Morecambe Offshore Windfarm: Generation Assets

Environmental Statement

Volume 5

Chapter 8 Marine Sediment and Water Quality

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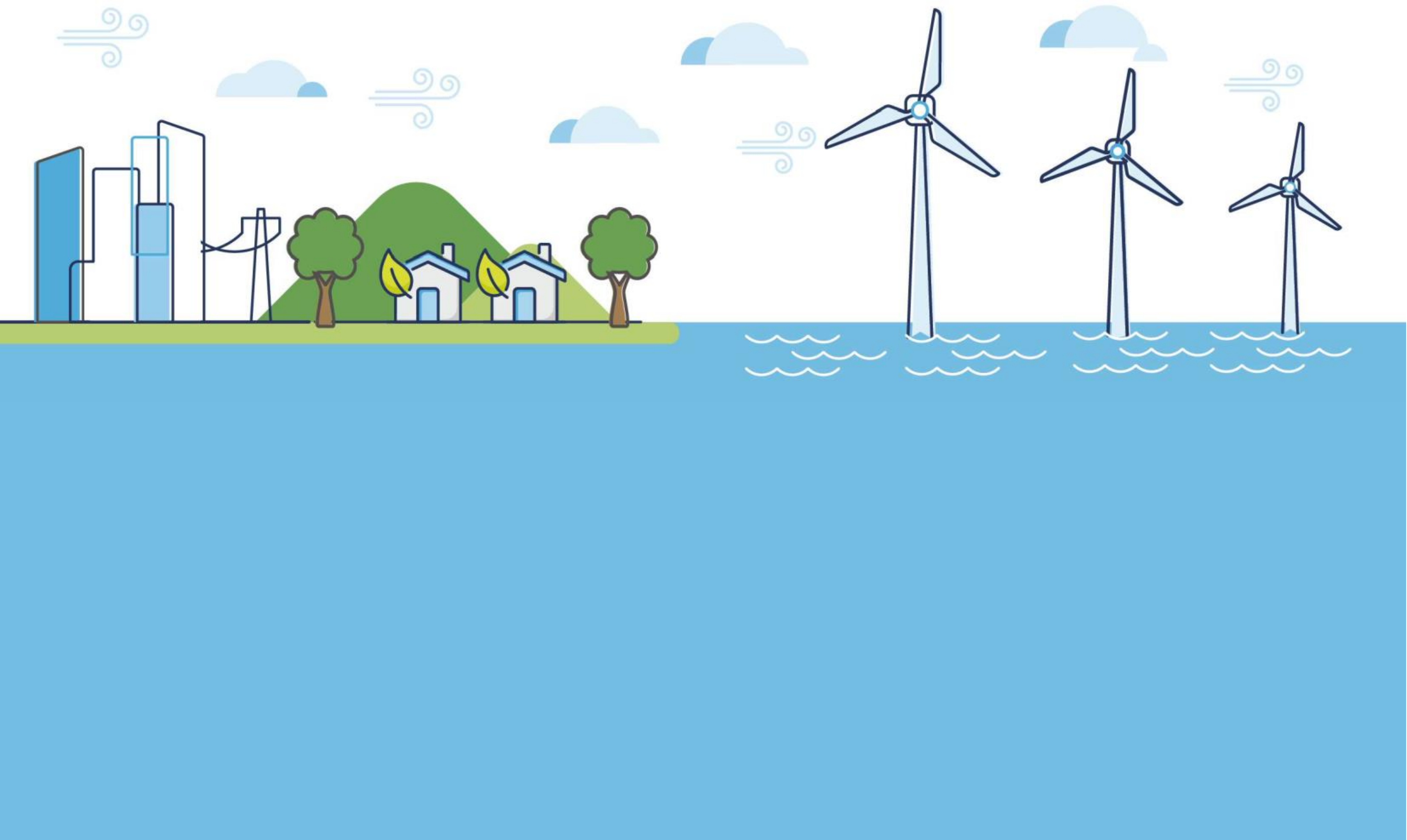
Rev 03



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Glossary of Acronyms

AfL	Agreement for lease
AL	Action Level
AyM	Awel y Môr
BAC	Background Assessment Concentration
BGS	British Geological Survey
CCSA	Carbon Capture Storage Area
CEA	Cumulative Effect Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture
CMS	Construction Method Statements
CPP	Central Production Platform
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPP	Evidence Plan Process
EQS	Environmental Quality Standard
ERL	Effects Range-Low
ES	Environmental Statement
ETG	Expert Topic Groups
EU	European Union
GBS	Gravity Base Structures
HM	His Majesty’s
HRA	Habitats Regulations Assessment
IPMP	In Principle Monitoring Plan
MEAS	Merseyside Environmental Advisory Service
MFE	Mass Flow Excavator
MMO	Marine Management Organisation
MPCP	Marine Pollution Contingency Plan
MPS	Marine Policy Statement
NPS	National Policy Statement
NWIFCA	Northwestern Inshore Fisheries and Conservation Authority
OSP	Offshore Substation Platform
OSPAR convention	Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm

PAH	Polyaromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
PEMP	Project Environment Management Plan
PINS	Planning Inspectorate
PSA	Particle Size Analysis
QSR	Quality Status Reports
RSPB	Royal Society for the Protection of Birds
SPR	Source Pathway Receptor
SSC	Suspended sediment concentrations
THC	Total hydrocarbons
TSHD	Trailing suction hopper dredger
UK	United Kingdom
UXO	Unexploded ordnance
WFD	Water Framework Directive
WTG	Wind turbine generator
ZoI	Zone of Influence

Glossary of Unit Terms

km	kilometre
km	kilometre
km^2	square kilometre
m	metre
mg/l	milligram per litre
mg/kg	milligram per kilogram
µg/kg	micrograms per kilogram
m^2	square metre
m^3	cubic metre

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Glossary of Terminology

Applicant	Morecambe Offshore Windfarm Ltd
Application	This refers to the Applicant's application for a Development Consent Order (DCO). An application consists of a series of documents and plans which are published on the Planning Inspectorate's (PINS) website.
Centre for Environment, Fisheries and Aquaculture (Cefas) Action Levels (AL)	Guideline contaminant concentration levels used as part of a weight of evidence approach for decision-making on the suitability of dredged material for disposal to sea.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics. The EPP provides a mechanism to agree the information required to be submitted to PINS as part of the DCO Application. This function of the EPP helps Applicants to provide sufficient information in their application, so that the Examining Authority can recommend to the Secretary of State whether or not to accept the application for examination and whether an appropriate assessment is required.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Far-field	The wider area that might also be affected indirectly by the Project.
Generation Assets (the Project)	Generation assets associated with the Morecambe Offshore Windfarm. This is infrastructure in connection with electricity production, namely the fixed foundation wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSP(s).
Inter-array cables	Cables which link the WTGs to each other and the OSP(s).
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	The transmission assets for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm. This includes the OSP(s)[1],interconnector cables, Morgan offshore booster station, offshore export cables, landfall site, onshore export cables, onshore substations, 400kV cables and associated grid connection infrastructure such as circuit breaker infrastructure. Also referred to in this chapter as the Transmission Assets, for ease of reading.

[1] At the time of writing the Environmental Statement (ES), a decision had been taken that the offshore substation platforms (OSP(s)) would remain solely within the Generation Assets application and would not be included within the Development Consent Order application for the Transmission Assets. This decision post-dated the Preliminary Environmental Information Report (PEIR) that was prepared for the Transmission Assets. The OSP(s) are still included in the description of the Transmission Assets for the purposes of this ES as the Cumulative Effects Assessment (CEA) carried out in respect of the Generation/Transmission Assets is based on the information available from the Transmission Assets PEIR.

Near-field	The area within the immediate vicinity (tens or hundreds of metres) from the point of disturbance.
Offshore export cables	The cables which would bring electricity from the OSP(s) to the landfall.
Offshore substation platform(s)	A fixed structure located within the windfarm site, containing electrical equipment to aggregate the power from the WTGs and convert it into a more suitable form for export to shore.
Onshore export cables	The cables which would bring electricity from landfall to the onshore project substation and from the onshore project substation to a National Grid substation.
Onshore substation	Part of an electrical transmission and distribution system. Substations transform voltage from high to low, or the reverse by means of electrical transformers.
Platform link cable	An electrical cable which links one or more OSP(s).
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations due to the flow of water.
Study area	This is an area which is defined for each EIA topic which includes the windfarm site as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each EIA topic is intended to cover the area within which an effect can be reasonably expected. For the purpose of the marine sediment and water quality assessment, this is an area which includes the windfarm site and the Zone of Influence (see below), as well as wider areas within the Eastern Irish Sea from which water and/or sediment quality data can be reported.
Technical stakeholders	Technical consultees are considered to be organisations with detailed knowledge or experience of the area within which the Project is located and/or receptors which are considered in the EIA and HRA. Examples of technical stakeholders include the Marine Management Organisation (MMO), local authorities, Natural England and the Royal Society for the Protection of Birds (RSPB).
Tidal excursion ellipse	The path followed by a water particle in one complete tidal cycle.
Windfarm site	The area within which the WTGs, inter-array cables, OSP(s) and platform link cables will be present.
Wind turbine generator (WTG)	A fixed structure located within the windfarm site that converts the kinetic energy of wind into electrical energy.
Zone of Influence (ZoI)	The maximum anticipated spatial extent of a given potential impact.

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8 Marine Sediment and Water Quality

8.1 Introduction

8.1 This chapter of the Environmental Statement (ES) considers the potential effects of the Morecambe Offshore Windfarm Generation Assets (the Project) on marine sediment and water quality. This chapter provides an overview of the existing environment, followed by an assessment of the potential effects and associated mitigation, where identified, for the construction, operation and maintenance, and decommissioning phases.

8.2 The Project includes the Generation Assets to be located within the windfarm site (wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSP(s)). The Environmental Impact Assessment (EIA) of the transmission assets, including offshore export cables to landfall and onshore infrastructure, is part of a separate Development Consent Order (DCO) application as outlined in **Chapter 1 Introduction** (Document Reference 5.1.1).

8.3 This assessment has been undertaken with specific reference to the relevant legislation and guidance, of which the primary sources are the National Policy Statements (NPS). Details of these, and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Effect Assessment (CEA), are presented in **Chapter 6 EIA Methodology** and **Section 8.4** of this chapter.

8.4 This assessment has been informed by impacts assessed in **Chapter 7 Marine Geology, Oceanography and Physical Processes** (Document Reference 5.1.7) and informs the following linked ES chapters:

- **Chapter 9 Benthic Ecology** (Document Reference 5.1.9)
- **Chapter 10 Fish and Shellfish Ecology** (Document Reference 5.1.10)
- **Chapter 11 Marine Mammals** (Document Reference 5.1.11)
- **Chapter 12 Offshore Ornithology** (Document Reference 5.1.12)
- **Chapter 13 Commercial Fisheries** (Document Reference 5.1.13)
- **Chapter 19 Human Health** (Document Reference 5.1.19)

8.5 Inter-relationships with these chapters are further described in **Section 8.9.**

8.6 Additional information to support the assessment included a site-specific benthic characterisation survey undertaken in 2022 (**Appendix 9.1 Benthic Characterisation Survey**; Document Reference 5.2.9.1) and the outcome of discussions and agreements with key stakeholders.

8.2 Consultation

8.7 Consultation regarding marine sediment and water quality has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key elements undertaken to inform this ES have included Scoping (Scoping Opinion from the Planning Inspectorate (PINS) received on 2nd August 2022), comments received on the Preliminary Environmental Information Report (PEIR) which was published for statutory consultation in April 2023, and the Evidence Plan Process (EPP), via the Marine Ecology Expert Topic Group (ETG).

8.8 As part of the EPP, a Marine Ecology Method Statement was submitted to the Marine Ecology ETG in May 2022. This consultation was used to inform the data requirements and the methodology for the assessment of potential Project effects set out in the EIA Scoping Report submitted to PINS in June 2022 (Morecambe Offshore Windfarm Ltd, 2022).

8.9 ETG meetings were held in June 2022, September 2022, November 2022, June 2023, October 2023 and January 2024 with attendees at some, or all meetings including the following organisations:

- Natural England
- Marine Management Organisation (MMO)
- Centre for Environment, Fisheries and Aquaculture Science (Cefas)
- Wildlife Trusts
- North Western Inshore Fisheries and Conservation Authority (NWIFCA)
- Environment Agency
- Isle of Man Government
- Merseyside Environmental Advisory Service (MEAS)

8.10 The feedback received throughout the EPP, the Scoping Opinion published by PINS, and stakeholder comments on the PEIR, have been considered in preparing the ES. The key elements pertinent to this chapter are shown in **Table 8.1**, alongside details of how the Project team has had regard to the comments received and how they have been addressed within this chapter.

8.11 The consultation process is described further in **Chapter 6 EIA Methodology**. Full details of the consultation undertaken throughout the EIA process is presented in the Consultation Report (Document Reference 4.1), which has been submitted as part of the DCO Application.

Table 8.1 Consultation responses received in relation to marine sediment and water quality and how these have been addressed in the ES

Consultee	Date	Comment	Response/where addressed in the ES
Scoping Opinion responses			
PINS (ref. 3.2.1)	2nd August 2022	The Inspectorate agrees that control measures set out in regulations (such as the International Convention for the Prevention of pollution from Ships (MARPOL) 73/78), the proposed Project Environmental Management Plan (construction and decommissioning) and Marine Pollution Contingency Plan drafted with the approval of the MMO mean that the Proposed Development is unlikely to give rise to significant effects from leaks and spills. As such the Inspectorate is content to scope this matter out of further assessment.	Noted.
PINS (ref. 3.2.2)	2nd August 2022	The Scoping Report states that effects are unlikely to extend into EEA states. The Inspectorate agrees that significant effects on a European Economic Area site are unlikely to arise and therefore this matter can be scoped out of further assessment.	Noted.
PINS (ref. 3.1.5)	2nd August 2022	The study area is defined as the 'Morecambe Offshore Windfarm Site' as shown on Figure 8.1. However, the scoping report states that the study area also includes areas beyond the windfarm site and across the wider regional seabed and coastline. This is not shown on Figure 8.1. The ES should include a figure clearly showing the boundary of the study area and provide a justification for the final extent.	The study area is described in **Section 8.3.1** and presented in **Figure 8.1**.
PINS (ref. 3.2.4)	2nd August 2022	The datasets listed are, with one exception, over ten years old and it is not clear how relevant they are to the area affected by the Proposed Development. Given the age of previous surveys within the area, the distance from the Proposed Development and the lack of information on the	Whilst some of the data used is over 10 years old, the datasets help to provide context to the site-specific survey data collected to inform the assessment, given similarities in sediment grain sizes. Emphasis in the baseline section,

Consultee	Date	Comment	Response/where addressed in the ES
		survey methods used, there is a risk that the baseline may not be robust. The ES should clearly identify the datasets used to determine the baseline, supported with evidence of agreement with relevant stakeholders wherever possible.	however, is on the sediment data collected in 2022 (see **Section 8.5**). All proposed datasets and site-specific sediment contamination sampling were discussed and agreed in the ETG with stakeholders in June 2022. Survey methods are fully detailed in **Appendix 9.1**.
PINS (ref. 3.2.5)	2nd August 2022	The Applicant should ensure that sediment samples used for the analysis of contaminants (e.g. metals, polycyclic aromatic hydrocarbon (PAHs), and Polychlorinated biphenyls (PCBs)) are collected separately from faunal samples and utilise suitable collection techniques. The ES should include a detailed description of the survey methodology used. The intention to agree the survey approach through the EPP is noted; the Applicant should also seek to agree the suite of contaminants to be considered through the EPP.	All parameters listed here are covered in the sediment analysis described in **Section 8.5.2**. Detail regarding sampling collection is provided in **Appendix 9.1**. The proposals for sediment analysis were presented in the ETG as part of the EPP process in June 2022.
Natural England	2nd August 2022	Increases in suspended sediment concentrations (SSC) during construction and operation and maintenance (e.g. future dredging works) have the potential to smother sensitive habitats. The ES should include information on the sediment quality and potential for any effects on water quality through suspension of contaminated sediments. The EIA should also consider whether increased SSC resulting are likely to impact upon the interest features and supporting habitats of the designated sites.	The potential effects associated with increases in suspended sediment concentrations (SSCs) are assessed in **Section 8.6** and **Section 8.7**. Associated effects on interest features and designated sites are considered in **Chapter 7 Marine Geology, Oceanography and Physical Processes** and **Chapter 9 Benthic Ecology**.
Natural England	2nd August 2022	The ES should consider whether there will be an increase in the pollution risk as a result of the construction or operation and maintenance of the development.	Pollution prevention measures are outlined in **Section 8.3.3** alongside the commitment to the development of Project Environment Management Plan

