14. The overall requirement of the WFD is that all waterbodies must achieve Good Ecological Status 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.

15. Ecological status is assessed against a scale of high, good, moderate, poor or bad, with ‘High’ denoting largely undisturbed conditions and the other classes representing a deterioration from the undisturbed condition. The ecological status classification for the water body, and the confidence in this, is determined from the worst scoring quality element.

16. 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. The Project is located within the Western Wales River Basin District.

17. At its nearest point the MDZ is located 0.5 km from the west coast of Holy Island, Anglesey, and falls within the Caernarfon Bay North WFD coastal water body which currently has an overall Good status, with a Good chemical status and a Good ecological status.

8.2.5. Marine Strategy Framework Directive

18. 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.

19. 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.

20. 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.

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

8.2.6. The Dangerous Substances Directive and the Priority Substances Directive

22. The Dangerous Substances Directive and its associated Directives are concerned with controlling discharges that may contain dangerous substances that may reach inland, coastal and territorial waters.

23. The Dangerous Substances Directive set specific emission limit values and quality objectives for 17 substances (List I) in five specific directives, also called ‘daughter’ directives.

24. Some of these Environmental Quality Standards (EQS) have now been superseded by standards established by the Priority Substances Directive 2008/105/EC. Where this is not the case, limit values and environmental quality standards set by the ‘daughter’ Directives remain valid.

25. The Priority Substance Directive is implemented in England and Wales by the River Basin District Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. Compliance with these standards forms the basis of good surface water chemical status under the WFD.

26. The EQS under the Dangerous Substances Directive and Priority Substances Directive for selected List I substances are shown in **Table 8-3**.

Table 8-3 Environmental Quality Standards for Selected List I Substances

Substance	EQS Type	EQS under Priority Substances Directive (annual average, µg/l)	EQS under Dangerous Substances Directive (annual average, µg/l)
Arsenic (dissolved)	Annual average	-	25
Chromium (dissolved)	Annual average	-	15
Copper (dissolved)	Annual average	-	5
Lead (dissolved)	Annual average	7.2	25
Nickel (dissolved)	Annual average	20	30
Tributyl tin (TBT)	Maximum concentration	0.0002	0.002
Zinc (total)	Annual average	-	40

27. The EQSs for selected List II substances, based on data from the EA (2011) are shown in **Table 8-4** and includes the relevant EQSs under the Priority Substances Directive (where applicable).

Table 8-4 Selected List II Environmental Quality Standards (EA, 2011)

Substance	EQS Type	EQS under Priority Substances Directive (annual average, µg/l)	EQS under Dangerous Substances Directive (annual average, µg/l)
Mercury (dissolved)	Annual average	0.05	0.3
Cadmium (dissolved)	Annual average	0.2	2.5
HCH (Lindane)	Annual average	0.002	0.02
Total DDT	Annual average	0.025	0.025
ppDDT	Annual average	0.01	0.01
Pentachorophenol	Annual average	0.4	2
Aldrin	Annual average	Σ = 0.01	0.01
Dieldrin	Annual average	Σ = 0.01	0.01
Endrin	Annual average	Σ = 0.01	0.005
Isodrin	Annual average	Σ = 0.01	0.005
Total 'Drins'	Annual average	-	0.03
Hexachlorobenzene	Annual average	0.01	0.03
Hexachlorobutadiene	Annual average	0.1	0.1
Carbon tetrachloride	Annual average	12	12
Chloroform	Annual average	-	12
1,2-dichloroethane	Annual average	10	10
Trichloroethyleme	Annual average	10	10
Perchloroethylene	Annual average	-	10
Trichlorobenzene	Annual average	0.4	0.4

8.2.7. Bathing Waters Directive

28. The Bathing Water Directive is implemented through the Bathing Waters Regulations 2008. Member States must monitor bathing waters 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. Upon the monitoring results gathered in four years, Member States should assess the bathing waters at the end of every season. A shorter period may be acceptable in some cases.

29. The Environment Agency (EA) monitors and assesses bathing water quality at each designated bathing water site in England and Wales between May and September.

30. 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 listed above have been replaced by tests for:

- Escherichia coli; and
- Intestinal enterococci.

31. Given that bathing water is measured by testing for the above parameters and this Project has no pathway to introduce such bacterial elements, this has been scoped out of the assessment.

8.2.8. Shellfish Waters Directive

32. This Directive concerns the quality of shellfish waters and applies to those coastal and brackish waters designated by the Member States as needing protection or improvement in order to support shellfish (bivalve and gastropod molluscs) life and growth and thus to contribute to the high quality of shellfish products directly edible by man.

33. The parameters applicable to the waters designated by the Member States are listed in Annex I.

8.2.9. MARPOL Convention 73/78

34. 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 minimize pollution of the oceans and seas, including dumping, oil and air pollution. The UK is a signatory to the MARPOL Convention 73/78.

35. 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.

36. 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 minimize accidental spillage of such substances.

8.2.10. International and National Sediment Quality Standards

8.2.10.1. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment (CCME), 2002).

37. 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.

38. 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).

39. They are not statutory standards 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. The higher level, the Probable Effect Level (PEL), defines a concentration above which adverse effects may be expected in a wider range of organisms.

40. Selected Canadian guidelines are presented in **Table 8-5**.

Table 8-5 Selected Canadian Sediment Quality Guideline Values (taken from CCME, 2002)

Contaminant	Units	TEL	PEL
As	mg/kg	7.24	41.6
Cd	mg/kg	0.7	4.2
Cr	mg/kg	52.3	160
Cu	mg/kg	18.7	108
Hg	mg/kg	0.13	0.7
Pb	mg/kg	30.2	112
Zn	mg/kg	124	247
Acenaphthene	µg/kg	6.71	88.9
Acenaphthylene	µg/kg	5.87	128
Anthracene	µg/kg	46.9	245
Benz(a)anthracene	µg/kg	74.8	693
Benzo(a)pyrene	µg/kg	88.8	763
Chrysene	µg/kg	108	846
Dibenz(a,h)anthracene	µg/kg	6.22	135
Fluoranthene	µg/kg	113	1494
Fluorene	µg/kg	21.2	144
Napthalene	µg/kg	34.6	391
Phenanthrene	µg/kg	86.7	544
Pyrene	µg/kg	153	1398

8.2.10.2. Cefas Action Levels for the Disposal of Dredged Material (Cefas, 2000)

41. 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, these are not statutory standards.

42. 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.

43. 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, but 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.

44. Selected current Action Levels are set out in **Table 8-6**.

Table 8-6 Selected Cefas Action Levels

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
Orgotins; TBT DBT MBT	0.1	1
PCB's, sum of ICES 7	0.01	none
PCB's, sum of 25 congeners	0.02	0.2
*DDT	*0.001	
*Dieldrin	*0.005	

Levels marked with * were set in 1994

8.3. CONSULTATION

45. Consultation with statutory bodies and key stakeholders was undertaken through a formal Environmental Impact Assessment (EIA) scoping process for the Project. Key responses of relevance to marine water and sediment quality have been summarised in **Table 8-7**.

Table 8-7 Summary of Consultation Responses as a Result of Scoping, Relating to Marine Water and Sediment Quality

Consultee	Date/Document	Comment	Response
Planning Inspectorate	2018 Scoping	The Scoping Report identifies marine water quality designations including bathing waters and a European Shellfish Water within the offshore scoping area and adjacent Holy Island coastal area. Table 7-2 (Potential impacts on marine sediment and water quality) of the Scoping Report identifies potential impacts but does not relate impacts to specific receptors such as designated sites for water quality. The ES should clearly identify and assess impacts to specific receptors where significant effects are likely. The ES should include figures that clearly depict the locations of such receptors.	See **Table 8-13**, which provides details of designated or sensitive sites within the vicinity of the MDZ and of relevance to the marine water and sediment quality assessment, and **Section 8.6** for the assessment.
Planning Inspectorate	2018 Scoping	Section 7.2.1.2 of the Scoping Report indicates the potential for contaminated sediments in the offshore area. The mobilisation of contaminants during construction has not been identified as a potential impact in Table 7-2 of the	**Section 8.6.4.3** assesses change in water quality due to release of

Consultee	Date/Document	Comment	Response
		Scoping Report, although it is noted that it has been identified as a potential impact on benthic ecology in Table 8-4. The Applicant should identify other receptors that may be significantly affected by the mobilisation of contaminants and if so, assess any impacts accordingly within the ES.	contaminated sediments.
Planning Inspectorate	2018 Scoping	Evidence should be provided within the ES to justify the assertion that any suspended sediments would be rapidly dispersed due to tidal flows, particularly in the nearshore and intertidal areas.	**Section 8.6.4.1** assesses change in water quality due to sediment plumes generated via foundation installation. Detailed information on tidal flows is provided in **Chapter 7, Metocean Conditions and Coastal Processes**.
Planning Inspectorate	2018 Scoping	Site-specific sediment contaminant sampling: It is recommended that the sampling programme is discussed and agreed with NRW.	No project-specific sediment contaminant sampling undertaken – See **Section 8.4.2.2**.
Planning Inspectorate	2018 Scoping	The Scoping Report has not detailed how the potential impacts will be assessed. The methodology must be detailed in the ES. It is considered that modelling will be required to predict the anticipated increase in suspended sediment from the Proposed Works. The ES should include details of the parameter inputs to the model and provide an explanation/justification of any worst case scenario that has been assumed.	Impact assessment methodology is included in **Section 8.4.3** and **Chapter 5, EIA Methodology**. Modelling has been used to assess the baseline hydrodynamic regime and the impacts from the Proposed Works on the baseline hydrodynamic regime. A description of this modelling process is provided in **Appendix 7.1** (**Volume III**). The results from the baseline understanding and

Consultee	Date/Document	Comment	Response
			hydrodynamic modelling have then been used to inform the assessment (**Section 8.6**).
NRW	2018 Scoping	In section 7.2.1.1 there is reference to the bathing water quality for eight beaches in the MDZ coastal area and reference to one designated European Shellfish Water. There is, however, no inclusion of the Water Framework Directive (WFD) existing water body status for the coastal water bodies within the demonstration zone. This must be included in the ES.	See **Table 8-13**, which provides details of all designated or sensitive sites within the vicinity of the MDZ (including coastal water bodies) of relevance to the marine water and sediment quality assessment.
NRW	2018 Scoping	The demonstration zone is located at its nearest point, 0.5 km (0.27 nautical miles) from the west coast of Holy Island Anglesey and falls within the Caernarfon Bay North WFD coastal water body which currently has an overall Good status, with a Good chemical status and a good ecological status. A Preliminary WFD Assessment report must be prepared by the applicant and submitted with the Marine Licence application and, where required, a detailed WFD Compliance Assessment Report should be undertaken.	A WFD compliance assessment report has been produced, please see **Appendix 8-1** (**Volume III**).
NRW	2018 Scoping	Contaminated sediments could be present in the demonstration zone and investigations should be carried out to determine the level of contaminated sediments particularly in areas where sediment may be disturbed into suspension during the construction phase i.e. installation of devices and the cable laying activities which could potentially release contaminants into the water column. We note your comment (section 7.2.3) “It is likely that site-specific sediment contaminant sampling would also be undertaken during the EIA” and advise that this activity is carried out.	No project-specific sediment contaminant sampling undertaken - See **Section 8.4.2.2**.
NRW	2018 Scoping	There has been no inclusion of tidal current data in the demonstration zone which shows the magnitude and direction of flow over the zone to substantiate the assumption that the suspended sediments would rapidly disperse. We agree that in fast flowing currents, dispersion of suspended sediments could occur rapidly and the	An assessment of the effects on the tidal regime have been included in **Chapter 7, Metocean Conditions and Coastal Processes**.

Consultee	Date/Document	Comment	Response
		potential for smothering would be reduced as a result (table 7.2). However, there is no baseline evidence presented in the metocean section that supports this assessment of impact. Further evidence should be presented in the ES to show the magnitude and direction of the tidal currents in the nearshore and intertidal areas which are often much smaller than those experienced offshore, and which may not be enough to promote rapid dispersion of suspended sediments and potential contaminants released through trenching activities over this zone.	
NRW	2018 Scoping	Section 7.2.3 states "baseline water quality conditions within the offshore scoping area. This would be done through a review of available literature". It is unclear which baseline water quality conditions are being referred to. If the baseline water quality conditions are not adequately evidenced after review of available literature, further surveys should be carried out to inform the baseline characterisation.	There is suitable data on bathing water quality for nearby designated bathing beaches and these data have been used in this assessment (see **Section 8.5**) and the WFD compliance assessment (**Appendix 8-1, Volume III**).
NRW	2015 Scoping	The potential impacts on marine sediment are provided in Table 6.2 which we agree with, however, there is also potential for the release of contaminants into the water column if marine sediment is disturbed. This should be assessed in the EIA.	**Section 8.6.4.3** assesses change in water quality due to release of contaminated sediments.

8.4. METHODOLOGY

8.4.1. Study Area

46. The study area for marine water and sediment quality has a total area of 39.75 km², comprising the MDZ of 35 km², the export cable corridor (ECC) area of 4.75 km² and includes an intertidal area of 0.01 km² shared between the ECC and the onshore development area (ODA). The ECC connects the MDZ to the landfall location at Abraham's Bosom on the west coast of Holy Island. The ECC encompasses much of the sea area to landward of the MDZ, to the landfall at Abraham's Bosom.

8.4.2. Data Sources

8.4.2.1. Desk Study

47. The data and information presented in this section uses information collated for **Chapter 7, Metocean Conditions and Coastal Processes**. Data sources include information from existing

nearby projects, such as the Deep Green Holyhead Deep Project Phase I (0.5 MW) Environmental Statement (Minesto, 2016), as well as published literature. Baseline data and information have been collected from the following sources:

- Barne *et al*., 1995. Coasts and seas of the United Kingdom, Region 12 Wales;
- British Geological Survey (BGS) seabed sediment data;
- BGS Offshore Regional Report for the Irish Sea;
- Horizon Nuclear Power, 2018. Wylfa Newydd Project Water Framework Directive Compliance Assessment. 429pp;
- Horizon Nuclear Power, undated. Wylfa Newydd Project Disposal Site Characterisation Report. 227pp;
- Howarth, 2005. Technical report on the hydrography of the Irish Sea conducted as part of the Strategic Environmental Assessment (SEA) process; and
- Minesto, 2016. Deep Green Holyhead Deep Project Phase I (0.5 MW) Environmental Statement. 487pp.

8.4.2.2. Site-Specific Surveys and Reports

48. In addition to the general baseline data and information indicated in **Section 8.4.2** a number of site-specific surveys have also been used in this assessment (**Table 8-8**). Further details can be found in **Chapter 7, Metocean Conditions and Coastal Processes** of this ES.

Table 8-8 Data Sources

Data	Year	Coverage	Confidence	Notes
Geophysical Survey	2018	MDZ, buffer zone and Abraham's Bosom	High	High-resolution sea bed bathymetry, seabed texture and morphological features, and shallow geology using multibeam echosounder, side-scan sonar, and boomer (Partrac, 2018).
Subtidal Grab Sample Survey	2018	MDZ and buffer zone	High	Drop-down camera and five grab samples at selected suitable sites (Ocean Ecology, 2018).
Intertidal Survey	2018	Abraham's Bosom	High	Unmanned Aerial Vehicle (UAV) survey and intertidal walkover (Ocean Ecology, 2018).
Metocean Survey	2014	MDZ	High	Bottom-mounted Acoustic Doppler Current Profilers (ADCP) deployed for a continuous 40-day period in November and December 2014 at two locations.

49. With respect to any site-specific sediment contaminant sampling, following review of the local seabed conditions in the MDZ and ECC, it was clear that given the area's very high tidal energy and limited sediment cover, as well as the absence of any history of, or any apparent mechanism for, contaminant inputs, the potential for sediment contamination was low. In addition, the highly limited presence of sediment would limited opportunity for any sediment samples to be collected. Therefore, inclusion of contaminant sampling within project-specific EIA characterisation surveys was judged inappropriate and unlikely to be successful.

50. In practice, as indicated by initial review of the site, only limited sediment samples were able to be collected within the MDZ site during the summer 2018 survey, due to the absence of sediment cover for most of the site. These samples were of insufficient quality and quantity to have enabled any sediment contamination analysis.

51. Consideration has also been given to the outcome of recent sediment sampling for the adjacent Minesto project. This site is located much closer to the active Holyhead Deep marine disposal site (ISO40) than the MDZ and ECC and has seabed sediment present which might be expected to act as a sink for contaminants.

52. Analysis of samples for this project, collected by Minesto as part of their EIA studies in close proximity to the active disposal site, showed that levels of contamination in all the sediment samples were below Cefas AL1.levels (Minesto, 2016). Were sediment contamination to be an issue in this region, it would be more likely to occur in the Minesto site than the MDZ or ECC because of the greater proximity to the active disposal site and the larger amount of sediment cover compared to the MDZ and ECC.

8.4.3. Impact Assessment Methodology

53. This impact assessment follows the general methodology as set out in **Chapter 5, EIA Methodology**, of this ES.

54. The first stage in the assessment of potential impacts on marine water and sediment quality is to determine the baseline conditions of the marine water (i.e. the naturally occurring levels of contamination and concentrations of suspended sediments) and the sediments (in terms of physical properties and contamination). 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.

55. Potential effects on marine water and sediment are then compared against existing baseline conditions and potential impacts are assessed against natural variation, the study area characteristics, spatial and temporal scales.

56. The EIA framework used in this assessment is based on the 'source-pathway-receptor' conceptual model process where the 'source' describes the origin of potential effects, and the 'pathway' describes the means by which the effect reaches the receiving sensitive 'receptor'. If the source, pathway or receptor is absent, no linkage exists and thus there will be no potential for an impact to occur.