Consultee	Date	Comment	Response/where addressed in the ES
			(PEMP) (Document Reference 6.2) and Marine Pollution Contingency Plan (MPCP). These risks are therefore not considered further in the ES (and in line with PINS Scoping Opinion comment ID 3.3.4 under Benthic Ecology, which confirms that these effects are capable of mitigation through standard management practices and therefore can be scoped out).
Natural England	2nd August 2022	Section 8 paragraph 174, includes a quantified reference to the expected higher SSC at greater depth. This brings forward data already given in paragraph 219 on Water Quality. Other changes relating to SSC are also made in paragraph 239 on the causes of resuspension in operation and maintenance stages. The scoping retains reference to SSC as a pathway to benthic and fisheries impact in construction and operation and maintenance (e.g., paragraphs 290, 343). For offshore windfarm (OWF) impact assessment there must be a discussion of vertical SSC profiles, especially in a zone of muddy sediment, given what is now known about the wakes that effect vertical redistribution of sediment plumes in the lee of monopiles. This should also include reference to the frequency of storm conditions and the settling periods for sediments raised to elevated levels. Wakes are not mentioned in the Scoping study, but the PEIR should discuss potential temporal impact on turbidity, relevant to Section 8.2, not only in respect of contaminants but for the overall extent and duration of any incidences of elevated SSC. Include assessment re presence of OWF piles on SSC as a result of hydrodynamic effects (not just mechanical effects).	Hydrodynamic effects (changes in tidal and current speeds due to presence of monopiles and gravity base structures (GBS)) are addressed in Section 7.6.3.1 and Section 7.6.3.2 in **Chapter 7 Marine Geology, Oceanography and Physical Processes**. The effect of the vertical redistribution of suspended sediments in the lee of foundation structures is outlined in Section 7.6.3.3 of **Chapter 7 Marine Geology, Oceanography and Physical Processes**. Seasonal variations in turbidity are likely to have an impact on vertical suspended sediment profiles due to storms and changes in the position of ocean fronts. Storm surges, and climate change and future trends are discussed in Section 7.5.3.3 and Section 7.5.8 in **Chapter 7 Marine Geology, Oceanography and Physical Processes**.

Consultee	Date	Comment	Response/where addressed in the ES
Evidence Plan Process			
Cefas – ETG meeting	June 2022	Project benthic characterisation survey (which included particle size analysis (PSA) and contaminant sampling): Requested details of sampling equipment used to collect samples for contaminant analysis.	Details are included in **Section 8.4.2**. More detailed information can be found in **Appendix 9.1**.
Cefas – ETG meeting	November 2022	Project benthic characterisation survey: Requested full survey data, including mercury levels.	All data provided in **Appendix 9.1**.
Natural England and MMO – Consultation on the benthic survey plan	May 2022 (Natural England) August 2022 (MMO)	Project benthic characterisation survey: Comments provided on the benthic survey sampling plan.	Comments and project responses are provided in **Appendix 9.1.**
Statutory consultation feedback on the PEIR			
MMO (ref. DCO/2022/00001, 4.4)	30th May 2023	MMO would expect the report to clarify if data is below Action Level 1 for organotins and PCB data, as these are not readily detailed in the report as the trace metals and PAHs data are.	These parameters recorded values below the limit of detection and therefore the data is not presented within the text. This is outlined in **Section 8.5.2.**
Natural England (ref. A3)	2nd June 2023	*Topic: Conceptual assessment approach to physical processes assessment* Natural England's preferred approach would be to use modelling that is specific to the project being assessed. Whilst justification for use of the conceptual approach is presented, we do not consider this to be an acceptable standard approach.	The response to these comments is covered in detail in **Chapter 7 Marine Geology, Oceanography and Physical Processes**. It is noted however, that in September 2023 as part of the EPP (and following further information provided by the Applicant on the conceptual assessment approach for the ES), that Natural England '*acknowledges that including the Morgan and Mona Offshore Wind Projects modelling studies in addition to Awel-y-Mor Offshore Windfarm modelling study provides a*
MMO (ref. 3.2)	30th May 2023	*Topic: Conceptual assessment approach to physical processes assessment* The main information gaps still remain around the justification for the use of proxy data from another OWF site for the Morecambe OWF, relating to the transferability of	

Consultee	Date	Comment	Response/where addressed in the ES
		data based on numerical-magnitude comparison of the sites. Qualitative location-specific detail is required to enhance the mainly quantitative comparison made to date, to illustrate the implied impact envelopes for the Morecambe OWF site itself.	*more appropriate evidence base than Awel-y-Mor alone. NE advises that this presents an improvement to the conceptual approach and will result in a better supported ES'* DAS/UDS-A001761/364191) (NE, 2023). Furthermore, the MMO confirmed the proposed approach as '*largely appropriate'* by the MMO (MMO, 2023).

8.3 Scope

8.3.1 Study area

8.12 The windfarm site (encompassing all Project infrastructure) is located in the Eastern Irish Sea and encompasses a seabed area of 87km^2. It is located approximately 30km from the nearest point on the coast of Lancashire.

8.13 The study area for marine sediment and water quality is informed by **Chapter 7 Marine Geology, Oceanography and Physical Processes** and is defined as the Eastern Irish Sea, confined between the north coast of Wales, coastline of England to Whitehaven and the Isle of Man (**Figure 8.1**). This has been defined on the basis that it encompasses both potential near-field effects (within the immediate vicinity (tens or hundreds of metres) from the point of disturbance) and far-field (the wider area that might also be affected indirectly by the Project) and across the wider regional seabed and coastal environment.

8.3.2 Realistic worst-case scenario

8.14 The final design of the Project would be confirmed through detailed engineering design studies that would be undertaken post-consent to enable the commencement of construction. To provide a precautionary, but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined. The realistic worst-case scenario (having the most impact) for each individual impact is derived from the Project Design Envelope (PDE) to ensure that all other design scenarios would have less or the same impact. Further details are provided in **Chapter 6 EIA Methodology** (Document Reference 5.1.6). This approach is common practice for developments of this nature, as set out in PINS Advice Note Nine: Rochdale Envelope (2018).

8.15 The realistic worst-case scenarios for the marine sediment and water quality assessment are summarised in **Table 8.2**. These are based on the PDE described in **Chapter 5 Project Description** (Document Reference 5.1.5), which also provides further details regarding specific activities and their durations. The envelope presented has been refined as much as possible between PEIR and ES, presenting a project description with design flexibility only where it is needed.

8.16 A separate marine licence application would be made for the UXO clearance once the scale of UXO clearance required is further understood through detailed surveys and upon refinement of the layout. A high-level assessment is provided in **Section 8.6.1.4** (Impact 4) based on information from UXO clearance campaigns undertaken at other offshore windfarms.

Table 8.2 Realistic worst-case scenarios for marine sediment and water quality

Impact	Worst-case scenario	Notes and rationale
Construction phase		
Impact 1: Increase in SSCs due to seabed preparation for foundation installation	**Sediment displaced during seabed preparation for WTGs and OSP foundations:** ▪ 35 WTGs with GBS foundations = 455,438m³ ▪ Two OSPs with GBS foundations = 26,025m³ Total = **481,463m³**	Seabed preparation (e.g. excavation using a trailing suction hopper dredger (TSHD) or other specialist bed leveller/trencher such as mass flow excavation) may be required. This is a volume of sediment that is disturbed prior to installation of WTG/OSP foundation and involves the removal of sediment from the seabed. The worst-case scenario assumes that sediment would be removed and returned to the water column at the sea surface (e.g. during disposal from a dredger vessel[2]) for WTGs and OSPs. Given the seabed preparation area is the same per foundation for the smaller and larger WTGs, the worst-case assumes the larger number of smaller WTGs with GBS foundations, with a diameter of 65m + 10m either side. The seabed preparation area also includes area for two jack-up visits per WTG/OSP foundation in different positions over the construction period. This equates to a total footprint of 1,500m² per jack-up vessel visit and 3,000m² over the construction period per WTG/OSP foundation. The seabed preparation area would be dredged to a depth of up to 1.5m.

[2] It is possible that seabed preparation would be undertaken by plough and sediment would therefore not be released at the surface, however disposal at the surface has been retained for the worst-case scenario.

Impact	Worst-case scenario	Notes and rationale
Impact 2: Increase in SSCs due to drill arisings for foundation installation	**Drill arisings for WTG and OSP foundations:** - 30 monopile WTGs = 52,373m^3 - Two monopile OSPs = 3,492m^3 Total = **55,865m^3**	The worst-case assumes the lower number of the larger monopile foundations given the larger drill diameter compared to smaller WTGs. The drill diameter is 12.6m and is drilled to a depth of 56m. This assumes a drive-drill-drive methodology (50% drill arisings per foundation) at 50% of WTG locations.
Impact 3: Increase in SSCs associated with inter-array & platform link cable installation	**Sediment displaced during sandwave clearance/ levelling for cable installation:** - Inter-array cables = 70,000m^3 - Platform link cables = 10,000m^3 Total = **80,000m^3**	The worst-case length of inter-array cables is 70km and platform link cables is 10km. The worst-case assumes that 10% of the length of inter-array and platform link cables would require sandwave clearance/levelling, with a clearance width of 10m and height of 1m. The worst case assumes sediment would be released at the water surface.
	Sediment displaced during cable installation: - Inter-array cables = 472,500m^3 - Platform link cables = 67,500m^3 Total = **540,000m^3**	The worst-case assumes that 50% of inter-array and platform link cables are buried at 3m and 50% length is buried at 1.5m by jetting in a box-shaped trench, with a 3m trench width.
Impact 5: Deterioration in water quality associated with release of sediment bound contamination	As for construction Impacts 1 to 3.	

Impact	Worst-case scenario	Notes and rationale
Operation and maintenance phase		
Impact 1: Increase in SSCs associated with cable repair/replacement and reburial	**Average sediment volume disturbed per year:** ▪ Cable repair or replacement = 6,000m^3 ▪ Cable reburial = 3,000m^3 Total over one year = **9,000m^3** Total over operational period = **315,000m^3**	The worst-case for cable repair/replacement over the operational period assumes an average of up to 200m of cable repaired/replaced every year with a 10m disturbance width. Cable reburial assumes an average of up to 100m of cable reburied every year with a 10m disturbance width. The worst-case for sediment volume disturbed assumes both cable repair/replacements and reburial would have a 3m maximum depth for a box-shaped trench. The volume of sediment that could be suspended due to the presence of jack-up vessels has not been calculated but would be a much smaller proportion compared to the quantity generated by construction and decommissioning activities. It is noted that the assessment considered the total volume over the 35-year operational period based on yearly averages and thus assesses for example that there may be no cable repair in one year and then longer lengths of cable repair/replacement and/or reburial in other years. Further detail on maximum temporary O&M footprints in the windfarm site and cable corridors is provided in Table 5.21 of **Chapter 5 Project Description.**
Impact 2: Deterioration in water quality associated with release of sediment bound contamination	As for operation and maintenance Impact 1.	

<table>
<tr><th>Impact</th><th>Worst-case scenario</th><th>Notes and rationale</th></tr>
<tr><td colspan="3">Decommissioning phase</td></tr>
<tr><td>Impact 1: Increases in SSCs associated with foundation removal and removal of parts of the inter-array cables</td><td rowspan="2">The decommissioning policy for the Project infrastructure is not yet defined, however, it is anticipated that structures above the seabed would be removed.
The following infrastructure is likely be removed, reused, or recycled where practicable:
WTGs and foundations
OSPs, including topsides and foundations.
The following infrastructure is likely to be decommissioned and could be left in situ depending on available information at the time of decommissioning:
Inter-array and platform link cables
Scour protection
Crossings and cable protection
Part of the foundations (e.g. some foundation material below the seabed may be left in situ)</td><td rowspan="2">The detail and scope of the decommissioning works would be determined by the relevant legislation and guidance at the time.
Decommissioning arrangements would be detailed in a Decommissioning Programme, which would be drawn up and agreed with the relevant authority at the time, prior to decommissioning.
For the purposes of the worst-case scenario, it is anticipated that the impacts would be comparable to those identified for the construction phase.</td></tr>
<tr><td>Impact 2: Deterioration in water quality associated with release of sediment bound contamination</td></tr>
</table>

8.3.3 Summary of mitigation embedded in the design

8.17 This section outlines the embedded mitigation relevant to the marine sediment and water quality assessment, which has been incorporated into the design of the Project (**Table 8.3**). Where additional mitigation measures are proposed, these are detailed in the impact assessment (**Section 8.6** and **Section 8.7**).

8.18 Due to the presence and movements of Project related vessels/equipment there is the potential for spills and leaks which could result in changes to water and sediment quality. All vessels involved would be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. Pollution controls would be contained within the final PEMP which would be produced and implemented to cover the construction and the operation and maintenance phases of the Project. This would set out all procedures and measures (in the form of a MPCP) to be followed during the construction and the operation and maintenance phases to minimise the accidental spill risk. An Outline PEMP (Document Reference 6.2) is provided as part of the DCO Application and would be further developed in consultation with key stakeholders for approval by the MMO post-consent. This potential pollution risk to the marine sediment and water environment was therefore scoped out of the EIA in agreement with PINS (**Table 8.1**).

Table 8.3 Embedded mitigation measures related to marine sediment and water quality

Parameter	Mitigation measures embedded into the design of the Project
SSCs and release of sediment bound contamination	The Applicant is committed to the use of best practice techniques and due diligence regarding the potential for pollution throughout all construction, operation and maintenance, and decommissioning activities through the preparation of a PEMP including MPCP and chemical risk assessment in line with international and national regulations and guidance.
	Micro-siting would be used (for foundations and cable installation) where possible to minimise the requirements for seabed preparation.
	Application of foundation installation techniques using methods and equipment most suitable for seabed conditions and where possible to minimise sediment suspension.
	Selection of cable installation methods and equipment most suitable for seabed conditions and where possible to minimise sediment suspension.
	Preparation of Construction Method Statements (CMS), post-consent and pre-construction, setting out detailed WTG/OSP foundation and cable installation methods and techniques (based on final Project design). For the decommissioning phase, an Offshore Decommissioning Programme would be developed and implemented before any decommissioning activity takes place. This would include consideration of options to minimise sediment suspension.

Parameter	Mitigation measures embedded into the design of the Project
	For piled foundation types, such as monopiles and jackets with pin piles, pile-driving would be used in preference to drilling where it is practicable to do so (i.e. where ground conditions allow).

8.4 Impact assessment methodology

8.4.1 Policy, legislation and guidance

8.4.1.1 National Policy Statements

8.19 The assessment of potential effects on marine sediment and water quality has been made with specific reference to the relevant NPS. These are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the Project are:

- Overarching NPS for Energy (EN-1) (Department for Energy Security and Net Zero (DESNZ), 2023a)
- NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b)

8.20 The specific assessment requirements for marine water and sediment quality, as detailed in the NPS, are summarised in **Table 8.4**, together with an indication of the section of the ES chapter where each is addressed.

Table 8.4 NPS assessment requirements for marine sediment and water quality

NPS requirement	NPS reference	ES reference
NPS for Energy (EN-1)		
Infrastructure development can have adverse effects on the water environment, including groundwater, inland surface water, transitional waters, coastal and marine waters. During the construction, operation, and decommissioning phases, development can lead to increased demand for water, involve discharges to water, and cause adverse ecological effects resulting from physical modifications to the water environment. 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 result in surface waters, groundwaters or protected areas failing to meet environmental objectives established under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and the Marine Strategy Regulations 2010.	Paragraph 5.16.1 – 5.16.2	Potential impacts of the Project on water quality are assessed in **Section 8.6** and **Section 8.7**. Mitigation for leaks and spills is outlined in **Section 8.3.3**. The Project is outside of any Water Framework Directive (WFD) water body. Impacts to human health are considered in **Chapter 19 Human Health**.
Where the project is likely to have effects on the water environment, the applicant 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, and how this might change due to the impact of climate change on rainfall patterns and consequently water availability across the water environment, as part of the ES or equivalent.	Paragraph 5.16.3	The existing baseline is presented in **Section 8.5**. Potential impacts of the Project on water quality are assessed in **Section 8.6** and **Section 8.7**.