8.4.3.1. Sensitivity

57. The sensitivity of a receptor is a measure of its ability to adapt to change, tolerate, and/or recover from potential impacts. The overall receptor sensitivity is therefore determined by a consideration of the receptor value, adaptability, tolerance and recoverability.

58. The sensitivity criterion also combines an assessment of the value of the receptor, which considers whether, for example, the receptor is rare, has protected or threatened status, has

importance at a local, regional, national or international scale, and in the case of biological receptors whether the receptor has a key role in the ecosystem function.

59. In order to define the sensitivity on marine water and sediment quality receptors, the criteria indicated in **Table 8-9** have been used.

Table 8-9 Definitions of the Sensitivity Levels for the Marine Water and Sediment Quality Receptors

Sensitivity	Definition
High	The marine water and sediment quality receptors support or contribute towards the designation or nationally important feature and have a very limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	The marine water and sediment quality receptors support high biodiversity and have a limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	The marine water and sediment quality of the receptor have a high capacity to accommodate change to status, due, for example, to large relative size of the receiving water and capacity for dilution and flushing. Background concentrations of certain parameters may already exist.
Negligible	Specific marine water and sediment quality conditions are likely to be able to tolerate proposed change with very little or no impact upon the detectable baseline conditions

8.4.3.2. Magnitude

60. An assessment of the magnitude of effect is based on the consequences the effect has on marine water and sediment quality. The definitions of magnitude, specific to this assessment of marine water and sediment quality are indicated in **Table 8-10**.

Table 8-10 Definitions of the Magnitude Levels for the Marine Water and Sediment Quality Receptors

Magnitude	Description
High	Very significant changes to key characteristics of the marine water and sediment quality status of the receiving water feature. Water quality status degraded to the extent that a permanent or long-term change occurs.
Medium	Significant changes to key characteristics of the marine water and sediment quality status, taking account of the receptor volume, mixing capacity, flow rate, etc. Marine water and sediment quality status likely to take considerable time to recover to baseline conditions.
Low	Noticeable but not considered to be significant changes to the marine water and sediment quality status taking account of the receiving water features. Activity not likely to alter local status to the extent that water quality characteristics change considerably or EQSs are compromised.
Negligible	Although there may be some impact upon marine water and sediment quality status, activities predicted to occur over a short period. Any change to marine water and sediment quality status will be quickly reversed once activity ceases.

8.4.3.3. Impact Significance

61. Impacts are assessed by relating the magnitude of an effect to the sensitivity/value of the receptor, which in this case is marine water and sediment quality. The relationship is presented as a matrix, as shown in **Table 8-11**.

Table 8-11 Impact Assessment Matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

62. In the context of marine water and sediment quality, the impact significance categories in **Table 8-12** can be defined.

Table 8-12 Impact Significance Definitions

Impact Significance	Definition
Major	Very large or large change in marine water and sediment quality, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in marine water and sediment quality, which is likely to be important considerations at a local level.
Minor	Small change in marine water and sediment quality, which may be raised as local issue but is unlikely to be important in the decision-making process.
Negligible	No discernible change in marine water and sediment quality

63. For the purposes of the EIA, 'major' and 'moderate' impacts are significant in terms of the EIA regulations and have to be avoided or reduced through mitigation, where possible. In addition, whilst 'minor' impacts are not significant in their own right, they may contribute to significant impacts cumulatively or through interactions.

64. Where the potential for an accidental spillage is concerned, the assessment is based on the risk of a spill or other accidental pollution event occurring. This is considered in relation to control measures that are available to minimise the risk.

8.5. EXISTING ENVIRONMENT

8.5.1. Regional Context

65. The MDZ is situated west of Holy Island and Anglesey, in an offshore area known as the Holy Island Shelf. The Holy Island Shelf is identified as an inlier of Precambrian metamorphic bedrock fringed to the north and west southwest with Lower Palaeozoic (undivided) sedimentary strata (Jackson et al., 1995).

66. The seaward coastline of Holy Island is formed of hard rock cliffs, and small sandy bays. The northern coastline is also rocky but has significant development through the port town of Holyhead. East of Holyhead the rocky cliffs persist as far as Penrhos beach. The eastern coastline of Holy Island is characterised by the salt marshes and mud-flats of the Alaw Estuary.

67. This bedrock, like the bedrock on areas of Anglesey, is part of the Monian Supergroup, comprising Holy Island, New Harbour and Gwna Groups. It is thought to have formed more than 570 million years (Ma) ago, although there is some debate that the formation may extend into

the Cambrian (Gibbons, 1983; McIlroy and Horak, 2006). The Monian Supergroup comprises gneisses, schists and igneous rocks, overlain by extrusive igneous rocks (Jackson et al., 1995). The igneous rocks are mostly volcanic-arc types, although some, as with the Gwna Group, show affinities with ocean floor basalts (Jackson et al., 1995).

68. The Holy Island Shelf to the west and north of South Stack is cut by Anglesey dykes of Tertiary age, orientated north northwest to south southeast (Jackson et al., 1995). These dykes are thought to be igneous in origin (Dolerite) (BGS, 2017) formed during a period of regional extension in the Palaeocene, resulting from a major north-south uplift (Jackson et al., 1995) as part of the final breakup of Pangea and the early stages of the opening of the Atlantic Ocean.

69. The BGS (1990) Seabed Sediments chart of Anglesey indicates that much of the MDZ consists of this exposed bedrock substrate with only local and/or intermittent cover of mobile and lag sediment in the nearshore. The BGS (1990) indicates that, offshore, there is less potential for finer sediment as it is likely to have been winnowed out by strong tidal processes, leaving a coarser surficial sediment.

70. A number of statutory and non-statutory designated sites occur in the vicinity of the MDZ and are potentially relevant to this assessment. These are detailed in **Table 8-13** and shown in **Figure 8-1** (**Volume II**).

Table 8-13 Designated or Sensitive Sites Within the Vicinity of the MDZ and of Relevance to the Marine Water and Sediment Quality Assessment

Site Name	Designation	Relevance to Assessment	Distance from the MDZ (km)
Caernarfon Bay North	Coastal Water Body	Welsh Coastal Water Body	Partial overlap
Holyhead Bay	Coastal Water Body	Welsh Coastal Water Body	3.0
Porth Dafarch	Bathing Water	Bacterial water quality monitoring for public health	1.4
Trearddur Bay	Bathing Water	Bacterial water quality monitoring for public health	4.2
Anglesey Inland Sea Shellfish Sites	Bivalve mollusc production area	Shellfish Water	21.0
Borth Wen	Bathing Water	Bacterial water quality monitoring for public health	6.7
Silver Bay Rhoscolyn	Bathing Water	Bacterial water quality monitoring for public health	8.3
Church Bay	Bathing Water	Bacterial water quality monitoring for public health	10.0

Site Name	Designation	Relevance to Assessment	Distance from the MDZ (km)
Rhosneigr	Bathing Water	Bacterial water quality monitoring for public health	11.2
Maltraeth	Cockle Fishery	Shellfish Water	21.7

71. The MDZ lies in close proximity to two Welsh WFD Coastal Water Bodies – the eastern part of the MDZ overlaps the Caernarfon Bay North (GB621010380000) water body, while the Holyhead Bay (GB681010360000) water body is located approximately 3 km away from the MDZ at its nearest point (**Figure 8-1, Volume II**).

72. The Caernarfon Bay North water body is classified as having good status overall. Data reported by Horizon Nuclear Power (2018) show that biological quality elements are at good status (based on benthic invertebrates); the classification of physico-chemical quality elements is high (based on dissolved oxygen, copper and zinc); the hydromorphological supporting elements are classified as 'supports good' (based on morphology); and the chemical assessment is good (based on an assessment of priority substances).

73. There are six bathing water beaches along the west coast of Anglesey (**Figure 8-1, Volume II**), all of which meet the higher water quality standard and have consistently met the higher standard since 2010.

74. The water catchment areas have a mix of rural, residential and commercial use but are predominantly rural in nature. Water catchment areas typically have a low level of sewage and industrial run-off. Based on the classifications reviewed as part of this assessment, there are no known issues with agricultural run-off.

8.5.2. Physical Environment

8.5.2.1. Hydrodynamics

75. Tides within the MDZ are semi-diurnal, with a spring tidal range of up to 4.5 m. Tides enter the Irish Sea from the Atlantic Ocean through St George's Channel and the North Channel to the south and north respectively.

76. Tidal currents within part of the MDZ are characterised by the ADCP surveys from Sites 1 and 2 (**Table 8-14**). These data show that current velocities at the measurement locations are slightly lower towards the sea bed due to bed-friction, but all values recorded exhibit very high baseline current speeds.

Table 8-14 Peak Tidal Currents at Sites 1 and 2 within the MDZ (source: OpenHydro, 2015)

Height above sea bed	Peak Velocities on a Mean Spring Tide Site 1 (m/s)	Peak Velocities on a Mean Spring Tide Site 2 (m/s)
10 m	2.71	2.64
15 m	2.84	2.79

20 m	2.92	2.90

77. Current roses from Sites 1 and 2 (and shown in **Figure 7-11, Volume II**) show that at both sites the baseline current velocities are strongly aligned from just east of south to north-northwest. However, further north in the MDZ, the tidal currents flow around Holy Island (to the north on a flooding tide and to the south on an ebbing tide) along a more south-north and then (with progression north) south-southwest-north-northeast axis.

78. Tidal current speeds and directions were also predicted by the baseline numerical modelling undertaken by HR Wallingford (2017) and showed peak speeds are generally faster through the eastern parts of the sub-zones, reaching around 2.6 – 2.8 m/s in most areas, apart from the northernmost and southernmost sub-zones. The highest velocities within the MDZ are recorded just off Holy Island (4.0 m/s; as discussed within **Chapter 7, Metocean Conditions and Coastal Processes**). For the western parts of the sub-zones, peak speeds are lower, reaching around 2.2 – 2.6 m/s.

79. These data are supported by other studies, e.g. Minesto (2016) indicates that the peak depth averaged mean spring current speeds at the coastal margins of the North Channel are up to 3 m/s, while peak depth-averaged mean neap currents approach 1.5 m/s. Horizon Nuclear Power (Undated) also reports tidal velocities in excess of 2.5 m/s during spring tides. Horizon Nuclear Power (Undated) also reports that the tidal current velocity is relatively unvarying with depth, except near the seabed, and results in well mixed unstratified waters.

80. SEACAMS modelling, reported in Minesto (2016), shows that the bed shear stresses (the frictional force exerted on the seabed by the movement of water) within the MDZ for a 15 day simulation is between 6 N/m^2 at the western offshore boundary, increasing to approximately 22 N/m^2 at points closest to Holy Island. These bed shear stresses are sufficient to transport fine and medium sands, and help to explain the swept bedrock in much of the MDZ (see below and Partrac, 2018). The MDZ is, therefore, dispersive of fine sediments and sands, generally transporting them to the north-east.

81. As a result of the semi-enclosed nature of the Irish Sea, waves are mostly locally generated (Morlais, 2016). Horizon Nuclear Power (Undated) reports that predominant wave directions are from the southwest and west, with the highest frequency from the southwest. These waves also have the longest fetch distances.

82. The wave regime was characterised using data obtained from the Met Office at three locations northwest of the MDZ and show the dominant offshore wave direction is south-southwest to southwest (see **Chapter 7, Metocean Conditions and Coastal Processes** for more details). The annual mean significant wave height (SWH) for the area is 1.26 – 1.50 m, ranging from 0.76 – 1.00 m in the summer to 1.51 – 1.75 m in the winter (Atlas of UK Marine Renewable Energy Resources, 2008).

83. Potential bed sediment transport is dominated by the tidal flow because water depths are, typically, sufficiently large that wave energy does not reach the seabed. Minesto (2016) shows that bed shear stresses are dominated by tidal flows, but that under extreme wave conditions (e.g. 8 m waves and larger) some wave interaction with the seabed could occur.

8.5.2.2. Seabed Sediments

84. Seabed data across the MDZ, collected and interpreted by Partrac (2018) show that throughout most of the northern, central and eastern parts of the MDZ the surface is dominated by outcropping rock. Sandy gravels are considered to generally make up the sediment patches that overlie the rock; and the deeper, western part of the MDZ consists of a relatively uniform gravel or gravelly sand, with small areas of outcropping rock to the north and localised megaripples to the south. Along the northwestern boundary of the MDZ, an increase in grain size is interpreted, meaning the gravels that dominate the seabed may contain coarser material.

85. Three grab samples collected by Ocean Ecology Ltd (2018) from the offshore area returned gravelly sands and sandy gravels with very low fines content (one sample contained 1.9 % <63 µm, while the other two samples contained no sediments finer than 63 µm). The very low fines content is consistent with sediments present in high energy environments, where fine grained material is rapidly winnowed and transported away. Only three samples were able to be collected due to the generally hard rock, tidally-swept seabed.

86. Within the shallower bays, along the Holy Island coast, are deposits of finer sediments. Sediments in the bays generally consist of sandy gravel or coarse sand, and in the case of the shallow waters within ‘Abraham’s Bosom’ the sediments become finer, being interpreted as consisting of fine sand. A grab sample collected within ‘Abraham’s Bosom’ by Ocean Ecology Ltd (2018) returned a sample of moderately sorted medium sand, with a d50 of approximately 0.4mm and a low fines content (3.6 % <63 µm).

87. The seabed in the north of Anglesey is characterised by exposed bedrock, or bedrock thinly overlain by boulders and gravels in a patchy composition (Rees, 2005). The intertidal areas around Anglesey are extensive areas of relatively undisturbed habitats comprised of high energy rocky shores, sea cliffs, coastal heathlands and coastal grazing. The west of Anglesey, where the export cable will landfall, has substantial areas of exposed shores which are largely coastal cliff headlands with beaches comprise of moderate coarse sediments.

88. Boulders are identified by Partrac (2018) as occurring over almost the entire offshore area surveyed. These range in size between 0.2 m – 1.5 m. Further, within the subtidal and intertidal surveys conducted to support **Chapter 9, Benthic and Intertidal Ecology**, extensive areas of both stony reef and bedrock reef were recorded (Ocean Ecology Ltd, 2018). Bedrock and stony reefs are both types of rocky reef which occur where the bedrock or stable boulders and cobbles arise from the surrounding seabed. A stony reef is defined as an area which is comprised of coarse sediments with a diameter of greater than 64 mm (cobbles and boulders) that provide a hard substratum. A reef is defined as having relief from the seafloor and elevation is used as a criterion in its classification. Epifaunal communities of a potential reef are also key in the determination of reefiness, with percentage cover of fauna used as a determination criterion. Irving (2009) classification of reef requires an area of potential stony reef habitat to be greater than 25 m^2 to be classified as a reef.

89. The north east spreading along the eastern central area of the site to the south west of the MDZ were dominated by stony reefs, while the central and north east area of the site were recorded as bedrock reef areas. Within the south east of the site, there were several areas of patchy

bedrock reef observed, and likewise in the southwest there were areas of patch stony reefs. Within the intertidal zone, the immediate seabed is covered by an expanse of bedrock reef, tailing into stony/bedrock reef in the north east and south east of the site.

90. Partrac (2018) also identified a large sandwave feature was identified near to South Stack which extends to the northwest for approximately 1 km. Bed levels either side of this feature are approximately 8 to 10 m different in height either side of the ridge, with bed levels deeper on the southwest side. This ridge is generally symmetrical in profile. Several smaller ridge features run parallel to the main ridge, extending to the north-northeast.

8.5.2.3. Suspended Sediment Transport

91. Measurements of suspended sediment concentration were carried out generally across the Irish Sea during June and November 1997, and April and September 1998 at a total of 85 stations. Overall, suspended sediment concentrations were between 2.55 and 23 mg/l over the period (**Table 8-15**), although concentrations varied seasonally (Bowers *et al*., 2002). More specific to the sea bed off Anglesey, suspended sediment concentrations remain very low, reaching about 5mg/l in summer and 10 – 15 mg/l in winter.

Table 8-15 Concentration of Total Suspended Solids (mg/l) in the Irish Sea 1997 - 1998

	Min	Max	Mean
June 1997, 16 stations	3.73	14.18	6.57
November 1997, 17 stations	2.55	20.38	9.82
April 1998, 26 stations	3.30	23.00	10.27
September 1998, 26 stations	2.76	17.18	5.70

8.5.2.4. Marine Disposal Areas

92. Marine water and sediment quality can be affected by the presence of marine disposal sites. The MDZ is located close to the boundary of the currently active Holyhead Deep disposal site (ISO40). The MDZ is also close to two closed disposal sites, namely Holyhead South (IS041), and Holyhead East (IS042) (**Figure 8-2, Volume II**).

93. The currently active Holyhead North site lies 5 km northwest of Holy Island and extends over an area of approximately 28.8 km^2. Horizon Nuclear Power (undated) indicates that since Holyhead Deep was opened in 1983, licences have been granted for the disposal of both capital and maintenance dredge arisings.

94. Horizon Nuclear Power (undated) also indicates that, over the period of operation of Holyhead Deep, approximately 1.66 Mt (1.1 Mm^3) of sediment has been disposed of at the site. This helps set the context for the potential worst-case sediment resuspension calculations for the MDZ presented in **Section 8.6.4.1** and **8.6.4.2** of this chapter.

95. Minesto (2016) indicates that all recent (since at least 2009) dredge spoil disposal at the Holyhead Deep disposal site has been maintenance dredge material from Holyhead Port; and Potter (2014; reported in Minesto (2016)) determined that the material dredged from the harbour is in the silt range (i.e. 0.0039 to 0.0625 mm on the Wentworth scale (Wentworth, 1922)).