NPS requirement	NPS reference	ES reference
The ES should in particular describe: ▪ the existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges ▪ existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Abstraction Licensing Strategies) and also demonstrate how proposals minimise the use of water resources and water consumption in the first instance ▪ 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 ▪ any impacts of the proposed project on water bodies or protected areas (including shellfish protected areas) under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and source protection zones (SPZs) around potable groundwater abstractions ▪ how climate change could impact any of the above in the future ▪ any cumulative effects	Paragraph 5.16.7	Baseline information is provided in **Section 8.5**, including consideration of climate change. Impacts to marine water quality are described and assessed in **Section 8.6** (Project-alone) and **Section 8.7** (cumulative effects). The Project (and study area) is outside of any WFD water body as described in **Section 8.7** where pathways between the Project and the Transmission Assets are discussed. Impacts to protected areas are assessed in **Chapter 9 Benthic Ecology**, **Chapter 10 Fish and Shellfish Ecology, Chapter 11 Marine Mammals** and **Chapter 12 Offshore Ornithology** where impacts to water quality are considered. Cumulative effects have been addressed in **Section 8.7**.
The risk of impacts on the water environment can be reduced through careful design to facilitate adherence to good pollution control practice.	Paragraph 5.16.9	An Outline PEMP has been submitted with the DCO Application (Document Reference 6.2). Embedded mitigation is described in **Section 8.3.3**.

NPS requirement	NPS reference	ES reference
NPS for Renewable Energy Infrastructure (EN-3)		
Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options which should be undertaken.	Paragraph 2.8.104	The MMO and Cefas have been consulted with throughout the DCO pre-application process, including via the EPP and consultation on the PEIR (**Section 8.2**).
The construction, operation and decommissioning of offshore energy infrastructure, including the preparation and installation of the cable route and any electricity networks infrastructure can affect the following elements of the physical offshore environment, which can have knock on impacts on other biodiversity receptors: ▪ water quality – disturbance of the seabed sediments or release of contaminants can result in direct or indirect effects on habitats and biodiversity, as well as on fish stocks thus affecting the fishing industry	Paragraph 2.8.111	Potential impacts during construction, operation and maintenance, and decommissioning are assessed in **Section 8.6** and **Section 8.7**. Contaminant analysis of samples collected from the seabed within the Project windfarm site indicate very low levels of contaminants. Effects on habitats are assessed in **Chapter 9 Benthic Ecology**, and on fish in **Chapter 10 Fish and Shellfish Ecology** and **Chapter 13 Commercial Fisheries**.

8.4.1.2 Additional relevant policy and guidance

8.21 Other United Kingdom (UK) policies and plans of relevance to this chapter are the Marine Policy Statement (MPS) (His Majesty's (HM) Government, 2011), which states that developments must consider impacts to water quality, and the North West Offshore Marine Plan (HM Government, 2021), which highlights that proposals must demonstrate they will avoid, reduce or mitigate deterioration to marine water quality. These documents guide decision making with regard to marine developments and signpost the relevant legislation to be followed. These are discussed further in **Chapter 3 Policy and Legislation** (Document Reference 5.1.3).

8.22 There is no specific guidance available for the impact assessment of marine sediment and water quality.

8.23 Where available data supports it, sediment quality guidelines used by the OSPAR Commission and the MMO have been used.

8.24 The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') is the mechanism by which 15 Governments and the European Union (EU) cooperate to protect the marine environment of the North-East Atlantic. The convention required that all contracting parties take all possible steps to prevent and eliminate pollution and protect the maritime area against the adverse effects of human activities. The aims are to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.

8.25 Resulting from this cooperation are assessments, produced by the OSPAR Commission (a group made up of representatives of the Governments of the signatory nations, and which manages the convention), on the quality status of the marine environment for the maritime area, or for regions or sub-regions, thereof. These are presented in Quality Status Reports (QSRs). An element contributing to these assessments considers sediment quality data and uses Background Assessment Concentrations (BAC) and the US Environmental Protection Agency's (EPA) Effects Range-Low (ERL) to determine levels of contamination and trends over time. BACs are statistical tools, defined in relation to the background concentrations, which enable statistical testing of whether observed concentrations can be considered to be near background concentrations. The ERL value is defined as the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects. Adverse effects on organisms are rarely observed when concentrations fall below the ERL value. Relevant BACs and ERLs are provided in **Table 8.5**.

8.26 In England, the MMO licenses dredge material disposal to sea. To undertake the assessment regarding suitability of sediment for disposal, the MMO applies Cefas action levels (ALs) (sediment quality criteria) for contaminants on a primary list. These action levels are then used as part of a 'weight of evidence' approach to decision making on the disposal of dredged material. There are two levels AL1 and AL2. Contaminant levels below AL1 are generally assumed to be of no concern and are unlikely to influence the licensing decision. Contaminant levels between AL1 and AL2 generally trigger further investigation of the material, and contaminants in dredged material above AL2 are generally considered unsuitable for sea disposal (MMO, 2015).

8.27 Although the majority of the material assessed against these standards arises from a specific activity, i.e. dredging and disposal activities, they are also considered suitable for undertaking an initial risk assessment with respect to determining risks to marine waters from other marine activities, as part of EIA and associated Water Framework Directive (WFD) compliance assessments If, overall, levels do not generally exceed AL1, then contamination levels are considered to be low risk in terms of the potential for impacts on water quality. Where concentrations fall close to, or above AL2, then more quantitative assessment regarding water quality effects might be required, which would consider the risk of breaching water quality Environmental Quality Standards (EQS). This approach is recommended by the Environment Agency in their WFD compliance assessment guidance 'Clearing the Waters for All' (Environment Agency, 2017). Relevant values are presented in **Table 8.5**.

Table 8.5 Sediment quality guidelines used in this assessment

Contaminant	Units	OSPAR BAC	OSPAR ERL	Cefas AL1	Cefas AL2
Arsenic[3]	mg/kg	25	8.2	20	100
Cadmium		0.31	1.2	0.4	5
Chromium		81	81	40	400
Copper		27	34	40	400
Mercury		0.07	0.15	0.3	3
Nickel[4]		36	21	20	200
Lead		38	47	50	500
Zinc		122	150	130	800
Acenaphthene	µg/kg	-	-	100	-
Acenaphthylene		-	-	100	-
Anthracene		5	85	100	-
Benz(a)anthracene		16	261	100	-
Benzo(a)pyrene		30	430	100	-
Chrysene		20	384	100	-
Dibenzo(a,h)anthracene		-	-	10	-
Fluoranthene		39	600	100	-
Fluorene		-	-	100	-
Naphthalene		8	160	100	-
Phenanthrene		32	240	100	-
Pyrene		24	665	100	-
Benzo(ghi)perylene		80	85	100	-
Indeno[1,2,3-cd]pyrene		103	240	100	-

[3] The ERLs for arsenic and nickel are below the OSPAR Background Concentrations therefore arsenic and nickel concentrations are only assessed against the BAC.

8.4.2 Data and information sources

8.4.2.1 Site-specific surveys

8.28 To provide site-specific information on which to base the impact assessment, a site-specific geophysical survey was completed in 2021 (**Appendix 7.1 Offshore Geophysical Survey**; Document Reference 5.2.7.1); MMT, 2022). A ground truthing benthic characterisation survey was also undertaken between May and June 2022 (Ocean Ecology Limited, 2022) (**Appendix 9.1**).

8.29 Grab sampling was undertaken during the benthic characterisation survey and samples were sent for PSA for 50 sampling sites distributed across the survey area. The survey area reflected the Project 125km^2 Agreement for lease (AfL) area, which was the windfarm site presented in the PEIR. With a subsequent reduction in the windfarm site boundary since PEIR (as described in **Chapter 4 Site Selection and Assessment of Alternatives**), this represents 36 sampling stations located within the revised (87km^2) windfarm site and a further 14 stations located to the west (within 5km) of the western boundary.

8.30 Chemical contaminant analysis was undertaken at 20 sampling sites, 14 of which are within the revised windfarm site. The sampling sites were selected to provide maximum geographic coverage of the survey area, whilst also ensuring that sampling of all main sediment types was undertaken (**Appendix 9.1**). The samples were analysed for the following parameters:

- Trace metals
- Polyaromatic Hydrocarbons (PAHs)
- Total hydrocarbons (THC)
- Organotins
- Polychlorinated Biphenyls (PCBs)

8.31 Chemical analysis was undertaken in line with the MMO accreditation scheme regarding sediment sampling for disposal to sea licensing at the MMO accredited laboratory SOCOTEC. A 0.1m^2 Day grab sampler was used to collect the samples. The results are presented in **Section 8.5.2**.

8.4.2.2 Other available sources

8.32 Information to support this chapter has been drawn from the existing environment and effects assessment presented in **Chapter 7 Marine Geology, Oceanography and Physical Processes** regarding predicted sediment plumes arising from the Project. In addition, a series of data collection exercises and associated studies, as detailed in **Table 8.6**, provide context to the site-specific survey information gathered to inform the Project baseline.

8.33 Given the interconnected nature of the Project and the Morgan and Morecambe Offshore Wind Farms: Transmission Assets, the sediment contaminant analysis available in the benthic subtidal baseline survey for the Transmission Assets PEIR was also assessed (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023a).

Table 8.6 Existing data sources used in this chapter

Data source	Date	Data contents
Walney Extension Offshore Wind Farm Environmental Statement and associated technical supporting documents (Ørsted, 2012)	2012	Sediment contaminant analysis
West of Duddon Sands Offshore Windfarm Environmental Statement and associated technical supporting documents (Dong Walney (UK) Limited, 2006)	2006	
Walney 1 & 2 Offshore Windfarm Environmental Statements and associated technical supporting documents	2006	
Gwynt y Môr Environmental Statement (Gwynt y Môr Offshore Wind Farm Limited, 2005)	2005	Information gathered on SSCs during storm conditions
Awel y Môr (AyM) Offshore Wind Farm Environmental Statement and associated technical supporting documents (AyM Offshore Wind Farm Ltd., 2022a)	2022	Sediment contaminant analysis and modelling output
OSPAR Quality Status Report 2010 and Interim Assessment 2017	Various	Chemical contamination overview and sediment quality in the 'Celtic Seas' Region, within which the Project sits
Morgan Offshore Wind Project Generation Assets PEIR and the Physical Processes technical report (Morgan Offshore Wind Limited, 2023a,b)	2023	Chemical contamination overview and numerical modelling information. Water quality only recorded at Morgan.
Mona Offshore Wind Project PEIR and the Physical Processes technical report (Mona Offshore Wind Limited, 2023a,b)	2023	
Morgan and Morecambe Offshore Wind Farms: Transmission Assets PEIR and technical appendices (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023a)	2023	

8.4.3 Impact assessment methodology

8.34 **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied to the Project. The assessment of sediment quality and the potential risk to water quality is based on the Source-Pathway-Receptor (SPR) conceptual model, as described further in **Chapter 7 Marine Geology, Oceanography and Physical Processes** in relation to sediment disturbance. The risk associated with the release of sediment contamination is based on site-specific survey data (as described in **Section 8.4.2.1**) and use of recognised sediment quality guidelines, such as the Cefas ALs (as described in **Section 8.4.1.2**). The following sections outline the methodology used to assess the potential impacts on marine water quality.

8.35 The following key terms have been used in this assessment:

- **Impact** – used to describe a change via the Project (i.e., increased SSCs etc.)
- **Receptor** – used to define the environment being exposed to the Impact (i.e., water quality)
- **Effect** – the consequence of an Impact combining with a Receptor, defined in terms of Significance (exact significance dependant on magnitude of impact and the sensitivity of the receptor)
- **Adverse effect** – an alteration of the existing environment with negative implications for the affected receptor
- **Beneficial effect** – an alteration of the existing environment with positive implications for the affected receptor

8.4.3.1 Definitions of sensitivity and magnitude

8.36 The sensitivity of a receptor (in this case marine water quality) is dependent upon its:

- Tolerance to an impact (i.e. the extent to which the receptor is adversely impacted)
- Adaptability (i.e. the ability of the receptor to accommodate adverse impacts that would otherwise arise from a particular effect)
- Recoverability (i.e. a measure of a receptor's ability to return to a state at, or close to, that which existed before the project caused a change)

8.37 The sensitivity was assessed using evidence-based judgement and described with a standard semantic scale. Definitions for each term are provided in **Table 8.7**. Water quality is considered to be of low sensitivity because the Project is not located within a confined area and therefore has a high capacity to accommodate change and ability to dilute/flush any contamination.

Table 8.7 Definitions of sensitivity for water quality

Sensitivity	Definition
High	Supports, or contributes towards, the designation of an internationally or nationally important feature and/or has a very low capacity to accommodate any change to current water quality status, compared to baseline conditions.
Medium	Supports high biodiversity and/or has low capacity to accommodate change to water quality status.
Low	Has a high capacity to accommodate change to water quality status due, for example, to large relative size of the receiving water and capacity for dilution and flushing. Background concentrations of certain parameters already exist.
Negligible	Specific conditions are likely to be able to tolerate proposed change with very little or no impact upon the baseline conditions detectable.

8.38 The descriptions of magnitude are specific to the assessment of impacts and are considered in addition to the generic descriptors of impact magnitude presented in **Chapter 6 EIA Methodology**. Potential impacts have been considered in terms of permanent or temporary, and adverse or beneficial effects. The magnitude of an effect is dependent upon its:

- Scale (i.e. size, extent or intensity)
- Duration
- Frequency of occurrence
- Reversibility (i.e. the capability of the environment to return to a condition equivalent to the baseline after the effect ceases)

8.39 The magnitude of effect is assessed using evidence-based judgement and described with a standard semantic scale. Definitions for each term are provided in **Table 8.8**.

Table 8.8 Definition of magnitude for water quality

Magnitude	Definition
High	Fundamental, permanent/ irreversible changes and/or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness. Water quality status degraded to the extent that a permanent or long term change occurs. Inability to meet (for example) EQS is likely.
Medium	Considerable, permanent/irreversible changes, over the majority of the receptor, and/or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness. Water quality likely to take considerable time to recover to baseline conditions.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness. Activity not likely to alter local status to the extent that water quality characteristics change considerably or EQSs are compromised.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness. Any change to quality would be quickly reversed once activity ceases.

8.4.3.2 Effect significance

8.40 The potential significance of effect for a given impact, is a function of the overall sensitivity of the receptor and the magnitude of the impact (see **Chapter 6 EIA Methodology** for further details). A matrix is used (**Table 8.9**) as a framework to determine the significance of an effect. Definitions of each level of significance are provided in **Table 8.10**. Impacts and effects may be deemed as being either positive (beneficial) or negative (adverse).

8.41 It is important that the matrix (and indeed the definitions of sensitivity and magnitude) is seen as a framework to aid understanding of how a judgement has been reached from the narrative of each effect assessment and it is not a prescriptive formulaic method.

8.42 Potential effects are described, followed by a statement of whether the effect is significant in terms of the EIA regulations. Potential effects identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Whilst minor effects (or below) are not significant in EIA terms, it is important to distinguish these, as they may contribute to significant effects cumulatively or through impact interactions.

8.43 Following initial assessment, if the effect does not require additional mitigation (or none is possible), the residual effect will remain the same. If, however, additional mitigation is proposed, an assessment of the post-mitigation residual effect is provided.

Table 8.9 Significance of effect matrix

Sensitivity		Adverse Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
	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*

Table 8.10 Definition of effect significance

Significance	Definition
Major	Very large or large changes in receptor condition, 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 changes in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as a local issue.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore, no change in receptor condition.

8.4.4 Cumulative effects assessment methodology

8.44 The CEA considers other plans, projects and activities that may impact cumulatively with the Project. As part of this process, the assessment considers which of the residual impacts assessed for the Project on its own have the potential to contribute to a cumulative effect. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the CEA.

8.45 As described in **Chapter 1 Introduction**, the Transmission Assets associated with the Project are undergoing a separate consent process as part of the Morgan and Morecambe Offshore Wind Farms: Transmission Assets project. To enable impacts from the Project and the Transmission Assets to be considered together, a 'combined' assessment is made within the cumulative assessment to identify any key interactions and additive effects (**Section 8.7.3.1**).