96. The sediment disposed of at Holyhead Deep is, therefore, much finer-grained than the bed sediments present in the MDZ and its associated cable corridor. This sediment, by virtue of its finer-grained nature, has 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. In addition, its fine-grained nature means it will remain in suspension longer than coarser material and, hence, is more likely to produce a sediment plume.

97. Marine disposal areas are also assessed within **Chapter 16, Infrastructure and Other Users** in relation to accessing the sites.

8.5.2.5. Marine Water and Sediment Contaminants

98. There is little site-specific information on water quality. The offshore area has a dynamic hydrological regime with a varied wave regime and a strong tidal regime that provides the site with high levels of mixing and dispersal. Given the generally low level of industrial activity in adjacent coastal areas and dynamic hydrological regime, it is anticipated that water quality offshore will be good.

99. Sources of sediment input to the coastal area are generally low, although periods of heavy rain increase surface run-off from rural and populated land, increasing riverine and coastal suspended sediment levels. However, sources of contaminated sediment are limited and no sources that would cause significant sediment contamination have been identified.

100. Sediment grain size is a significant factor that controls the capacity for both suspended and bed sediment to concentrate and retain metals and organic pollutants (Horoitz, 1991). Finer sediment fractions (clay and silt sized material (<2 μm)) have a greater adsorbing capacity, owing to larger surface area and greater cation exchange capacity. The proportion of fine sediments within the MDZ is low, with mainly coarse sediments and rock being present due to the presence of strong hydrological regimes. As a result, the sediments surrounding the MDZ are unlikely to contain high concentrations of contaminants.

101. Horizon Nuclear Power (undated) present the results of a water quality survey carried out within the Holyhead North sediment disposal site, approximately 4 km offshore from the WFD designated Caernarfon Bay North coastal water body. This is currently achieving ‘good’ ecological and chemical status under the WFD, while the classified bathing waters on the west coast of Anglesey are all currently rated as achieving excellent status.

102. Horizon Nuclear Power (undated) indicate that physico-chemical parameters were measured *in situ* throughout the vertical water column, including temperature, conductivity, salinity, dissolved oxygen (DO), pH and oxidation-reduction potential (ORP). The chemical and biochemical determinants monitored were total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD), total suspended solids (TSS), cations and anions, nutrients, metals, organic compounds and cyanide. There was no exceedance of EQS, all concentrations were in line with ‘good’ chemical status as defined by the WFD, most concentrations were below the analytical laboratory’s Minimum Reportable Value and all values were consistent with other coastal waters that are absent of pollutants.

103. In addition, during the October to December 2016 survey, seabed sediment samples were collected for analysis of chemical contaminants. Five samples were collected within the disposal site and one just outside, to the east. The majority of the samples were coarse, with two being finer slightly muddy gravelly sediment. The results showed that levels of contamination in all the sediment samples were below Cefas AL1.

8.5.3. Study Area Sensitivity

104. The study area has a large physical scale and a high degree of temporal and spatial variance. Whilst conservation designations are present within the study area, the sensitivity of the surrounding offshore marine environment with respect to water quality is considered to be Low. However, the landfall and near shore element of the cable route is located close to designated bathing water sites and therefore the sensitivity of the water for the landfall area is considered to be High.

8.6. IMPACT ASSESSMENT

8.6.1. Overview of Potential Impacts

105. The potential impacts on marine water and sediment quality receptors are:

- Changes in marine water quality as a result of sediment re-suspension caused by seabed disturbance;
- Change in marine water quality as a result of mobilisation of contaminants adsorbed onto potentially re-suspended seabed sediments; and
- Impacts on marine water quality and sediment quality as a result of potential accidental discharge and spillage of oils, fuels and materials utilised during construction, operation and decommissioning phases of the Project.

8.6.2. Mitigation Measures

8.6.2.1. Embedded Mitigation

106. Menter Môn has committed to several techniques and engineering designs/modifications inherent as part of the Project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process.

107. A range of different information sources has been considered as part of embedding mitigation into the design of the Project including engineering preference, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

108. The embedded mitigation relevant to marine water and sediment quality includes;

- So far as other constraints (for example, Chapter 24, Chapter Seascape, Landscape and Visual Impact Assessment) allow, devices within the MDZ are most likely to be placed towards the eastern part of the MDZ, where the baseline tidal currents are higher. This means that any suspended sediment effects will be more rapidly and more widely dispersed than if devices were to be placed towards the west of the MDZ.

8.6.2.2. Additional Mitigation Measures

109. An outline Pollution Prevention and Management Plan (**Document MOR/RHDHV/DOC/0077**) and outline Construction Environmental Management Plan (CEMP) (**Document MOR/RHDHV/DOC/0073**) have been prepared to provide an outline of the mitigation measures to be undertaken during construction, to minimise any impacts predicted. will be submitted with the TWAO application and Marine Licence application.

110. The development of the detailed design and final CEMP will refine the worst-case impacts assessed in this EIA. It is recognised that mitigation is an important element in the management and verification of the actual Project impacts. The requirement for appropriate design and scope of mitigation would be agreed with NRW prior to construction works commencing.

8.6.3. Worst Case Scenarios in Relation to Marine Water and Sediment Quality

111. In relation to the marine water and sediment quality within the MDZ and ECC, the worst case would relate to those scenarios which have the greatest potential to disturb seabed sediment. This would cause an increased suspended sediment concentration and could, in turn, lead to increased levels of contaminants within the water column, if contaminants exist in the seabed sediments.

112. With respect to foundation installation, the worst-case option would be pin-piles, as drill arisings (maximum of 117,780 m^3 predicted) and larger sediment plumes are produced during installation of this foundation type compared to Gravity Base Structure (GBS) foundations.

113. In addition, activities with the greatest risk of causing accidental spills/leaks of chemicals and other construction materials are also considered to represent the worst-case scenario. These scenarios are associated with the installation method and type of foundations as well as the installation methods chosen for the inter-array cables and subsea export cable.

114. For the purpose of defining impact assessment parameters for the repowering phase, an assumption has been made that 50 % of the tenants will undertake repowering, i.e. for 50 % of the tenants, their infrastructure will be removed and replaced (potentially with different infrastructure by a different tenant). For the other 50 % of tenants, their infrastructure will remain over the lifetime of the project.

115. In terms of impact assessment parameters, the repowering process has been defined as per below:

- Initial temporary seabed disturbance via deployment of barge anchors to remove foundations, TEC's, hubs, inter-array cables and monitoring equipment for 50 % of the Tenants (berths); and

- Further temporary seabed disturbance via re-installation (repowering) of foundations, TEC's, hubs, inter-array cables and monitoring equipment for the same 50 % of Tenants (berths).

116. The operational phase values include the temporary seabed disturbance that would arise via repowering and also up to ten cable repair events.

117. During all project phases, disturbance to sediments (temporary seabed disturbance) will occur via device, hubs and cable installation and also anchor deployments for installation barges. Based on information provided in **Chapter 4, Project Description**, the values in

118. **Table 8-16** have been calculated to define the worst-case parameters for temporary seabed disturbance. These are defined in terms of project phase, as different amounts of temporary seabed disturbance are predicted to arise in each phase.

Table 8-16 Summary of Worst-Case Scenario Temporary Habitat Loss during Construction, Operation (Repowering) and Decommissioning Phases

Activity	Footprint	Unit	Description of Activity
Construction Phase:			
Post-lay burial of cable	27,259	m^2	Area of sandwave field where post-lay burial via Mass-Flow Excavator (MFE) may be required.
Deployment of anchor blocks by barges during cable installation	100,240	m^2	Up to 8 x 25 m^2 (5x5 m) anchor blocks for a single barge = a total footprint per anchor deployment of 200 m^2 (8 x 25 m^2) Assumed that these types of anchor barges generally deploy a spread every 500 m. So, for every 500 m of cable installation a footprint of 200 m^2 of temporary seabed disturbance occurs (via the anchor blocks) Combining all potential export, array and cable tails the total length of cables (full 240 MW) is 250.6 km Assumes the footprint of 200 m^2 every 500 m (0.5 km), or 400 m^2 every 1 km, and assumes all cables are installed using anchor barges Temporary disturbance impact of (400 m^2 x 250.6) = 100,240 m^2 (0.10 km^2)
Deployment of anchor blocks by barges during TEC device installation	248,000	m^2	Max. no of devices set at 620 x small (0.3 kW devices) Assumed that deployment of each device requires 2 x anchor deployments from barge (2 x 200 m^2 = 400 m^2) Therefore, total temporary seabed disturbance = 620 x 400 m^2 = 248,000 m^2
Deployment of anchor blocks by barges during hub installation	48,000	m^2	Max. no of seabed mounted hubs set at = 120 Assumed that deployment of each hub requires 2 x anchor deployments from barge (2 x 200 m^2 = 400 m^2)

Activity	Footprint	Unit	Description of Activity
			Therefore, total temporary seabed disturbance = 120 x 400 m^2 = 48,000 m^2
Construction Phase TOTAL		**423,499 m^2 (0.42 km^2)**	
Operational Phase:			
50 % of tenants infrastructure (Foundations; TEC's; hubs' array cables; monitoring equipment) removed and replaced with new (different) tenant infrastructure	377,400 m^2	m^2	Initial removal of tenant infrastructure from 50 % of berths ▪ 50 % of anchor block value (above) for inter-array cables only (203.5/2 * 0.4) = 40,700 m^2 ▪ 50 % of anchor block value of tidal device installation = 124,000 m^2 ▪ 50 % of anchor block value for hub installation = 24,000 m^2 Sub-Total = 188,700 m^2 Subsequent re-installation (re-powering) of tenant infrastructure from 50 % of berths ▪ 50 % of anchor block value (above) for inter-array cables only (203.5/2 * 0.4) = 40,700 m^2 ▪ 50 % of anchor block value of tidal device installation = 124,000 m^2 ▪ 50 % of anchor block value for hub installation = 24,000 m^2 Sub-Total = 188,700 m^2
Cable repairs	3,000	m^2	Up to 10 major cable repairs (5 days each) may be required throughout the Project life. It is assumed that up to 750 m of cable will be subject to repair works per event (7,500 m in total). Using same value of 400 m^2 temporary seabed disturbance per 1 km of cable works (400 x 7.5) = 3,000 m^2
Operational Phase TOTAL		**380,400 m^2 (0.38 km^2)**	
Decommissioning Phase:			
Decommissioning Phase TOTAL		**423,499 m^2 (0.42 km^2) –** same worst-case as per construction phase due to same activities needed to remove infrastructure	

119. In addition to these worst-case parameter values for sediment disturbance, there is also the potential for the deterioration in water and sediment quality due to accidental spillages / leakages of construction and maintenance materials as well as fuels and oils from vessels and the tidal devices. It is estimated that there will be approximately 7,000 vessel days throughout the duration of the construction phase; therefore, this number of vessel movements will be taken forward as the worst case scenario.

120. With respect to the liquid inventory of actual devices deployed within the MDZ, the following worst-case values have been assumed:

- Oil (gearboxes, transformers etc.) 240,000 litres;

- Grease (bearing, seals etc.) 12,000 litres; and
- Hydraulic fluid 192,000 litres.

8.6.4. Potential Impacts during Construction

8.6.4.1. Construction Impact 1: Change in Water Quality Due to Sediment Plume Generated via Foundation Installation

121. During the construction phase there is the potential for disturbance and re-suspension of sediments, either directly from the sea bed, or from sub-seabed cuttings, and for these re-suspended sediments to be dispersed through the water column as a plume. This has the potential to increase the baseline suspended sediment concentrations and potentially increase turbidity around the MDZ.

122. During the drilling of pin pile foundations within the proposed MDZ development site, sediments will be released at the surface via the drilling equipment as cuttings of the bedrock which exists below the seabed. In addition, seawater and bentonite are likely to be used as a drilling fluid to lubricate the drill bit and the bentonite will be discharged along with the cuttings. Sediment generated as a result of the installation activities will be finer than the surface sediments. Data from Horizon Nuclear Power and Minesto show that the tidal currents within the MDZ are strong, while SEACAMS modelling shows that the bed shear stresses within the MDZ are sufficiently strong to transport fine and medium sands, and the MDZ is, therefore, dispersive of fine sediments and sands, generally transporting them to the northeast. The fine sediment arising from the pin pile installation activities is therefore likely to be dispersed quickly due to the surrounding energetic tidal environment; with any larger sediment clasts settling in the vicinity of the foundations. Further detail of the results of the coastal modelling conducted in relation to the Project are presented in **Chapter 7, Metocean Conditions and Coastal Processes**.

123. Based on a 240 MW capacity, the worst-case volume of cuttings for the entire site would amount to 117,780 m^3. However, this is the total for all foundations and foundations will be installed sequentially. A single device requiring four drilled piles will produce 160 m^3 of cuttings.

124. As discussed in **Chapter 7, Metocean Conditions and Coastal Processes**, this is likely to result in peak increases in suspended sediment concentration at the points of release within the Project being only a few mg/l (typically less than 10 mg/l) and peak values at only a short distance from each release point reducing rapidly to less than 1 mg/l. This low (barely measurable) effect is partly due to the low volume of sediment released from drilling at the location of each release point, and partly because any fine material released would be rapidly dispersed by the strong tidal currents along the axis of tidal flow.

125. The maximum envisaged effect associated with sediment plumes arising from the foundation installation activities will cause a small increase in suspended sediment concentration (typically less than 1 mg/l a short distance from the release point) over only a small geographical area (a few hundred metres). The effects will be temporary, with a return to very low background concentrations occurring rapidly upon cessation of installation activities (i.e. the effect is temporary only). Other than at the immediate release point, such a change would be immeasurable.

126. Therefore, the negligible magnitude of effect coupled with the low sensitivity of water quality receptors in this area result in a **negligible** impact via increased suspended sediment via foundation installation.

8.6.4.1.1. Mitigation

127. None required.

8.6.4.1.2. Residual Impact

128. The residual impact on water quality via sediment plume generated during foundation installation will remain **negligible**.

8.6.4.2. Construction Impact 2: Change in Water Quality Due to Sediment Plume Generated via Cable Installation

129. During the construction phase there is potential for offshore cable installation activities within the cable corridor (including the nearshore and landfall) to disturb sediments and release them into the water column as a plume. This will enhance the baseline suspended sediment concentrations in the water column, making it more turbid, until the plume becomes dispersed by tidal current action and the sediments settle once again on the sea bed.

130. The offshore parts of the cable corridor are mostly covered by large areas of outcropping bedrock, with minimal relief and only sparse sediment cover, predominantly gravel, cobbles and rock boulders. However, the northern part of the cable corridor is covered by a sand ridge north of South Stack headland and extending northwest for around 1 km. This is where post-lay jetting may be required to bury the offshore cable, which would cause some sea bed sediment disturbance.

131. Nearer to the landfall, Abraham's Bosom is a bay bounded by rock headlands to the north and south, with a cover of sediment overlying bedrock. The grab sample from this location recovered medium-grained sand. Just offshore of the bay is a patch of megaripples (up to 0.6 m high).

132. The free-laying of cables and the placement of cable protection would not cause plumes along the offshore sections of the cable corridor because the sea bed is characterised by bedrock or, where sparse sediment cover does exist, by sediments with a particle size that cannot be suspended in the water column. In the nearshore, the bedrock is overlain by sand which has the potential to be disturbed by the free-laying of cables and the placement of cable protection. However, any plume arising from these activities would only arise from the force of the cable or protection measures on the sea bed. At the landfall, the worst case scenario would be open trenching rather than the preferred option of Horizontal Directional Drilling (HDD). Under open trenching, approximately 8,880 m^3 of sand would be excavated and the majority replaced to backfill the trench, with only a small net loss to the inshore system. Due to these factors, the likely increase in suspended sediment concentration in areas with sand cover nearer to shore (including at the landfall) will remain within the bounds of natural behaviour that are governed by storm waves and surge effects. Furthermore, these effects will be one-off and temporary in duration and are unlikely to be measurable.

133. The principal effect would arise from the post-installation jetting to bury the offshore cable across the sand ridge feature in the northern half of the cable corridor. Under this activity, it is likely that the maximum envisaged effect associated with sediment plumes arising from the jetting will cause only modest (but measurable) increases in suspended sediment concentration locally (typically a few tens of mg/l above background levels). This increase would reduce rapidly with distance from the point of disturbance to a few mg/l over a small geographical area (within a few hundred metres, along the axis of tidal currents). Furthermore, these effects will be one-off and temporary in duration, with a return to the very low background concentrations occurring rapidly upon cessation of installation.

134. Therefore, the low magnitude of effect coupled with the low sensitivity of water quality receptors in this area result in a **minor adverse** impact via increased suspended sediments in the area around the sandwave field and a lower, **negligible** impact in other areas away from the sandwave field.

8.6.4.2.1. Mitigation

135. None required.

8.6.4.2.2. Residual Impact

136. The residual impact on water quality in the area around the sand-wave field will remain as **minor adverse.** The residual impact on water quality via cable installation in other parts of the MDZ will remain **negligible**.

8.6.4.3. Construction Impact 3: Change in Water Quality Due to Release of Contaminated Sediments

137. The re-suspension of sediments during construction activities could also lead to the release of any contaminants that may be present within them, which may in turn affect compliance with water quality standards.

138. The baseline environment section concluded that sediment contamination within the MDZ is low, due to the dynamic hydrological regime and generally low level of industrial activity in this region. The low proportion of fine sediments within the MDZ (which have a greater adsorbing capacity for contaminants) is another factor that indicates low sediment contamination levels.