8.4.5 Transboundary effects assessment methodology

8.46 **Chapter 6 EIA Methodology** provides details of the general framework and approach to the assessment of transboundary effects.

8.47 The localised nature of the potential impacts mean that significant transboundary impacts are unlikely. In accordance with the Scoping Opinion from PINS, transboundary impacts have been scoped out of this chapter.

8.4.6 Assumptions and limitations

8.48 Given the limited data regarding site-specific offshore water quality, information from more general monitoring programmes, such as those undertaken by the OSPAR Commission, as well as monitoring undertaken at the nearby proposed Morgan Offshore Wind Project Generation Assets has also been used to inform this assessment.

8.49 This limitation is not considered to significantly affect the certainty or reliability of the impact assessments presented in **Section 8.6** and **Section 8.7**.

8.5 Existing environment

8.5.1 Water quality

8.5.1.1 Physical parameters

8.50 Cefas (2016) published average SSCs between 1998 and 2015 for the seas around the UK (**Figure 8.2**) and showed that over this time period, the average SSC in the west of the windfarm site were approximately 3-5mg/l, gradually increasing to approximately 5-7mg/l in the east of the windfarm site.

8.51 This historical dataset was further developed with more recent monitoring from existing and proposed offshore wind projects. For example, monitoring within the proposed Morgan Offshore Wind Project Generation Assets (around 17km from the Project) recorded typical SSCs levels of 3mg/l, however as expected during a storm event this increased to circa 20mg/l corresponding with increased wave heights (Morgan Offshore Wind Limited, 2023).

8.52 Near bed SSC data is available from the Gwynt y Môr Offshore Windfarm array area (located around 30km south of the windfarm site), which provides an indication regarding variations in concentrations during storm conditions. This data indicates that during storm conditions, levels can reach in excess of 300mg/l (Gwynt y Môr Offshore Wind Farm Limited, 2005).

8.5.1.2 Chemical parameters

8.53 As outlined in **Section 8.4.1.2**, the OSPAR Commission collates information and produces assessments regarding the state of the marine environment for five regions. The Project is located in region III 'Celtic Seas'. In summary, the 2010 QSR stated that eutrophication is still a problem in Regions II, III and IV. Reductions in phosphorus discharges exceed the OSPAR target of 50% compared to 1985, but nitrogen discharges were the main problem, especially those from agriculture. With respect to hazardous substances, environmental concentrations of monitored chemicals were considered to have generally fallen but were still above acceptable concentrations in many coastal areas of Regions II, III and IV. Contamination with persistent organic pollutants was widespread and their long-range air transport to the OSPAR area, especially Region I, is of concern. It was also stated that historic pollution in aquatic sediments acts as a continued source for releases of persistent contaminants.

8.5.2 Sediment quality

8.5.2.1 Physical parameters

8.54 Sediment grain size is important to inform assessment of the risk of contamination because finer grained materials (silts and clays) function as a sink for contaminants and therefore have a greater potential to retain contaminants than larger grained materials (Cefas, 2001). Sediment grain size also assists in predicting the extent of any sediment plume, should the material be disturbed.

8.55 British Geological Survey (BGS) data indicates that the seabed across the windfarm site is predominantly muddy sand and slightly gravelly muddy sand, overlying a sequence of quaternary sediments (**Figure 8.3**). These are underlain by a bedrock of Permo-Triassic mudstone and sandstone (Mercia Mudstone and Sherwood Sandstone), which dominate the bedrock of the Eastern Irish Sea, and show relatively uniform rock properties (BGS, 2015).

8.56 As described in **Section 8.4.2.1**, a geophysical survey was undertaken across the Project in 2021 (MMT, 2022). The survey area covered the Project 125km^2 AfL area. This showed the windfarm site is broadly characterised[4] by sand, clayey sand and gravelly sand. The survey report notes that '*all of the depositional units mapped at the seabed have similar lithology of*

[4] Soil classification is in ISO 14688-1 which establishes the basic principles for the identification and classification of soils on the basis of those material and mass characteristics most commonly used for soils for engineering purposes.

predominately sand with laterally variable minor fractions of lithic or shell gravel, clay or silt'.

8.57 A site-specific grab sampling campaign with PSA and macrofaunal sampling was completed to ground truth the geophysical survey between 16th May and 8th June 2022 (Ocean Ecology Limited, 2022). The 125km^2 survey area included 36 sample locations across the windfarm site, with a further 14 locations sampled outside of the windfarm site (within 5km of the western site boundary).

8.58 The average sediment type across the windfarm site was fine sand (Folk and Ward description). Median particle sizes (d_{50}) ranged between 0.044mm (coarse silt) and 0.35mm (medium sand). Average gravel content was 0.1% across 35 samples, with only one station ST01 comprising a higher gravel content (20.6%) (**Figure 8.4**). Average mud content across all sediment samples within the windfarm site was 22.5%, ranging from 0% at ST 08 and ST 10 to 55.6% at ST45. Mud content was less than 30% in 67% of samples, and less than 10% in 19% of samples within the windfarm site. The stations with the highest silt content were found in the eastern half of the windfarm site. The average sand content of all 36 samples in the windfarm site was 76.9%. Further detail is presented in Section 7.5.6 in **Chapter 7 Marine Geology, Oceanography and Physical Processes** and **Appendix 9.1**.

8.59 Sediment samples were also collected for the Transmission Assets, located adjacent to the Project windfarm site (and within the study area for marine sediment and water quality). Sediment samples were collected at 77 sampling locations along the proposed export cable corridor which extends from the Morgan Offshore Wind Project windfarm site to the landfall on the Lancashire coast. The samples were classified into sediment types according to the Folk classification. Sediments ranged from gravelly muddy sand to slightly gravelly sand, with 42% of the samples classified as muddy sand. Of the other samples, 26% were classified as sand and 10% were classified as gravelly muddy sand, representing the three most common sediment types across the survey area. The coarseness of sediments generally increased with increasing distance from the coast, with sediments in the west of the survey area typically comprising gravelly muddy sands and gravelly sands. Sediments in the central area of the survey area were dominated by muddy sands and sandy muds, and in proximity to the landfall sediments comprised of sands (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023a).

8.5.2.2 Chemical parameters

8.60 The nearest oil and gas activity is the Calder CA1 gas platform (0.9km to the west of the Project windfarm site, with associated cables and pipelines bisecting the windfarm site) and the South Morecambe Central Production Platform (CPP1) (approximately 1.6km to the north of the windfarm site).

These gas platforms are operated by Spirit Energy. Calder CA1 is a small production platform with a single topside. CPP1 is a hub complex made up of three platforms on jacket substructures. There are also subsea cables and pipelines to the now decommissioned South Morecambe DP3 platform which was previously located within the windfarm site (however, these are no longer in use).

8.61 Chemicals are used for a variety of functions in the oil and gas industry. The discharge of production and drilling chemicals, residual oil and compounds released from gas extraction and production, in the Irish Sea, can contribute to the contaminant concentration in sediments and water (Cefas, 2005). Operators are required to source alternative products to avoid the use of those which contain chemicals that are very persistent, bio-accumulative or toxic, or have a combination of these properties.

8.62 Findings of sediment analysis undertaken to inform the EIAs for Walney Extension IV Offshore Wind Farm (Dong Energy, 2013) (approximately 18.8km from the Project) and West of Duddon Sands offshore windfarms (Dong Walney (UK) Limited, 2006) (approximately 12.9km from the Project) did not indicate significant levels of contaminants exceeding Cefas AL2 concentrations. There were some parameters (arsenic, cadmium, lead and nickel) which exceeded Cefas AL1, but these were all relatively marginal (i.e. only just above the concentrations for AL1).

8.63 In the AyM Offshore Wind Farm, all metals analysed as part of the site-specific survey within the array were below Cefas AL1 and the majority of PAH concentrations were below other sediment quality guideline values applied to the data (AyM Offshore Wind Farm Ltd., 2022a). Similar levels were recorded in the Morgan Offshore Wind Project Generation Assets and Mona Offshore Wind Project site-specific surveys (Morgan Offshore Wind Limited 2023a and Mona Offshore Wind Ltd, 2023a).

8.64 With respect to the Transmission Assets, the site-specific survey analysed 39 samples from the export cable corridor for metals, PCBs, PAHs and organotins. The data showed that most sites recorded contaminant concentrations below the Cefas AL1 with no sites exceeding the Cefas AL2. Concentrations of nickel at a single station located offshore and immediately east of the Morgan Offshore Wind Project Generation Assets windfarm site marginally exceeded Cefas AL1 but were well below Cefas AL2. Detectable levels of PCBs were only recorded in sediments at 13 stations, the majority of which were in the nearshore part of the survey area approaching the landfall and all samples were below the Cefas AL1s. Organotin concentrations across the survey area were below the limit of detection at all sample stations and levels of PAHs did not exceed the Cefas AL1 (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023a).

8.65 The OSPAR interim assessment report (2017) used a number of existing OSPAR pressure indicators, some of which have been developed since the QSR 2010. This included a revision of the BACs and Environmental Assessment Criteria (EACs) (**Section 8.4.1.2**). These assessment values are used to investigate the status of the OSPAR area with respect to hazardous substances. In relation to sediment quality and reference to parameters measured in the Project site-specific assessment (**Section 8.4.2.1**), the following parameters were assessed:

- Status and trends in the concentrations of PAHs in sediment
- Status and trends in the concentrations of PCBs in sediment
- Status and trends for heavy metals in sediment (cadmium, mercury and lead)

8.66 PAH concentrations were measured in sediment samples collected between 1995 and 2015 from monitoring sites throughout much of the Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast, at frequencies ranging from annually to every five years. With respect to the Celtic Seas region, mean PAH concentrations were found to be above the BAC but below the ERL.

8.67 For PCBs, concentrations were measured in sediment samples taken annually (or every few years) from monitoring sites throughout much of the Greater North Sea, Celtic Seas, Iberian Coast and Bay of Biscay over the same period as PAHs. While concentrations were decreasing in the Greater North Sea and Gulf of Cadiz, they show no statistically significant change in the Celtic Seas. With the exception of the most common congener (CB118), concentrations of all PCB congeners in sediment were below the level at which they could present an unacceptable risk to the environment.

8.68 With respect to heavy metals, the assessment was based on monitoring sites that have been monitored at least since 2009; with some monitored since 1989. Temporal trends were assessed from the 10 years of monitoring data (i.e. 2005–2015). Mercury and lead concentrations in sediment were at or above the BAC in all contaminants assessment areas. Mean concentrations of cadmium were below the BAC in three of the six areas assessed: Northern North Sea, Irish and Scottish West Coast, and the Irish Sea.

8.69 Mercury concentrations in sediment were at or above ERL in three of the six assessment areas and between the BAC and ERL in the Irish Sea assessment area. Concentrations of cadmium in sediment were below the ERL in all assessment areas and below the BAC in the Irish Sea assessment area. Lead concentrations were at or above the ERL in five of the six assessment areas including the Irish Sea assessment area, and below the ERL only in the Irish and Scottish West Coast assessment area.

8.70 As part of the Project site-specific survey work in 2022 (**Section 8.4.2.1**), 20 sediment samples were collected for chemical analysis for the following parameters:

- Trace metals
- PAHs
- THC
- Organotins
- PCBs

8.71 The locations of sediment sample sites analysed for contaminants are shown in **Figure 8.5.** Of the 20 sample sites, 14 were located within the windfarm site, with the remaining six samples located outside of the windfarm site (within 5km of the western site boundary). **Table 8.11** presents the survey data for metals, and **Table 8.12** and **Table 8.13** presents the data for PAHs compared to the sediment quality guidelines outlined in **Section 8.4.1.2.** Sampling sites located within the windfarm site are marked in red text in all tables. All other data were below the limits of detection and are available in **Appendix 9.1**.

8.72 With respect to metals, concentrations indicate very low levels of contamination across the sampled sites. The only parameter exceeding either of the sediment guideline values was mercury for OSPAR BAC (five samples) and only one sample recorded levels at the ERL (i.e., sample concentration equalled the ERL). These findings are broadly in line with the findings of the OSPAR interim assessment (2017) for the region. All other parameters were below all guideline values applied and therefore below findings in the OSPAR interim assessment (2017). No samples exceeded the Cefas ALs.

8.73 With respect to PAHs, several samples exceeded the BAC, but there were no exceedances of the Cefas AL1. Where exceedances occurred, concentrations were only marginally above the BAC value. Concentrations of PAHs were therefore very low across the sampled sites and in line with the findings of the OSPAR interim assessment (2017). No samples exceeded the Cefas AL1 value. THC in sediment samples ranged from 1.00mg/kg to 33.70mg/kg, again indicating relatively low levels of contamination.

8.5.3 Climate change and future trends

8.74 Baseline conditions have been largely shaped by a combination of the physical processes which exist within the Irish Sea (**Chapter 7 Marine Geology Oceanography and Physical Processes**) and anthropogenic impacts in the area (which influence pollutant levels). These processes will continue to influence the area in the future, and conditions are likely to remain in the same range as past patterns. Where additional regulations controlling pollutants have been implemented, concentrations would reduce.

8.75 The impacts of climate change to offshore water quality (for example, an increase in occurrence of storms) could influence the baseline in terms of increasing the period over which the extreme baseline concentrations in suspended sediments are experienced. This means any increases in SSCs associated with the Project would have a lesser effect as they are predicted to be within this baseline.

Table 8.11 Site specific data collected in 2022 for metals (Ocean Ecology Limited, 2022) (coloured dots against each sediment quality guideline are used to indicate where there is an exceedance). All data in mg/kg. Stations within the windfarm site are in red text.

Site reference	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
AL1 ● (yellow)	20	0.4	40	40	20	50	0.3	130
AL2 ● (red)	100	5	400	400	200	500	3	800
BAC ● (light blue)	25	0.31	81	27	36	38	0.07	122
ERL ● (dark blue)	-	1.2	81	34	-	47	0.15	150
ST01	8.7	<0.04	12.2	12.2	10.4	12.2	0.06	32.3
ST02	5.0	<0.04	8.4	8.4	6.5	8.8	0.05	28.6
ST05	5.9	0.08	14.7	14.7	11.2	15.4	0.11 ● (light blue)	47.8
ST11	4.6	<0.04	8.7	8.7	6.3	9.3	0.06	28.8
ST18	5.7	<0.04	8.1	8.1	6.0	8.0	0.05	24.3
ST20	5.0	0.06	9.2	9.2	7.3	10.0	0.06	29.8
ST22	5.8	0.08	13.5	13.5	10.8	15.4	0.15 ● (light blue) ● (dark blue)	47.1
ST23	4.9	0.05	7.8	7.8	5.8	7.9	0.06	22.4
ST26	8.3	0.05	6.6	6.6	5.3	8.6	0.04	27.2
ST31	6.7	<0.04	14.7	14.7	10.8	16.5	0.12 ● (light blue)	47.4
ST32	7.1	<0.04	7.1	7.1	5.1	8.1	0.03	26.0
ST35	5.8	<0.04	9.8	9.8	7.2	11.5	0.05	32.8
ST38	6.0	0.07	16.8	16.8	12.7	18.2	0.12 ● (light blue)	52.2
ST40	6.4	<0.04	15.9	15.9	11.5	16.1	0.12 ● (light blue)	46.5
ST42	4.6	0.08	7.2	7.2	5.6	7.3	0.02	22.1
ST43	9.2	<0.04	6.2	6.2	5.3	6.4	0.01	21.3

Site reference	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Mercury	Zinc
ST44	6.5	<0.04	6.4	6.4	5.0	8.5	0.03	25.0
ST48	6.0	<0.04	6.8	6.8	4.8	7.6	0.05	21.0
ST49	4.6	0.05	7.5	7.5	5.4	8.3	0.05	23.8
ST50	6.1	0.07	14.8	14.8	10.3	15.7	0.10 ●	44.1

Table 8.12 Site specific data for PAHs collected in 2022 (Ocean Ecology Limited, 2022) (coloured dots against each sediment quality guideline are used to indicate where there is an exceedance). All data in µg/kg. Stations within the windfarm site are in red text.