139. Therefore, even though mobilisation of the relatively limited amount of sediments in the MDZ will occur via construction works, none of these sediments are known to have high levels of contaminants, which will result in a negligible magnitude of effect. The sensitivity of receptors in this area to water quality changes is low, therefore a **negligible** impact is predicted on general water quality in the MDZ via release of contaminated sediments.

8.6.4.3.1. Mitigation

140. None required.

8.6.4.3.2. Residual Impact

141. The residual impact on water quality via potential release of contaminated sediments in the MDZ will remain **negligible**.

8.6.4.4. Construction Impact 4: Change in Water Quality Due to Discharge of Construction Material and/or Chemicals

142. The liquid inventory for the Project indicates that there are large amounts of chemicals including oil, grease and hydraulic fluid that could be accidentally released/leaked from Project components. Other sources of potential chemicals include drilling fluids from any drilled pin-piles and also from HDD works at landfall.

143. If any such substances were accidentally released/leaked, quantities would likely be small due to relatively small amounts being present in individual devices. Due to the dynamic nature of the tidal and wave regime in and around the MDZ, lateral and vertical dispersion rates of any spilled substances would be expected to be high. The magnitude of this potential effect is considered to be low, as it is not anticipated to significantly affect local water quality and would also be temporary in nature (established controls would prevent further spillage/leakage once an event was detected).

144. The receptor is defined as general water quality and is judged to be low. Therefore, a **minor adverse** impact on general water quality in and around the MDZ is predicted.

8.6.4.4.1. Mitigation

145. Adherence to a project-specific Construction Environmental Management Plan (CEMP) and Pollution Prevention and Management Plan (PPMP). All solids will be separated from the drill fluid and disposed of in accordance with a project-specific Site Waste Management Plan; this is expected to stipulate the offsite removal of solids from drill arisings. Bentonite clay and water are considered to be non-toxic earthen materials and any arisings are likely to be dispersed quickly due to the dynamic tidal environment.

146. Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. A Pollution Prevention Management Plan (PPMP) would be in place and agreed with NRW in line with the Integrated Pollution Prevention and Control (IPPC) Directive such that any potential risk is minimised. Any permitted discharges would be small volumes, intermittent and dilute and disperse quickly. An outline Pollution Prevention and Management Plan (**Document MOR/RHDHV/DOC/0077**) and outline Construction Environmental Management Plan (CEMP) (**Document MOR/RHDHV/DOC/0073**) has also been prepared to provide an outline of the mitigation measures to be undertaken during construction, to minimise any impacts predicted.

8.6.4.4.2. Residual Impact

147. The residual impact on local water quality via potential release of construction materials and/or chemicals is judged to be reduced to **negligible** if appropriate mitigation measures are adhered to.

8.6.4.1. Construction Impact 5: Deterioration in Status of WFD Waterbodies and/or Local Designated Bathing Waters

148. The existing environment section indicated the MDZ lies in close proximity to two Welsh WFD Coastal Water Bodies – the eastern part of the MDZ overlaps the Caernarfon Bay North (GB621010380000) water body, while the Holyhead Bay (GB681010360000) is located approximately 3 km away from the MDZ at its nearest point (**Figure 8-1, Volume II**).

149. There are also six designated bathing water beaches along the west coast of Anglesey all of which meet the higher water quality standard and have consistently met the higher standard since 2010.

150. Potential exists for the status of these waterbodies/beaches to be adversely affected via deterioration in water quality/release of contaminants due to construction activities. However, the preceding impact assessments have concluded that no significant impacts on water quality are predicted via planned works. Therefore, it is judged that the magnitude of any effect is low.

151. The sensitivity of these receptors is judged to be medium as they have formal EU-level designations that require regular monitoring and compliance with. Therefore, a **minor adverse** impact is predicted on local WFD waterbodies and designated beaches via deteriorations in water quality during construction.

8.6.4.1.1. Mitigation

152. Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations.

8.6.4.1.2. Residual Impact

153. The residual impact on these WFD waterbody and bathing beach receptors via potential release of construction materials and/or chemicals is judged to be reduced to **negligible** if appropriate mitigation measures are adhered to.

8.6.5. Potential Impacts during Operation

8.6.5.1. Operational Impact 1: Change in Water and/or Sediment Quality Due to Accidental Spillages/Leaks from Operational Devices

154. During the operational phase of the Project there is a potential risk to water and/or sediment quality via accidental spillage or release of materials such as grease and oils during maintenance work and from vessels associated with these works. Similar scope for accidental spillages/leaks will arise during any major cable repair works and/or repowering activities.

155. Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. An PPMP would be in place and agreed with NRW in line with the IPPC Directive such that any potential risk is minimised. Any permitted discharges would be small volumes, intermittent and dilute and disperse quickly.

156. As per during the construction phase, if any such substances were accidentally released/leaked, quantities would likely be small due to relatively small amounts being present in individual devices. Due to the dynamic nature of the tidal and wave regime in and around the MDZ, lateral and vertical dispersion rates of any spilled substances would be expected to be high. The magnitude of this potential effect is considered to be low, as it is not anticipated to significantly affect local water quality and would also be temporary in nature (established controls would prevent further spillage/leakage once an event was detected).

157. The receptor is defined as general water quality and is judged to be medium. Therefore, a minor adverse impact on general water quality in and around the MDZ is predicted.

8.6.5.1.1. Mitigation

158. Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations.

8.6.5.1.2. Residual Impact

159. The residual impact on local water/sediment quality via potential leaks/releases of chemicals and other substances from operational devices and/or operation and maintenance activities is judged to be reduced to **negligible** if appropriate mitigation measures are adhered to.

8.6.5.2. Operational Impact 2: Change in Water Sediment Quality Due to Sediment Plumes Generated by Repowering and/or Cable Repair Works

160. During the operational phase of the Project there is an assumption that repowering of a maximum of 50 % of the berths will occur. In the 50 % of berths affected, all tenant infrastructure (foundations; TEC's; hubs; array cables will be removed and then new (possibly different) infrastructure will be re-installed (repowered). This will result in two, temporally separate effects of temporary seabed disturbance via the deployment of barge anchors to firstly remove infrastructure and then, further barge anchor deployments to re-install new infrastructure.

161. An assumption has been made that cable repairs would be required in the operational phase, with further temporary seabed disturbance from barge anchors deployed to undertake these repair operations.

162. The quantification of these potential impact (as defined by footprint of temporary seabed disturbance) is set out in **Table 8-15**.

163. These activities will create similar effects as previously assessed for the construction phase. The potential removal and re-installation of seabed mounted devices and/or seabed anchor systems for floating devices coupled with potential cable de-burial and re-burial in sedimentary areas will all result in creation of localised sediment plumes and subsequent deposition.

164. The magnitude of this effect will be less than for the main construction phase (0.42 km^2) due to a lower amount of temporary seabed disturbance via these operational phase activities (0.38 km^2). Therefore, magnitude is assessed as negligible.

165. The sensitivity of water quality receptors is judged to remain as low, resulting in a **negligible** impact.

8.6.5.2.1. Mitigation

166. None required.

8.6.5.2.2. Residual Impact

167. Negligible.

8.6.5.3. Operational Impact 3: Change in Water Sediment Quality Due to Sediment Plumes Produced via Scour around Seabed Mounted Project Infrastructure

168. Placing any structure on the seabed has the potential to result in scour around the structure, leading in turn to mobilisation of any available sediment in the area around the structure via plumes.

169. In areas of the MDZ where the sea bed is comprised of bare bedrock or where this is covered with boulders, cobbles or gravels there is unlikely to be any scouring effects, therefore there will be no change in suspended sediment concentrations. Where devices are placed in areas of the MDZ characterised by sands (e.g. southwest section and in the vicinity of the sand ridge in the north) there is potential for locally accelerated flows around foundations to increase suspended sediment concentrations, but since flows in these areas are very high in the baseline conditions, this will not be a major exacerbation of the issue.

170. Given the nature of the sea bed morphology, comprised mostly of exposed bedrock, the potential for adverse effects of this nature is extremely limited.

171. Therefore, for the majority of the site, where sediment cover is absent/limited, the magnitude of this effect is judged to be negligible. Coupled with the low sensitivity of water quality receptors, a negligible impact is predicted.

172. In areas where there is some sediment cover and, thus where scour may occur, the magnitude of effect is judged to be low. Coupled with the low sensitivity of water quality receptors in this area this results in a minor adverse impact.

8.6.5.3.1. Mitigation

173. There is no recommended further mitigation.

8.6.5.3.2. Residual Impact

174. The residual impact on water quality via scour-induced plumes in the area around the sand-wave field will remain as **minor**. The residual impact on water quality via scour-induced plumes in all in other parts of the MDZ will remain **negligible**.

8.6.6. Potential Impacts during Decommissioning

8.6.6.1. Decommissioning Impact 1: Changes in Suspended Sediment Concentrations During Removal of Project Infrastructure

175. During the decommissioning phase the removal of Project infrastructure has the potential to disturb sediments on the sea bed and release them into the water column as a plume. If this effect does occur, the magnitude of the effect will generally be lower than the effects arising from installation of foundations/cables.