Site reference	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(e)pyrene	Benzo(k)fluoranthene	C1-Naphthalene	C1 -Phenanthrene	C2-Napthalene	C3-Napthalene	Chrysene	Dibenzo(ah)anthracene
AL1 ●	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10
AL2 ●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BAC ●	-	-	5	16	30	-	80	-	-	-	-	-	-	-	-
ERL ●	-	-	85	261	430	-	-	-	-	-	-	-	-	-	-
ST01	<1	<1	1.40	4.34	5.97	8.61	7.38	8.05	3.93	9.20	12.3	17.5	11.1	5.44	1.24
ST02	<1	<1	<1	2.48	3.45	5.37	4.89	5.03	2.63	5.82	5.22	11.8	6.27	3.07	<1
ST05	1.94	2.62	6.05 ●	16.9 ●	24.3	31.6	28.6	29.1	15.4	25.6	34.0	31.6	25.2	19.5	4.60
ST11	<1	<1	1.68	4.69	6.63	9.43	8.42	9.38	4.47	9.58	12.7	13.7	11.2	6.35	1.43
ST18	<1	<1	<1	2.07	3.16	4.07	4.98	4.56	2.05	4.18	5.04	7.54	5.22	2.68	<1
ST20	<1	<1	1.73	4.86	6.62	9.66	8.27	9.58	5.00	9.28	18.3	17.1	16.3	6.60	1.36
ST22	2.24	2.20	5.54 ●	17.1 ●	25.1	33.3	29.3	31.1	19.7	25.6	35.9	35.5	30.0	21.4	4.89
ST23	<1	<1	<1	2.85	4.23	5.69	4.82	5.79	3.74	5.14	5.40	11.1	5.57	3.53	<1
ST26	<1	<1	<1	<1	<1	1.78	1.45	1.85	<1	2.05	2.49	6.05	2.10	1.15	<1
ST31	2.43	2.96	5.37 ●	18.3 ●	26.8	34.7	30.2	32.3	20.0	29.9	32.9	44.0	28.9	22.2	5.21

Site reference	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(e)pyrene	Benzo(k)fluoranthene	C1-Naphthalene	C1 -Phenanthrene	C2-Napthalene	C3-Napthalene	Chrysene	Dibenzo(ah)anthracene
ST32	<1	<1	<1	1.08	1.49	2.21	1.71	2.40	1.29	2.43	3.65	5.06	3.62	1.52	<1
ST35	1.23	1.09	2.42	7.71	10.6	13.5	10.9	12.9	5.79	10.5	12.9	14.0	10.9	8.86	1.99
ST38	2.74	3.26	6.64 ●	20.8 ●	30.5 ●	40.0	35.0	38.3	22.4	33.9	40.1	47.8	37.4	24.4	5.98
ST40	2.45	2.89	5.23 ●	17.3 ●	25.7	33.6	29.4	31.8	18.0	29.7	29.7	42.5	26.7	18.8	5.30
ST42	<1	<1	1.01	3.03	4.39	5.93	4.80	5.93	3.36	5.29	6.63	13.9	5.30	4.77	1.14
ST43	<1	<1	<1	<1	<1	1.11	<1	1.11	<1	1.62	1.34	2.81	1.26	<1	<1
ST44	<1	<1	<1	1.05	1.70	2.66	2.05	2.53	1.10	2.80	2.93	8.50	2.81	1.45	<1
ST48	<1	<1	1.09	2.84	4.34	6.26	5.00	5.93	3.13	5.06	5.95	11.3	4.79	3.88	<1
ST49	<1	<1	1.21	3.33	4.81	6.30	5.03	6.29	3.01	5.41	6.29	8.05	4.82	4.06	<1
ST50	2.10	2.08	4.69	14.1	20.3	25.3	22.0	24.3	15.0	22.4	23.0	30.3	20.6	17.6	3.73

Table 8.13 Site specific data for PAHs collected in 2022 (Ocean Ecology Limited, 2022) (coloured dots against each sediment quality guideline are used to indicate where there is an exceedance). All data in µg/kg apart from THC which is in mg/kg. Stations within the windfarm site are in red text.

Site reference	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	THC (mg/kg)
AL1 ●	100	100	100	100	100	100	100	100mg/kg
AL2 ●	-	-	-	-	-	-	-	-
BAC ●	39	-	103	8	-	-	24	-
ERL ●	600	-	-	160	-	-	665	-
ST01	8.10	1.58	6.75	4.11	1.91	8.32	8.14	9.07
ST02	4.86	1.11	3.34	2.46	1.12	4.10	5.10	3.41
ST05	32.7	4.79	26.3	8.98 ●	9.06	30.0	32.7 ●	18.3
ST11	8.67	1.57	7.50	3.68	2.23	8.80	9.09	6.52
ST18	4.43	<1	2.58	2.08	1.06	3.89	4.35	3.33
ST20	8.96	1.71	7.57	3.91	2.47	10.8	10.1	4.50
ST22	31.1	4.40	27.6	10.2 ●	8.98	26.4	32.3 ●	33.7
ST23	5.22	<1	4.93	2.36	1.58	4.50	5.46	7.22
ST26	1.77	<1	1.24	1.06	<1	1.76	1.86	1.35
ST31	33.8	5.63	28.0	12.5 ●	9.33	28.3	34.7 ●	23.8
ST32	2.29	<1	1.54	1.27	<1	2.29	2.44	1.45
ST35	15.7	1.92	9.89	4.84	2.81	11.4	15.6	7.18

Site reference	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	THC (mg/kg)
ST38	40.1 ●	6.29	31.8	15.2 ●	11.1	33.6	40.0 ●	27.3
ST40	32.1	5.43	27.6	16.6 ●	8.87	25.8	32.8 ●	18.3
ST42	6.24	<1	4.01	2.67	1.34	5.57	6.33	3.99
ST43	1.02	<1	<1	1.11	<1	1.01	1.23	1.00
ST44	2.25	<1	1.92	2.90	<1	2.13	2.38	1.42
ST48	5.85	1.08	4.02	2.57	1.37	4.86	5.88	4.76
ST49	6.40	<1	4.42	2.36	1.94	5.04	6.56	3.62
ST50	27.3	4.37	20.2	10.3 ●	6.94	20.8	28.3 ●	16.6

8.6 Assessment of effects

8.77 The receptor for this assessment is water quality. It is also recognised that water quality is one of the pathways for impacts to other receptors (as described in **Section 8.9**).

8.6.1 Potential effects during construction

8.78 During the construction phase, there is the potential for foundation and inter-array and platform link cable installation activities to disturb sediment, potentially resulting in increases in SSCs. These potential effects are considered in construction Impacts 1 to 4 (as shown in **Table 8.2**). The realistic worst-case scenarios used to inform the assessment of these impacts are also discussed in **Table 8.2**.

8.79 Numerical modelling of impacts to tide, wave and sediment transport regimes has been undertaken for the following nearby offshore windfarm projects:

- AyM Offshore Wind Farm, located approximately 28.9km to the south of the Project windfarm site boundary (AyM Offshore Wind Farm Ltd., 2022b)
- Morgan Offshore Wind Project Generation Assets, located 16.7km west of the Project windfarm site boundary (Morgan Offshore Wind Limited, 2023b)
- Mona Offshore Wind Project, located approximately 10.0km south of the Project windfarm site boundary (Mona Offshore Wind Limited, 2023b)

8.80 The results of this modelling have been used in **Chapter 7 Marine Geology Oceanography and Physical Processes** as part of the evidence-based assessment to assess the potential effects of Project activities on marine geology, oceanography and physical processes receptors. The modelling is also relevant here to assess the potential effects associated with increases in SSCs arising from Project construction activities. Full justification for the use of the modelling outlined above is provided in **Chapter 7 Marine Geology Oceanography and Physical Processes**, but is also summarised below.

8.81 For the AyM Offshore Wind Farm:

- Water depth is comparable between the two sites
- Similar wave and tidal conditions
- Similar sediment transport directions
- Precautionary modelling scenarios

8.82 For the Mona Offshore Wind Project and Morgan Offshore Wind Project Generation Assets:

- Similar wave and tidal conditions

- Similar sediment transport directions
- Precautionary modelling scenarios

8.6.1.1 Impact 1: Increase in SSCs due to seabed preparation for foundation installation

Description of impact

8.83 Seabed sediments and shallow near-bed sediments within the windfarm site would be disturbed during preparation activities to create a suitable base prior to foundation installation. The worst-case scenario assumes that sediment would be dredged and returned to the water column at the sea surface as overflow from a dredge vessel. This process would cause localised and short-term increases in SSCs, both at the point of dredging at the seabed and, more importantly, at the point of its discharge back into the water column. The disposal of any sediment that would be disturbed or removed during foundation installation would occur within the windfarm site.

8.84 **Chapter 7 Marine Geology, Oceanography and Physical Processes** uses a conceptual evidence-based approach to assess the effects of seabed preparation. It is expected that medium and coarse-grained sand across the windfarm site (22.2% of PSA samples collected) would be disturbed by the drag head of the dredger at the seabed and would remain close to the seabed and settle back to the bed rapidly. Most of the sediment released at the water surface from the dredge vessel would fall rapidly (minutes or tens of minutes) to the seabed as a highly turbid dynamic plume immediately upon its discharge (within a few tens of metres along the axis of tidal flow (west-east)). The finer sand and clay fraction (fine sand: 30.6%, very fine sand: 30.6% and silt: 16.7% of samples) from this release is likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents.

8.85 Due to the sediment sizes present, this is likely to exist as a modest concentration plume (tens of mg/l) for around half a tidal cycle (around six hours). Sediment would settle to the seabed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower SSCs would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels (noting that concentrations during storm conditions can exceed 300mg/l (**Section 8.5.1.1**).

8.86 This assertion is supported by the modelling undertaken by AyM Offshore Wind Farm Ltd. (2022b) at AyM Offshore Wind Farm, which predicted that following sandwave clearance, a long thin plume extending downstream of the location would occur. The maximum area over which effects on SSCs are likely to occur is up to one tidal excursion along the flood/ebb tidal axis (a tidal excursion is approximately 11-12km from the centre of AyM Offshore Wind Farm and approximately 10km at the Project windfarm site). Modelling results showed that SSCs close to the activity would be in the order of thousands to hundreds of thousands of mg/l, rapidly reducing to hundreds or tens of mg/l (AyM Offshore Wind Farm Ltd., 2022b). SSCs are unlikely to exceed 150mg/l beyond about 5m away for gravel, 30m for coarse sand, 90m for medium sand and about 250-300m for finer sands (AyM Offshore Wind Farm Ltd., 2022b). The AyM Offshore Wind Farm ES outlined that where sediment is released at the water surface (on a spring tide), gravels and sands would settle to the bed (and so would not cause any effect on SSCs) within approximately 65m for gravel, 315m for coarse sand, 1,050m for medium sand and 3,150m for finer sands.

8.87 For sands and gravels, deposition time from a low height disturbance is likely to be in the order of seconds to a few minutes, and a few minutes to 1.5hrs for sediment release at the surface (AyM Offshore Wind Farm Ltd., 2022b). Silt sized sediment would persist in suspension for a longer period of time.

8.88 For the limited amount of silt modelled at AyM Offshore Wind Farm, SSCs were expected to be up to 50mg/l approximately 2km downstream of the activity, gradually decreasing to 1–5mg/l within 1 to 3 days through dilution and dispersion (AyM Offshore Wind Farm Ltd., 2022b).

8.89 With respect to the modelling for the Morgan Offshore Wind Project Generation Assets, the results showed that SSCs varied greatly over the sandwave clearance/levelling activities, extending for a maximum of one tidal excursion from each activity. During the dredge, the sediment plume exhibited a much lower concentration along the clearance route compared to the release phase plume at the disposal site. Higher SSCs were noted in the immediate vicinity of the activity and rapidly reduced with distance. However, following remobilisation on subsequent tides, several spots of high SSCs occur on the outer edges of the spring tidal ellipse, but these were still less than 500mg/l (Morgan Offshore Wind Limited, 2023b).

8.90 For the Mona Offshore Wind Project, only 21% of the sediment fraction was expected to be in the suspended load, however similar results were observed to the modelling output for Morgan Offshore Wind Project Generation Assets where 70.9% of the sediment fraction was expected to be in the suspended load (Morgan Offshore Wind Limited, 2023b). For both projects, the majority of the plume was predicted to be less than 30mg/l (Mona Offshore Wind Limited, 2023b).

Sensitivity

8.91 Water quality in the study area was assessed as **low** sensitivity because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.92 The scale of this impact would be relatively localised for coarser sediments (due to settling out) and further afield for finer sediments (up to one spring tidal excursion of approximately 10km), but SSCs would be expected to return to baseline conditions within days, due to dispersion and dilution. The magnitude of the impact was assessed as **low**.

Significance of effect

8.93 A **minor adverse** effect was identified, which is not significant in EIA terms.

8.6.1.2 Impact 2: Increase in SSCs due to drill arisings for foundation installation

Description of impact

8.94 During drilling, sediments below the seabed would be disturbed and released within the windfarm site close to each foundation. The disposal of any sediment would occur within the windfarm site close to each foundation.

8.95 This process would cause localised and short-term increases in SSCs at the point of discharge, which would then be transported by tidal currents in suspension. Most of the sediment released would be sand or aggregated clasts and, therefore, would fall immediately to the seabed in close proximity to the foundation. Where fines are released, the conceptual evidence-based assessment presented in **Chapter 7 Marine Geology, Oceanography and Physical Processes** indicates that SSCs would be very low away from the immediate release locations and within the range of natural variability. Additionally, SSCs arising from one foundation installation are unlikely to persist for sufficiently long for them to interact with subsequent foundation installations.

8.96 This assessment is supported by the modelling conducted for the AyM Offshore Wind Farm, which predicted that SSCs close to the activity would be in the order of thousands to hundreds of thousands of mg/l, rapidly reducing to hundreds or tens of mg/l (AyM Offshore Wind Farm Ltd., 2022b). SSCs were unlikely to exceed 150mg/l beyond about 5m away for gravel, 30m for coarse sand, 90m for medium sand and about 250-300m for finer sands (AyM Offshore Wind Farm Ltd., 2022b). For silt, SSCs were expected to be up to 50mg/l approximately 2km downstream of the activity, gradually decreasing to 1 – 5mg/l within 1 to 3 days, through dilution and dispersion (AyM Offshore Wind Farm Ltd., 2022b).

8.97 Numerical modelling results for the Morgan Offshore Wind Project Generation Assets and Mona Offshore Wind Project showed a similar pattern with most of the sediment transported mid-tide, settling during slack tide and a small amount being resuspended in successive tides (Morgan Offshore Wind Limited, 2023b and Mona Offshore Wind Limited, 2023b). The maximum SSCs of the plume at the drill site modelled was ~50mg/l, with SSCs reaching ~50mg/l at Morgan, and <30mg/l following remobilisation on subsequent tides (Morgan Offshore Wind Limited, 2023a; Mona Offshore Wind Limited, 2023a). The average SSCs of plumes following remobilisation on subsequent tides was <10mg/l across Morgan and Mona (Morgan Offshore Wind Limited, 2023a; Mona Offshore Wind Limited, 2023a).

Sensitivity

8.98 Water quality in the study area was assessed as **low** sensitivity because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.99 The scale of this impact would be relatively localised (confined to a small area, likely up to a kilometre from each foundation location) for coarser sediments (due to settling out) and further afield for finer sediments (beyond one kilometre), but SSCs would be expected to return to baseline conditions within days, due to dispersion and dilution. The magnitude of the impact was assessed as **low**.

Significance of effect

8.100 A **minor adverse** effect was identified, which is not significant in EIA terms.

8.6.1.3 Impact 3: Increase in SSCs associated with sandwave clearance, inter-array and platform link cable installation

Description of impact

8.101 Details of the inter-array and platform link cabling would be dependent upon the final project design. The worst-case cable laying technique is considered to be jetting as this method disperses more sediment into the water column compared to other methods (e.g. plough) which pushes sediment to the sides. The following assessment therefore considers 100% of inter-array and platform link cables would be installed by water jetting.

8.102 As a worse-case scenario, it is also assumed sandwave levelling may be required prior to cable installation[5]. This assumes that sediment would be dredged and returned to the water column at the sea surface as overflow from a dredge vessel. This process would cause local and short-term increases in SSCs both at the point of dredging at the seabed and, more importantly, at the point of its discharge back into the water column. **Table 8.2** summarises the worst-case scenario volumes of sediment predicted to be disturbed during sandwave clearance/levelling and cable installation activities.

8.103 Mobilised sediment from these activities may be transported by wave and tidal action in suspension in the water column. The disturbance effects at each location are likely to last for no more than a few days. The sediment released at any one time would depend on the capacity of the dredger and would be disposed of within the windfarm site, meaning there would be no net loss of sediment from the physical processes system.

8.104 The modelling conducted for AyM Offshore Wind Farm used to inform this assessment (as described in **Chapter 7 Marine Geology, Oceanography and Physical Processes**) predicted that increases in SSCs due to seabed preparation (using a Mass Flow Excavator[6] (MFE)) are expected to be very high (thousands to hundreds of thousands of mg/l) within small distances (less than 50m) of the activity, rapidly reducing with time and distance through settlement and dispersion. Finer sediment is likely to persist longer than coarser sediment and travel further. The small amount of fine-grained sediment (defined as sediment less than 0.063mm) modelled persisted in suspension up to approximately 2km downstream of the activity (50mg/l), decreasing to 1-5mg/l within one to three days through dilution and dispersion (AyM Offshore Wind Farm Ltd., 2022b).

8.105 Modelling for Morgan Offshore Wind Project Generation Assets and Mona Offshore Wind Project, also indicates that sandwave clearance and cable installation would result in increases in SSCs close to the cable trench (up to a kilometre), gradually decreasing beyond this point (Morgan Offshore Wind Limited, 2023b and Mona Offshore Wind Limited, 2023b). Maximum SSCs at the point of installation would be in the region of 500mg/l, with concentrations reaching 300-500mg/l during mobilisation on subsequent tides (Morgan Offshore Wind Limited, 2023a; Mona Offshore Wind Limited, 2023a).

[5] It is important to note that the volume of sediment disturbed during seabed preparation for cable installation would be released prior to the sediment volume released during cable installation and therefore would not be additive.

[6] This is considered to cause more disturbance than the worst-case method for the Project (jetting) and therefore this is considered a more precautionary scenario compared to the Project.

Sensitivity

8.106 Water quality in the study area was assessed as **low** sensitivity because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.107 The scale of this impact would be relatively localised (confined to a small area, likely up to a kilometre from each foundation location) for coarser sediments (due to settling out) and further afield for finer sediments (beyond one kilometre), but SSCs would be expected to return to baseline conditions within days due to dispersion and dilution. The magnitude of the impact was assessed as **low**.

Significance of effect

8.108 A **minor adverse** effect was identified, which is not significant in EIA terms.

8.6.1.4 Impact 4: Increase in SSCs associated with UXO clearance

Description of impact

8.109 Seabed sediments and shallow near-bed sediments within the windfarm site would be disturbed during UXO clearance and would cause localised and short-term increases in SSCs.

8.110 Chapter 7 Marine Geology, Oceanography and Physical Processes uses a conceptual evidence-based approach to assess the effects of increases in SSCs within the water column. It is expected that medium and coarse-grained sand across the windfarm site (22.2% of PSA samples collected) disturbed by UXO clearance would remain close to the seabed and settle back to the bed rapidly. The finer sand and clay fraction (fine sand: 30.6%, very fine sand: 30.6% and silt: 16.7% of samples) disturbed across the windfarm site would likely stay in suspension for longer and form a passive plume which would become advected by tidal currents in west-east orientation.

8.111 It is anticipated that the increases in SSCs caused by UXO clearance would be significantly less than that caused by sandwave clearance/clearance of sand features, as described in **Section 8.6.1.1**. Therefore, SSCs resulting from UXO clearance are expected to be in the order of tens of mg/l for around half a tidal cycle (around six hours). Sediment would settle to the seabed in proximity to its UXO clearance (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower SSCs would extend further from the disturbed area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels (noting that concentrations during storm conditions can exceed 300mg/l (see **Section 8.5.1.1**).

8.112 This assertion is supported by the modelling undertaken by Awel y Môr Offshore Wind Farm Ltd. (2022), Morgan Offshore Wind Limited (2023) and Mona Offshore Wind Limited (2023), detailed further in Section 7.6.21 of Chapter 7 Marine Geology, Oceanography and Physical Processes and **Section 8.6.1.1** of Chapter 8 Marine Sediment and Water Quality.

Sensitivity

8.113 Water quality in the study area was assessed as **low** sensitivity because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.114 The scale of this impact would be relatively localised for coarser sediments (due to settling out) and further afield for finer sediments (up to one spring tidal excursion of approximately 10km), but SSCs would be expected to return to baseline conditions within days, due to dispersion and dilution. The magnitude of the impact was assessed as **low**.

8.6.1.4.1 Significance of effect

8.115 A **minor adverse** effect was identified, which is not significant in EIA terms.

8.6.1.5 Impact 5: Deterioration in water quality associated with the release of sediment bound contamination

Description of impact

8.116 Site-specific data collected to inform this ES indicates that for all parameters, sediment contaminant concentrations were low (**Section 8.5.2**). Where exceedances of sediment guidelines occurred, these were marginal (i.e. only just above the lower guideline level value) and no samples exceeded the Cefas AL1 (where available), which indicates that there is minimal risk to water quality associated with sediment bound contaminants. This data is in line with other data sources, including the OSPAR Commission findings for the region (OSPAR, 2017) and survey data for other offshore windfarms in the vicinity of the Project which also show low levels of contaminants in the study area.

8.117 Additionally, as assessed in Impacts 1, 2 and 3 (**Section 8.6.1.1** – **8.6.1.3**), increases in SSCs arising from construction-related activities are not predicted to remain in suspension for long periods of time (1-3 days).

Sensitivity

8.118 Water quality in the study area was assessed as **low** sensitivity, because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.119 Given that sediment samples do not indicate elevated levels of contaminants, and suspended sediment plumes would be expected to return to baseline conditions within 1 to 3 days, the magnitude of the impact was assessed as **negligible**.

Significance of effect

8.120 A **negligible adverse** effect was identified, which is not significant in EIA terms.

8.6.2 Potential effects during operation and maintenance

8.121 During the operation and maintenance phase, there is the potential for maintenance activities to disturb sediment, potentially resulting in increases in SSCs. This potential effect has been considered in Impact 1. Any disturbance of sediment could then give rise to effects on water quality associated with the release of any sediment bound contamination. This potential effect has been assessed in Impact 2. The realistic worst-case scenarios used to inform the assessment are presented in **Table 8.2**.

8.122 Increases in SSCs in turbid wake features due to the presence of WTG/OSP(s) during the operation and maintenance phase are assessed in Section 7.6.3.3 in **Chapter 7 Marine Geology, Oceanography and Physical Processes**. Given that the magnitude of changes in SSCs within such turbid wakes would be within normal baseline conditions and would not be present at all times, no impacts are expected on water quality.

8.6.2.1 Impact 1: Increase in SSCs associated with cable repairs and reburial activities

Description of impact

8.123 Disturbance of sediments by maintenance activities that impact the seabed (e.g. cable repair, reburial or replacement) have the potential to re-suspend sediment and increase SSCs. Should these activities be required, a similar type of disturbance to that described for the construction phase (**Section 8.6.1.3**) for cable installation activities would be expected (i.e. near field drop out of coarser sediments, with finer sediments transported in suspension further from the point of activity).

8.124 Cable repairs and reburial could be needed over the operational lifetime of the Project. As set out in the worst-case scenario **Table 8.2**, the anticipated length of cables required to be repaired/replaced or reburied at any one time would represent a small proportion of the length of cabling associated with the Project. As such, the disturbance areas for reburial and repairs of cables are predicted to be extremely small in comparison to the construction assessment.

Sensitivity

8.125 Water quality in the study area was assessed as **low** sensitivity, because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.126 The scale of the impacts during these maintenance activities would be small, infrequent and of short-term duration, and of a lower magnitude than the impacts of seabed preparation for cables and cable installation during the construction phase. The magnitude of the impact was assessed as **negligible**.

Significance of effect

8.127 A **negligible adverse** effect was identified, which is not significant in EIA terms.

8.6.2.2 Impact 2: Deterioration in water quality due to resuspension of sediment bound contaminants

Description of impact

8.128 Site-specific data collected to inform this ES indicated that for all parameters, sediment contaminant concentrations were low (**Section 8.5.2**). Where exceedances of sediment guidelines occurred, these were marginal (i.e. only just above the lower guideline level value) and no samples exceeded the Cefas AL1 (where available), which indicated that there is minimal risk to water quality. This data is in line with other data sources, including the OSPAR Commission findings for the region (OSPAR, 2017) and survey data for other offshore windfarms in the vicinity of the Project which also show low levels of contaminants in the study area.

8.129 Additionally, as assessed in Impact 1, increases in SSCs are predicted to be small, infrequent and of short-term duration given that the seabed material is predominantly sand.

Sensitivity

8.130 Water quality in the study area is assessed as **low** sensitivity, because it is not within a confined area and therefore would have a high capacity to accommodate change due to its size and ability to dilute any alterations to water quality parameters.

Magnitude

8.131 Given that sediment samples do not indicate elevated levels of contaminants, and increases in SSCs are predicted to be small, infrequent and of short-term duration, the magnitude of the impact was assessed as **negligible**.

Significance of effect

8.132 A **negligible adverse** effect was identified, which is not significant in EIA terms.

8.6.3 Potential effects during decommissioning

8.133 Decommissioning impacts are considered at this stage to be comparable to construction.

8.134 Given the lack of information regarding timing and methodology used for decommissioning, it was not possible to undertake a detailed assessment. A further assessment would be undertaken at the time of decommissioning, however a high-level assessment has been undertaken in **Sections 8.6.3.1** and **8.6.3.2**.

8.6.3.1 Impact 1: Increases in SSCs associated with decommissioning (foundation removal and removal of parts of the cables)

8.135 Increases in SSCs could arise from decommissioning activities. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in Section 5.8 of **Chapter 5 Project Description** and the detail would be agreed with the relevant authorities at the time of decommissioning. For the Project, this is likely to involve removal of the WTGs/OSP(s), including foundations and topsides. Scour protection, cable protection and crossings protection and part of the foundations (e.g. some foundation material below the seabed) could be left *in situ*. Inter-array and platform link cables may either be left *in situ* and capped off, the entire cable network removed, or specific sections of the subsea cables could be removed.

8.136 With respect to cables, discussions would be held with stakeholders and regulators to determine the exact locations where offshore cables should be removed, or left *in situ* if considered appropriate, or where they may be wholly or partially removed. Where removal is undertaken, cables would potentially be pulled out of the seabed or exposed by jetting the seabed material. The decommissioning of the Project would be subject to a separate consent and would be fully compliant with legal and policy requirements at that time.

8.137 As per construction and operation and maintenance phases, the water quality sensitivity was considered to be **low**. Potential impacts on SSCs would be similar, or less, than those predicted during the construction phase and therefore the magnitude of impact was predicted to be **low**. This would give rise to a **minor adverse** effect, which is not significant in EIA terms.

8.6.3.2 Impact 2: Deterioration in water quality due to resuspension of sediment bound contaminants

8.138 As outlined in decommissioning Impact 1, there may be sediment disturbance, but this would be similar, or less, to that predicted for the construction phase. Overall, the predicted impact considering resuspension of sediment bound contaminants during decommissioning would be the same as that identified for the construction phase (Impact 5), i.e. **low** sensitivity of water quality and a **negligible** magnitude of impact, giving rise to an overall **negligible adverse** effect, which is not significant in EIA terms.

8.7 Cumulative effects

8.139 In order to undertake the CEA, and as per the PINS advice note (PINS, 2019), the potential for cumulative effects has been established considering each Project-alone impact (and the Zone of Influence (ZoI) of each impact) alongside the list of other plans, projects and activities that could potentially interact. These stages are detailed below.

8.7.1 Identification of potential cumulative effects

8.140 Part of the cumulative assessment process was the identification of which individual impacts assessed for the Project have the potential for a cumulative effect on receptors (impact screening). This information is set out in **Table 8.14**. Screening considered the ZoI of the impacts and the plans and projects identified in **Table 8.15** (presented in **Figure 8.6**). Impacts for which the significance of effect was assessed in the Project-alone assessment as ‘negligible’, or above, were considered in the CEA screening (i.e. only those assessed as ‘no change’ were not taken forward as there is no potential for them to contribute to a cumulative effect).

Table 8.14 Potential cumulative effects (impact screening)

Impact	'Project-alone' residual effect significance	Potential for cumulative effect	Rationale
Construction phase			
Impact 1: Increase in SSCs due to seabed preparation for foundation installation	Minor adverse	Yes	Increases in SSCs during the construction phase, although of low magnitude and temporary in nature, may have an interaction with sediment plumes from other activities and, hence, the significance of the impact may be affected.
Impact 2: Increase in SSCs due to drill arisings for foundation installation	Minor adverse	Yes	Increases in SSCs during the construction phase, although of low magnitude and temporary in nature, may have an interaction with sediment plumes from other activities and, hence, the significance of the impact may be affected.
Impact 3: Increase in SSCs associated with inter-array and platform link cable installation	Minor adverse	Yes	Increases in SSCs during the construction phase, although of low magnitude and temporary in nature, may have an interaction with sediment plumes from other activities and, hence, the significance of the impact may be affected.
Impact 4: Increase in SSCs associated with UXO clearance	Minor adverse	No	Increases in SCC are likely to be localised to the area of clearance and temporary.
Impact 5: Deterioration in water quality associated with release of sediment bound contamination	Negligible adverse	No	Sediment contaminant concentrations are so low at the windfarm site that significant loads are unlikely to be released into the water column. Site-specific surveys undertaken to inform the Transmission Assets PEIR also did not indicate significant concentrations are present either within the Morgan Offshore Wind Project Generation Assets array area or along the export cable corridor and as a result, cumulative effects are not predicted.

Impact	'Project-alone' residual effect significance	Potential for cumulative effect	Rationale
Operation and maintenance phase			
Impact 1: Increase in SSCs associated with cable repairs and reburial	Negligible adverse	Yes	Sediment disturbance is likely to be minimal, localised to the development and temporary, however there is the potential for sediment plumes created during maintenance activities to overlap (temporally and spatially) with other project/activities giving rise to significant sediment disturbance.
Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination	Negligible adverse	No	Sediment contaminant concentrations are so low at the windfarm site, and across the survey area, that significant loads are unlikely to be released into the water column.
Decommissioning phase			
Impact 1: Increases in SSCs associated with foundation removal and removal of parts of the cables	Minor adverse	Yes	Sediment disturbance is likely to be minimal, localised to the development and temporary, however there is the potential for sediment plumes created during decommissioning to overlap (temporally and spatially) with other projects/activities giving rise to significant sediment disturbance.
Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination	Negligible adverse	No	Sediment contaminant concentrations are so low at the windfarm site, and across the survey area, that significant loads are unlikely to be released into the water column.

8.7.2 Identification of other plans, projects and activities

8.141 The identification and review of the other plans, projects and activities that may result in cumulative effects for inclusion in the CEA (described as 'project screening') was undertaken alongside an understanding of Project-alone effects. For this chapter, a 30km screening distance was used to identify possible plans and projects as this distance encompassed the ZoI for all relevant impacts, as well as incremental changes over the wider area. This project screening information is set out in **Table 8.15**. This includes a consideration of the relevant details of each project, including current status (e.g. under construction), planned construction period, distance to the Project, status of available data, and rationale for including or excluding from the assessment.

8.142 All projects considered for CEA across all topics have been identified within **Appendix 6.1 CEA Project Long List** of **Chapter 6 EIA Methodology**, which forms an exhaustive list of plans, projects and activities relevant to the Project.