176. The magnitude of effect is judged to be low and receptor sensitivity low, resulting in a **negligible impact.**

8.6.6.1.1. Mitigation

177. There is no recommended further mitigation.

8.6.6.1.2. Residual impact

178. The residual impact on water quality via plumes created via decommissioning activities will remain **negligible.**

8.6.6.2. Decommissioning Impact 2: Change in Water and/or Sediment Quality due to Accidental Spillages/Leaks from Vessels Involved in Decommissioning Works

179. During the decommissioning phase of the Project there is a potential risk to water and/or sediment quality via accidental spillage or release of materials from vessels associated with the works. Similar scope for accidental spillages/leaks will arise during any major cable repair works and/or repowering activities.

180. As per during the construction phase, if any such substances were accidentally spilt/leaked, quantities would likely be small due to relatively small amounts being present in individual devices. Due to the dynamic nature of the tidal and wave regime in and around the MDZ, lateral and vertical dispersion rates of any spilled substances would be expected to be high.

181. The magnitude of this potential effect is considered to be low, as it is not anticipated to significantly affect local water quality and would also be temporary in nature (established controls would prevent further spillage/leakage once an event was detected.

182. The receptor is defined as general water quality and is judged to be low. Therefore, a minor adverse impact on general water quality in and around the MDZ is predicted.

8.6.6.2.1. Mitigation

183. As per for the construction and operational phase impacts, Menter Môn is committed to the use of best practice and pollution prevention guidelines at all times. A PPMP would be in place and agreed with NRW in line with the IPPC Directive such that any potential risk is minimised.

184. Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance.

8.6.6.2.2. Residual Impact

185. The residual impact on local water/sediment quality via potential leaks/releases of chemicals and other substances from devices being decommissioned and/or vessels involved in these works is judged to be reduced to **negligible** if appropriate mitigation measures are adhered to.

8.6.7. Cumulative Impacts

186. Of the projects listed in **Chapter 27, Cumulative and In-combination Effects**, the only one which could potentially have a cumulative or in-combination effect with the Project in respect of marine water and sediment quality is judged to be Minesto's Holyhead Deep project, which lies immediately to the west of the MDZ. All other projects listed are either too remote from the Project for interactions between water/sediment quality impacts or on land and thus do not affect coastal processes.

187. In June 2014, Minesto was awarded an Agreement for Lease by The Crown Estate for a 10 MW installation, the Holyhead Deep project. An initial deployment of a 0.5 MW device was undertaken in summer 2018.

188. Minesto are now beginning EIA studies for a planned 80 MW installation of tidal energy devices, delivered in a phased manner, and located a short distance due west of the MDZ Project. Based upon the geographical configuration of the Minesto Project Development Area (PDA) with respect to the MDZ Project, there is no possibility of changes in tidal flow interacting between projects, due to the alignment of flood and ebb flows off the coast of Anglesey (i.e. the two projects are not upstream/downstream of each other).

189. Similarly, any (minor) sediment plumes arising from construction from either project will not coalesce because of: (i) the alignment of principal tidal flows; and (ii) likely different construction programmes (note that phase 1 of the Holyhead Deep project is already installed).

190. The one area where potential cumulative impact may occur were if construction activities were to occur simultaneously on both projects, which could produce a cumulative impact via spill events and accidental discharges of liquids/materials. If this cumulative impact occurred, a major adverse impact on local marine water quality could be produced. However, both projects would independently adopt standard best practice measures with respect to spill prevention and response and as such, the significance of this potential cumulative impact would be reduced to a negligible level.

8.6.8. Inter-Relationships

191. **Table 8-17** lists out the inter-relationships between this chapter and other chapters within the ES.

Table 8-17 Inter-Topic Relationships

Topic and description	Related Chapter	Where addressed in this Chapter	Rationale
Metocean Conditions and Coastal Processes	Chapter 7	Section 8.5.2 and 8.6.4	Both chapters consider the potential effects of the Project on suspended sediment concentrations
Infrastructure and Other Users	Chapter 16	Section 8.5.2	Both chapters consider the potential effects of disposal sites on the Project

192. Habitat loss and disturbance is also discussed separately in a number of other chapters, including **Chapter 9, Benthic and Intertidal Ecology** and **Chapter 10, Fish and Shellfish Ecology**.

8.6.9. Interactions

193. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within the chapter take these interactions into account and for the impact assessments are considered conservative and robust. For clarity the areas of interaction between impacts are presented in **Table 8-18**, along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 8-18 Potential Interaction Between Impacts

Potential interaction between impacts					
Construction	1. Change in water quality via foundation installation	2. Change in water quality via cable installation	3. Change in water quality due to release of contaminated sediments	4. Change in water quality due to discharge of construction material and/or chemicals	5. Deterioration in status of WFD waterbodies etc.
1. Change in water quality via foundation installation	-	Yes	No	Yes	No
2. Change in water quality via cable installation	Yes	-	No	Yes	No
3. Change in water quality due to release of contaminated sediments	No	No	-	No	No
4. Change in water quality due to discharge of construction material and/or chemicals	Yes	Yes	No	-	Yes
5. Deterioration in status of WFD waterbodies and/or local designated bathing waters	No	No	No	Yes	-

Potential interaction between impacts			
Operation / Repowering	1. Change in water and/or sediment quality due to accidental spillages/leaks	2. Change in water sediment quality due to sediment plumes	3. Change in water sediment quality due to sediment plumes produced via scour
1. Change in water and/or sediment quality due to accidental spillages/leaks from operational devices	**-**	Yes	Yes
2. Change in water sediment quality due to sediment plumes generated by repowering and/or cable repair works	Yes	**-**	Yes
3. Change in water sediment quality due to sediment plumes produced via scour around seabed mounted Project infrastructure	Yes	Yes	-
Decommissioning	1. Changes in suspended sediment concentrations	Change in water and/or sediment quality	
1. Changes in suspended sediment concentrations during removal of Project infrastructure	**-**	Yes	
2. Change in water and/or sediment quality due to accidental spillages/leaks from vessels involved in decommissioning works	Yes	-	

8.7. SUMMARY

194. This chapter has provided an overview on the potential impacts which may occur within the several stages associated with the development of the Project: construction, operation, repowering and maintenance, and decommissioning to marine and water sediment quality within the MDZ.

195. **Table 8-19** collates the determinations of each of the impacts assessed and is presented as a summary of the determinations. It is evident that the vast majority of the impacts to the Marine Water and Sediment Quality throughout the various stages of development are likely to be of minor adverse significance, even when assessed with the worse-case scenario. Therefore, the effects on the Marine Water and Sediment Quality are unlikely to cause long-term changes to the MDZ environment and surrounding region, either through direct changes in the species composition or due to changes in sediment structure.

Table 8-19 Summary of Potential Impacts on Marine Water and Sediment Quality Associated with the Development of the Project

Potential Impact	Effect Magnitude	Receptor Sensitivity	Significance	Additional Mitigation Measures	Residual Impact
Construction Phase					
1. Change in water quality due to sediment plume generated via foundation installation	Negligible	Low	Negligible	None required	Negligible
2. Change in water quality due to sediment plume generated via cable installation	Low (sandwave area) Negligible (other areas)	Low	Minor Adverse (sandwave area) Negligible (other areas)	None required	Negligible
3. Change in water quality due to release of contaminated sediments	Negligible	Low	Negligible	None required	Negligible
4. Change in water quality due to discharge of construction material and/or chemicals	Low	Low	Minor Adverse	Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations	Negligible
5. Deterioration in status of WFD waterbodies and/or local designated bathing waters	Low	Medium	Minor Adverse	Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations	Negligible
Operational / Repowering Phase					
1. Change in water and/or sediment quality due to accidental spillages/leaks from operational devices	Low	Low	Negligible	Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations.	Negligible

Potential Impact	Effect Magnitude	Receptor Sensitivity	Significance	Additional Mitigation Measures	Residual Impact
2. Change in water sediment quality due to sediment plumes generated by repowering and/or cable repair works	Negligible	Low	Negligible	None required	Negligible
3. Change in water sediment quality due to sediment plumes produced via scour around seabed mounted Project infrastructure	Low (sandwave/ sediment areas) Negligible (no sediment areas)	Low	Minor	None required	Minor adverse (sandwave / sediment areas) Negligible (no sediment areas)
Decommissioning Phase					
1. Changes in suspended sediment concentrations during removal of Project infrastructure	Negligible	Low	Negligible	None required	Negligible
2. Change in water and/or sediment quality due to accidental spillages/leaks from vessels involved in decommissioning works	Low	Low	Minor Adverse	Adherence to project-specific CEMP and PPMP which themselves will take full account of relevant pollution control legislation and guidance, i.e. MARPOL regulations.	Negligible

8.8. REFERENCES

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