Table 8.15 Summary of projects considered for the CEA in relation to marine sediment and water quality

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Pre-application stage. PEIR published in October 2023.	2026 – 2029	0 (adjacent)	Y	Small potential for temporal overlap and some interaction between the dredging plumes from the export cable installation or other activities such as booster station installation.
Vodafone Lanis 1 telecom cable	Operational	N/A	0 (bisects the windfarm site)	Y	There is potential for some interaction between the sediment plumes arising from cable operation and maintenance activities given these cables overlap or are adjacent to the windfarm site. Existing cables and pipelines outside of the windfarm site are not considered, given the
EXA Atlantic (formerly GTT	Operational	N/A	0 (along the southern		

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Hibernia Atlantic) telecom cable			boundary of the windfarm site)		small scale and low frequency of any maintenance activities.
Carbon Capture Storage Area (CCSA) (EIS Area 1)	Licences awarded in 2023 (see Morecambe Net Zero Cluster Project below)	Unknown	0	Y	Licence area noted and awarded to Spirit Energy (the project considers repurposing the North and South Morecambe natural gas fields to create a carbon storage cluster). Exploration surveys are being undertaken (2024), however, project timescales are unknown and there are no specific details of associated offshore works. It is possible existing infrastructure would be used.
Morecambe Net Zero Cluster Project (carbon storage cluster)	Early planning				
South Morecambe DP3 (gas platform)	Decommissioned	N/A	0	N	Gas platform and jacket decommissioning activities completed in 2023 with no above ground infrastructure remaining.
Calder CA1 platform (and associated cables and pipelines)	Operational	N/A	0 (the associated cables and pipelines bisect the windfarm site, whilst the platform itself is located 0.9km to the west of the windfarm site)	Y	Limited activities at the platform anticipated to interact with marine sediment and water quality. Possible interaction with maintenance activities. Other existing oil and gas infrastructure located at a greater distance from the Project windfarm site are not considered cumulatively given the small scale and low frequency of any maintenance activities and uncertainty around potential decommissioning timeframes.
South Morecambe CPP1 (and surrounding South	Operational	N/A	1.6	Y	

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Morecambe platforms)					
Gateway Gas Storage Project	On hold	N/A	4.1	Y	Project noted, however there is insufficient information available as the project has been on hold since 2010.
Isle of Man Interconnector	Operational	N/A	4.6	Y	Licence for maintenance works to repair/replace cable protection. Programme unknown.
South Morecambe DP4 (gas platform)	Decommissioned	N/A	5.1	N	As per South Morecambe DP3.
Carbon Capture Storage Licence (CS004)	Licensed in 2020	Unknown	7.5	Y	Licence area linked to the HyNet North West project. Applications for the HyNet Carbon Dioxide pipeline and HyNet North West Hydrogen Pipeline projects encompass onshore works only and there are no specific details of associated offshore works, however it is possible existing infrastructure would be used.
Liverpool Bay aggregate production area (Area 457)	Open	N/A	9.7	Y	There is potential for some interaction between the dredging plumes from the aggregate exploration and option areas and sediment plumes from cable/foundation installation/decommissioning and operation and maintenance activities from the Project.

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Mona Offshore Wind Project	Pre-application stage. PEIR published in 2023	2026 - 2029	10.0	Y	Potential for temporal overlap and some interaction between the dredging plumes from the cable/foundation installation as well as additive effects from infrastructure.
West of Duddon Sands Offshore Windfarm	Operational	N/A	12.9	Y	Fully commissioned, operational OWFs would only be subject to small scale operational and maintenance activities; however, there may potentially result in interaction of suspended sediment plumes.
Morgan Offshore Wind Project Generation Assets	Pre-application stage. PEIR published in 2023	2026 - 2029	16.7	Y	As per Mona Offshore Wind Project.
Site Y Disposal Area	Open	N/A	16.8	Y	There is potential for some interaction between the sediment disposal plumes of the disposal area and plumes from cable/foundation installation/decommissioning and operation and maintenance activities for the Project.
Walney Extensions Offshore Windfarms	Operational	N/A	18.8	Y	As per West of Duddon Sands Offshore Windfarm.
Walney 1 Offshore Windfarm	Operational	N/A	20.3		
Barrow Offshore Windfarm	Operational	N/A	21.0		

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Walney 2 Offshore Windfarm	Operational	N/A	22.7		
IS205 Barrow D Disposal Area	Open	N/A	22.7	Y	As per Site Y Disposal Area.
Size Z Disposal Area	Open	N/A	23.9		
Liverpool Bay aggregate exploration and option area (Area 1801)	Open	N/A	25.7	Y	As per Liverpool Bay aggregate production area (Area 457).
Ormonde Offshore Windfarm	Operational	N/A	27.0	Y	As per West of Duddon Sands Offshore Windfarm.
AyM Offshore Wind Farm	Consent granted 2023.	2027 – 2030	28.9	Y	As per Mona Offshore Wind Project.
Gwynt y Môr Offshore Windfarm	Operational	N/A	28.9	Y	As per West of Duddon Sands Offshore Windfarm.
Hilbre Swash Aggregate Production Area	Open	N/A	29.0	Y	As per Liverpool Bay aggregate production area (Area 457).
Burbo Bank Extension	Operational	N/A	29.1	Y	As per West of Duddon Sands Offshore Windfarm.

Project	Status	Construction period	Closest distance from the Project (km)	Screened into CEA (Y/N)	Rationale
Offshore Windfarm					
Morecambe Bay: Lune Deep Disposal Area	Open	N/A	30.1	Y	As per Site Y Disposal Area.

8.7.3 Assessment of cumulative effects

8.143 Having established the residual effects from the Project with the potential for a cumulative effect, along with the other relevant plans, projects and activities, the following sections provide an assessment of the level of cumulative effect that may arise. These are detailed below per impact where the potential for cumulative effects has been identified (in line with **Table 8.14**).

8.144 Given the interconnected nature of the Project and the Transmission Assets, a separate 'combined' assessment of these is provided within the CEA (**Section 8.7.3.1**), Thereafter, the cumulative assessment considers all plans, projects and activities screened into the CEA (**Section 8.7.3.2**).

8.7.3.1 Cumulative assessment – the Project and Transmission Assets (combined assessment)

8.145 While the Transmission Assets[7] are considered in a separate ES as part of a separate DCO application (combined with the Morgan Offshore Wind Project transmission assets), given the functional link, a combined assessment has been made considering both the Project and the Transmission Assets. This provides an assessment of impact interactions and additive effects and thus any change in the significance of effects as assessed separately.

8.146 The Transmission Assets PEIR (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023) informs the assessment. The assessment was undertaken in reference to the baseline presented in **Section 8.5,** which includes sediment and water quality sampling across the Project and Transmission Assets boundaries.

8.147 Only the marine elements of the Transmission Assets would interact with the Project in relation to marine sediment and water quality, including:

- Export cables adjoining the Morgan Offshore Wind Project Generation Assets and the Project and making landfall south of Blackpool
- Booster station required for the Morgan Offshore Wind Project Generation Assets
- OSP(s) (for the Project and Morgan Offshore Wind Project)

8.148 The impacts assessed for the Project align with those assessed for the Transmission Assets (namely increased SSCs and remobilisation of

[7] As the Transmission Assets includes infrastructure associated with both the Project and the Morgan Offshore Wind Project Generation Assets, it should be noted that the combined assessment considers the transmission infrastructure for both the Project and the Morgan Offshore Wind Project Generation Assets (and includes all infrastructure as described in the Transmission Assets PEIR).

contaminated sediments). These are detailed below in the combined assessment.

Construction phase

8.149 The following (project-alone) impacts were concluded in the Transmission Assets PEIR (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023) during the construction phase:

- Increase in SSCs due to construction related activities - **negligible/minor adverse** effect (not significant in EIA terms)
- Increase in chemical concentrations of parameters in the water associated with increases in SSCs – **negligible/minor adverse** effect (not significant in EIA terms)

8.150 As set out in **Table 8.14**, deterioration in water quality associated with release of sediment bound contamination was screened out of the CEA due to the low sediment contaminant concentrations at the windfarm site, and across the survey area. Consideration of potential cumulative effects of increased SSCs due to construction activities are however considered below.

8.151 A detailed description of the potential combined effect of increased SSCs associated with construction activities is outlined in Section 7.7.3.1 of **Chapter 7 Marine Geology, Oceanography and Physical Processes**.

8.152 While there is potential for sediment plumes of the projects to partially overlap during construction activities, given the limited spatial extent, rate of dispersal and the temporary and transient nature of these impacts, cumulative effects are not considered to be beyond the Project-alone assessment.

Operation and maintenance

8.153 The following (project-alone) impacts were concluded in the Transmission Assets (Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Ltd, 2023) during the operation and maintenance phase:

- Increase in SSCs due to operation and maintenance related activities - **negligible adverse** effect (not significant in EIA terms)
- Increase in chemical concentrations of parameters in the water associated with increases in SSCs – **negligible/minor adverse** effect (not significant in EIA terms)

8.154 Only the impacts screened in for potential cumulative effects (**Table 8.14**) are considered below.

8.155 Suspended sediment plumes arising during the operation and maintenance phase for both the Project and the Transmission Assets (cable repairs/reburial) would be intermittent and on a much smaller scale than those arising during the construction phase. The potential for cumulative effects is therefore significantly reduced and not considered to be beyond the Project-alone assessment.

8.156 With respect to contaminant concentrations, and as identified in **Table 8.14**, cumulative effects are not identified given the low levels of contaminants across the windfarm site. Site-specific surveys undertaken to inform the Transmission Assets PEIR also did not indicate significant concentrations are present either within the windfarm arrays or transmission corridor and as a result, cumulative effects are not predicted.

Decommissioning

8.157 Decommissioning activities would be similar to those of construction and are therefore not considered to be above the effects assessed for the Project-alone.

Summary

8.158 Key interactions and additive effects between the Project and the Transmission Assets have been considered, with no identification of effects on water quality that would result in impacts of greater significance than the Project-alone assessment (**negligible** to **minor adverse**). A summary is provided in **Table 8.16** considering all residual effects from the Project and Transmission Assets.

Table 8.16 Summary of impacts from the Project and Transmission Assets alone and combined (note: wording of impacts has been summarised to encompass both projects)

Impact	Transmission Assets significance of effect	Project-alone significance of effect	Combined assessment
Construction/decommissioning phases			
Increase in SSCs due to construction related activities	Negligible/Minor adverse	Minor adverse	While additive in nature across the study area, the significance of these impacts is not considered to be elevated beyond individually assessed in terms of EIA significance.
Increase in chemical concentrations of parameters in the water associated with increases in SSCs	Negligible/Minor adverse	Negligible adverse	Given the low levels of contaminants across both projects, cumulative effects are not predicted.
Operation and maintenance phase			
Increase in SSCs due to operation and maintenance related activities	Negligible adverse	Negligible adverse	While additive in nature across the study area, the significance of these impacts is not considered to be elevated beyond individually assessed in terms of EIA significance.
Increase in chemical concentrations of parameters in the water associated with increases in SSCs	Negligible/Minor adverse	Negligible adverse	Given the low levels of contaminants across both projects, cumulative effects are not predicted.

8.7.3.2 Cumulative assessment – All plans and projects

8.159 Based on both the impacts (**Table 8.14**) and plans and projects (**Table 8.15**) identified, where required, a detailed cumulative assessment was undertaken considering all relevant information from the Project and other plans and projects (including the Transmission Assets).

Cumulative impacts with offshore windfarms in the Eastern Irish Sea

8.160 Offshore windfarm projects with construction phases that have the potential to interact with the Project are Morgan and Morecambe Offshore Wind Farms: Transmission Assets; Morgan Offshore Wind Project Generation Assets; Mona Offshore Wind Project; and AyM Offshore Wind Farm.

8.161 Morgan Offshore Wind Project Generation Assets is located approximately 16.7km to the north-west (**Figure 8.6**) of the Project and AyM Offshore Wind Farm is located approximately 28.9km south of the Project. Given the spring tidal ellipses of approximately 10km in an east-west orientation (**Figure 8.1**), any suspended sediment plumes arising from construction phase activities for the Project are not anticipated to coalesce with the suspended sediment plumes arising from Morgan Offshore Wind Project Generation Assets or AyM Offshore Wind Farm (**Figure 8.7**). Therefore, they have not been assessed further[8].

8.162 Mona Offshore Wind Project has a provisional maximum number of 107 WTGs, four OSPs and an offshore export cable route of 360km connecting the project to the North Wales coastline (Mona Offshore Wind Limited, 2023b). The Transmission Assets offshore encompasses both the export cables for the Morgan Offshore Wind Project Generation Assets and Morecambe Offshore Windfarm, and an offshore booster station. Impacts identified by these projects are similar in nature to those identified by the Project, and the resulting Project-alone effects on receptors identified for physical processes for all projects are assessed to be not significant in EIA terms (see Section 7.7.3.2 of **Chapter 7 Marine Geology, Oceanography and Physical Processes**).

8.163 Mona Offshore Wind Project is located approximately 10.0km west of the Project (however the export cable route is approximately 25km south from the Project) and the Transmission Assets are adjacent to the Project. If the construction programmes of the projects overlap, it is possible that their sediment plumes could coalesce. As shown in **Figure 8.7**, there is potential for a slight overlap in suspended sediment plumes from Mona Offshore Wind Project and the Transmission Assets with the Project (with no potential for

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[8] The offshore export cables for the Morgan Offshore Wind Project Generation Assets are assessed under the Transmission Assets.

interaction with suspended sediment plumes from the Mona offshore export cable route). Given that suspended sediments would be advected on the same tide, any overlap in suspended sediments would be minimal and the majority of sedimentation would occur in close proximity to each activity.

8.164 All effects are local and minor in comparison with the large processes driving tidal currents, waves and sediment transport. While there is potential for sediment plumes to partially overlap during construction activities, given the limited spatial extent, rate of dispersal and the temporary and transient nature of these impacts, cumulative effects to water quality would result in impacts of no greater significance than the Project-alone (**minor adverse** and not significant in EIA terms).

8.165 Increases in SSCs caused by maintenance activities over the operational lifespan of the projects would be minimal and considerably less than during construction. Most of the suspended sediment arising from each maintenance activity would fall rapidly to the seabed after the start of works and would not travel further than one spring tidal excursion (approximately 10km). Given the separation of the projects, and that impacts are local in spatial extent during maintenance activities, no cumulative effects to water quality above Project-alone (**negligible adverse** and not significant in EIA terms) are anticipated with the Transmission Assets, Mona Offshore Wind Project or operational projects in the study area. Any additive effects from the presence of physical infrastructure associated with other offshore windfarms and the Project are localised and minor in comparison with the large-scale processes driving sediment transport. As such cumulative effects would result in impacts of no greater significance than assessed for the Project-alone (**negligible adverse** and not significant in EIA terms).

8.166 Decommissioning activities would be similar to that of construction and are therefore not considered to be above the Project-alone effects (**minor adverse** and not significant in EIA terms).

Cumulative impacts with maintenance activities for cables and pipelines

8.167 The Lanis 1 telecom cable, EXA Atlantic cable, Calder CA1 platform (and associated pipelines and cables) and South Morecambe platforms overlap or are in the vicinity of the Project windfarm site. The Isle of Man Interconnector is located 4.6km to the north of the Project windfarm site.

8.168 **Figure 8.1** shows the likely maximum ZoI arising from the proposed Project on the tidal regime. Given that the ZoI extends a maximum distance of 10km from the Project windfarm site (in a west-east orientation), there is a potential cumulative impact with maintenance activities for both cables as their ZoIs could overlap.

8.169 Maintenance activities for the cable/pipeline projects could include inspections, upkeep, repairs, adjustments, alterations, removals, reconstruction, and replacement. Increases in SSCs during these activities would be minimal and considerably less than those generated during installation of the projects.

8.170 Increases in SSCs arising during operation and maintenance activities for the Project would be minimal compared to construction related SSCs, whilst decommissioning would be comparable or less than the construction phase. As such, cumulative effects would result in impacts of no greater significance than assessed for the Project-alone (**minor adverse** to **negligible adverse** and not significant in EIA terms).

Cumulative impacts with marine aggregate dredging

8.171 The southern margin of the Project windfarm site is approximately 9.7km from the Liverpool Bay aggregate production area, 25.7km from Liverpool Bay exploration option area and 29.0km from Hilbre Swash aggregate production area.

8.172 The Hilbre Swash aggregate area has been in operation for over 50 years and is currently licenced to Lafarge Tarmac Marine Ltd and Norwest Sand & Ballast Company Ltd. The target material of the aggregate area is sand and the area is said to be composed of relatively few fines (less than 5%). Dredging activities at this area are restricted to anchor or TSHD methods and the dredge amount is restricted to 0.8 million tonnes per year (NRW, 2013).

8.173 The Liverpool Bay aggregate extraction area has been active since 1959 and is currently licenced to Westminster Gravels Ltd (Marinet, undated). The current licence permits the extraction of 1.2 million tonnes per year from 2008 to 2023. Licence renewal is expected to be supported by an application in 2024 to extend the licence for a further 15 years (with a scoping report submitted to the MMO in 2023). The target material is also sand.

8.174 Based on the Project-alone assessment, seabed preparation for GBS foundations (**Table 8.2**) would result in the greatest amount of sediment released into the water column. However, as assessed in **Section 8.6.1**, sediment present at the windfarm site would be subject to rapid dispersion and dilution. The maximum area over which effects on SSC are likely to occur would be up to one tidal excursion along the flood/ebb tidal axis (which is approximately 10km at the Project windfarm site).

8.175 Plume modelling undertaken at analogous aggregate extraction sites by HR Wallingford (2011) show that SSC in excess of tens of mg/l would be restricted to within approximately 2km of the aggregate dredging boundary. Given the distance of Liverpool Bay and Hilbre Swash aggregate dredging sites from the Project, and the alignment of the tidal axis in a west-east orientation, it is considered unlikely that sediment plumes from installation activities at the Project windfarm site and aggregate dredging activities would coalesce. No cumulative effects to water quality above Project-alone (**minor adverse** and not significant in EIA terms) are anticipated.

8.176 Increases in SSCs arising during operational maintenance activities associated with the Project would be minimal compared to construction related increases in SSCs, and therefore cumulative effects are not considered to be above the Project-alone effects.

8.177 Increases in SSCs during decommissioning would be comparable to, or less than, those identified for the construction phase. Therefore, no cumulative effects above Project-alone (**minor adverse** and not significant in EIA terms) are anticipated.

Cumulative impacts with disposal sites

8.178 Given that all disposal areas are located over 15km from the Project (and that one spring tidal excursion is approximately 10km; **Figure 8.1**), it is unlikely that sediment plumes arising from Project construction activity and disposal areas would coalesce. Cumulative effects on water quality would therefore result in impacts of no greater significance than assessed for the Project-alone (**minor adverse** and not significant in EIA terms).

8.179 Increased SSCs caused by maintenance activities over the operational lifespan of the Project would be minimal and considerably less than during construction. The majority of SSCs arising from each maintenance activity would fall rapidly to the seabed after the start of construction and would not travel further than one spring tidal excursion (approximately 10km). Therefore, cumulative effects would result in impacts of no greater significance than assessed for the Project-alone (**negligible adverse** and not significant in EIA terms).

8.180 Increased SSCs during decommissioning activities would be comparable to or less than those identified for the construction phase. Therefore, cumulative effects would result in impacts of no greater significance than assessed for the Project-alone (**minor adverse** and not significant in EIA terms).

Cumulative impacts with carbon capture storage sites

8.181 The CCSA (EIS Area 1) and the Morecambe Net Zero Cluster Project overlap with the Project windfarm site, while the Carbon Capture Storage Licence (CS004) is located 7.5km south/southeast of the Project windfarm site. It is not clear what infrastructure would be required for the CCSA (EIS Area 1) or the Morecambe Net Zero Cluster Project, however this could include well workovers, retrofitting/reconditioning of pipelines or possibly the installation of new infrastructure.

8.182 Given that the CCSA (EIS Area 1) and the Morecambe Net Zero Cluster Project overlaps the Project, there is a potential cumulative effect with construction related activities (should their construction periods overlap). In this case, there would be an increase in SSCs where sediment plumes overlap, however the plumes would be advected in the same tidal axis for approximately 10km from the point of activity.

8.183 It is unlikely that any operational maintenance activities for the CCSA (EIS Area 1) or Morecambe Net Zero Cluster Project would be undertaken at the same time as maintenance activities for the Project. Any increases in SSCs during these activities would be minimal and considerably less than those generated during the construction phase. Most of the suspended sediments arising from each maintenance activity would fall rapidly to the seabed after the start of works and would not travel further than one spring tidal excursion (approximately 10km). Although there is a potential overlap of sediment plumes between these activities and the sediment plumes created during construction of the Project, the SSCs and sedimentation on the outer edges of the plume (10km) would be minimal. Increases in SSCs during decommissioning would be comparable to or less than those identified for the construction phase.

8.184 Considering the above, cumulative effects would result in impacts of no greater significance than those assessed for the Project-alone for the construction, operation or decommissioning phase (**negligible** to **minor adverse** and not significant in EIA terms).

8.7.3.3 Summary

8.185 In summary, considering all plans and projects, given the spatial distribution of other plans and projects and the temporary and transient nature of increased suspended sediments, no cumulative effects on water quality beyond Project-alone are identified (**negligible** to **minor adverse** and not significant in EIA terms).

8.8 Transboundary effects

8.186 Transboundary effects were scoped out of the EIA (as outlined in **Section 8.4.5**).

8.9 Inter-relationships

8.187 There are clear inter-relationships between the marine sediment and water quality topic and several other topics that have been considered within this ES. **Table 8.17** provides a summary of the principal inter-relationships and sign-posts to where those issues have been addressed in the relevant chapters.

8.188 This chapter is also closely informed by **Chapter 7 Marine Geology, Oceanography and Physical Processes** which identifies, for example, the ZoI over which suspended sediment would travel as a result of Project activities.

Table 8.17 Marine sediment and water quality inter-relationships

Topic and description	Related chapter	Where addressed in this chapter	Rationale
Construction phase			
Impacts 1, 2, 3 and 4 - Increase in SSCs/concentrations of contaminants	**Chapter 9 Benthic Ecology** **Chapter 10 Fish and Shellfish Ecology** **Chapter 11 Marine Mammals** **Chapter 12 Offshore Ornithology** **Chapter 13 Commercial Fisheries** **Chapter 19 Human Health**	**Section 8.6** and **Section 8.7** – assessment is used to inform other chapters	Suspended sediment could be contaminated and could cause disturbance to fish and benthic species through smothering and indirect effects to marine mammals and birds. Effects to human health due to changes in water quality have also been considered.
Operation and maintenance phase			
Impacts 1 and 2: Increase in SSCs/concentrations of contaminants	**Chapter 9 Benthic Ecology** **Chapter 10 Fish and Shellfish Ecology** **Chapter 11 Marine Mammals** **Chapter 12 Offshore Ornithology**	**Section 8.6** and **Section 8.7** – assessment is used to inform other chapters	Suspended sediment could be contaminated and could cause disturbance to fish and benthic species through smothering and indirect effects to marine mammals and birds. Effects to human health due to changes in water quality have also been considered.

Topic and description	Related chapter	Where addressed in this chapter	Rationale
	Chapter 13 Commercial Fisheries **Chapter 19 Human Health**		
Decommissioning phase			
Impacts 1 and 2: Increase in SSCs/concentrations of contaminants	Inter-relationships for impacts during the decommissioning phase would be the same as those outlined above for the construction phase.		

8.10 Interactions

8.189 The impacts identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between impacts are presented in **Table 8.18**, **Table 8.19** and **Table 8.20**. This provides a screening tool for which impacts have the potential to interact. The impacts have been assessed relative to each development phase (i.e., construction, operation and maintenance or decommissioning) to see if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor.

8.190 Following this, a lifetime assessment has been undertaken, which considers the impact interactions identified as well as effects on receptors relevant across all development phases (**Table 8.21**).

Table 8.18 Interaction between impacts – screening (construction phase)

	Potential interaction between construction phase impacts				
	Impact 1: Increase in SSCs due to seabed preparation for foundation installation	Impact 2: Increase in SSCs due to drill arisings for foundation installation	Impact 3: Increase in SSCs associated with inter-array and platform link cable installation	Impact 4: Increase in SSCs associated with UXO clearance	Impact 5: Deterioration in water quality associated with release of sediment bound contamination
Impact 1: Increase in SSCs due to seabed preparation for foundation installation		No	No	Yes	Yes
Impact 2: Increase in SSCs due to drill arisings for foundation installation	No		No	Yes	Yes
Impact 3: Increase in SSCs associated with inter-array and platform link cable installation	No	No		Yes	Yes
Impact 4: Increase in SSCs associated with UXO clearance	Yes	Yes	Yes		Yes
Impact 5: Deterioration in water quality associated with	Yes	Yes	Yes	Yes	

			Potential interaction between construction phase impacts		
release of sediment bound contamination					

Table 8.19 Interaction between impacts – screening (operation and maintenance phase)

	Potential interaction between operation and maintenance phase impacts	
	Impact 1: Increase in SSCs associated with cable repairs and reburial	Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination
Impact 1: Increase in SSCs associated with cable repairs and reburial		Yes
Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination	Yes	

Table 8.20 Interaction between impacts – screening (decommissioning phase)

	Potential interaction between decommissioning phase impacts	
	Impact 1: Increase in SSCs associated with decommissioning (foundation removal and removal of parts of the cables)	Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination
Impact 1: Increase in SSCs associated with decommissioning (foundation removal and removal of parts of the cables)		Yes
Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination	Yes	

Table 8.21 Interaction between impacts – phase and lifetime assessment

Receptor	Highest significance of effect level				
	Construction	**Operation & maintenance**	**Decommissioning**	**Phase assessment**	**Lifetime assessment**
Water Quality	Minor adverse	Negligible	Negligible	**No greater than individually assessed impact for each phase**. The impacts are considered to have a negligible adverse effect on the receptor. Given that each impact is localised, it is considered that effects would not, when considered together, result in appreciably greater impact than assessed individually.	**No greater than individually assessed impact.** As with the phase assessment, all potential impacts are non-significant and localised in nature, limiting the potential for different impacts to interact within and across the different phases.

8.11 Potential monitoring requirements

8.191 Monitoring requirements are described in the In-Principle Monitoring Plan (IPMP) (Document Reference 6.4), included alongside the DCO Application. The IPMP would be further developed and agreed with stakeholders prior to construction, based on the IPMP and taking account of the final detailed design of the Project.

8.192 Contaminant analysis of samples collected from the seabed within the Project windfarm site indicate very low levels of contaminants. No further monitoring is proposed in relation to marine water and sediment quality given that all of the potential impacts considered would result in either negligible or, at worse, minor adverse effects on water quality. The conclusions can be made with a high degree of certainty, due to the accumulation of evidence from a range of studies and other existing windfarms (details in Section 7.4.2 of **Chapter 7 Marine Geology, Oceanography and Physical Processes**), including comparable modelling from three other windfarm projects within the study area.

8.12 Assessment summary

8.193 This chapter has provided a characterisation of the existing environment for marine water and sediment quality based on both existing and site-specific survey data. The assessment has established that the impacts on water quality during the construction, operation and decommissioning phases of the Project are '**minor adverse**' or '**negligible adverse**', which is not significant in EIA terms.

8.194 This chapter also assessed the level of change to water quality that act as a pathway to impact other receptors. As such, this chapter has been used to inform other chapters of the ES.

8.195 A summary of the assessment is presented in **Table 8.22**.

Table 8.22 Summary of potential impacts on marine sediment and water quality receptors

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
Construction phase							
Impact 1: Increase in SSCs due to seabed preparation for foundation installation	Water quality	Low	Low	Not Significant (Minor adverse)	N/A	Not Significant (Minor adverse)	As per Project-alone impact
Impact 2: Increase in SSCs due to drill arisings for foundation installation	Water quality	Low	Low	Not Significant (Minor adverse)	N/A	Not Significant (Minor adverse)	As per Project-alone impact
Impact 3: Increase in SSCs associated with inter-array and platform link cable installation	Water quality	Low	Low	Not Significant (Minor adverse)	N/A	Not Significant (Minor adverse)	As per Project-alone impact
Impact 4: Increase in SSCs associated with UXO clearance	Water quality	Low	Low	Not Significant (Minor adverse)	N/A	Not Significant (Minor adverse)	As per Project-alone impact
Impact 5: Deterioration in water quality associated with release of sediment bound contamination	Water quality	Low	Negligible	Not Significant (Negligible adverse)	N/A	Not Significant (Negligible adverse)	As per Project-alone impact

Potential impact	Receptor	Sensitivity	Magnitude	Significance of effect	Additional mitigation measures proposed	Residual effect	Cumulative residual effect
Operation and maintenance phase							
Impact 1: Increase in SSCs associated with cable repairs and reburial activities	Water quality	Low	Negligible	Not Significant (Negligible adverse)	N/A	Not Significant (Negligible adverse)	As per Project-alone impact
Impact 2: Deterioration in water quality due to resuspension of sediment bound contamination	Water quality	Low	Negligible	Not Significant (Negligible adverse)	N/A	Not Significant (Negligible adverse)	As per Project-alone impact
Decommissioning phase							
Impact 1: Increases in SSCs associated with decommissioning (foundation removal and removal of parts of the cables)	Water quality	Low	Low	Not Significant (Minor adverse)	N/A	Not Significant (Minor adverse)	As per Project-alone impact
Impact 2: Deterioration in water quality due to resuspension of sediment bound contaminants	Water quality	Low	Negligible	Not Significant (Negligible adverse)	N/A	Not Significant (Negligible adverse)	As per Project-alone impact

8.13 References

AyM Offshore Wind Farm Ltd. (2022a). Awel y Môr Offshore Wind Farm Category 6: Environmental Statement Volume 2, Chapter 3: Marine Water and Sediment Quality

AyM Offshore Wind Farm Ltd. (2022b). Awel y Môr Offshore Wind Farm: Category 6: Environmental Statement, Volume 4, Annex 2.3: Physical Processes Modelling Results.

BGS (2015). Geology of the seabed and shallow subsurface: The Irish Sea. Available online at: http://nora.nerc.ac.uk/id/eprint/512352/1/BGS_Report_Irish_Sea_Geology_CR-15-057N.pdf (Accessed December 2023)

Cefas (2001). Contaminant Status of the North Sea. Technical report produced for Strategic Environmental Assessment – SEA2 Available online at Microsoft Word - TR_004.doc (publishing.service.gov.uk)

Cefas (2005) Management of persistence, bioconcentration and toxicity of chemicals used by the UK offshore oil and gas industry.

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

DESNZ (2023a). Overarching National Policy Statement for Energy (EN-1). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015233/en-1-draft-for-consultation.pdf. (Accessed January 2024)

DESNZ (2023b). National Policy Statement for Renewable Energy Infrastructure (EN 3) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015236/en-3-draft-for-consultation.pdf (Accessed January 2024)

Dong Walney (UK) Ltd (2006). Walney Offshore Windfarm Environmental Statement

Dong Energy (2013). Walney Extension Offshore Wind Farm, Environmental Statement.

Environment Agency (2017). Clearing the Waters for All. Available online at: Water Framework Directive assessment: estuarine and coastal waters - GOV.UK (www.gov.uk)

Gwynt y Môr Offshore Wind Farm Limited (2005). Gwynt y Môr Offshore Wind Farm Environmental Statement

HM Government (2011). Marine Policy Statement. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf (Accessed October 2023)

HM Government (2021). North West Offshore Marine Plan. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1004490/FINAL_North_West_Marine_Plan__1_.pdf (Accessed January 2024) (Accessed October 2023)

HR Wallingford (2011). Plume dispersion arising from aggregate dredging by large trailing suction hopper dredgers. Report no.EX6437

MMO (2015). High Level Review of Current UK Action Level Guidance MMO Project No: 1053. Available online at: High_level_review_of_current_UK_action_level_guidance_report__1053_.pdf (publishing.service.gov.uk) (Accessed January 2024)

MMO (2023). Response to technical note: Approach to Marine Geology, Oceanography and Physical Processes, and the Marine Sediment and Water Quality Assessment (DCO/2022/00001)

MMT (2022). Morecambe Offshore Windfarm: Offshore Geophysical Survey – Irish Sea (October – December 2021).

Mona Offshore Wind Limited (2023a). Mona Offshore Wind Project: Preliminary Environmental Information Report. Volume 6, annex 7.1: Benthic subtidal and intertidal ecology technical report

Mona Offshore Wind Limited (2023b). Mona Offshore Wind Project: Preliminary Environmental Information Report. Volume 6, annex 6.1: Physical processes technical report.

Morecambe Offshore Windfarm Limited (2022). Scoping Report: Morecambe Offshore Windfarm. Generation Assets. Available online at: https://infrastructure.planninginspectorate.gov.uk/projects/north-west/morecambe-offshore-windfarm/?ipcsection=docs (Accessed January 2024)

Morgan Offshore Wind Limited (2023a). Morgan Offshore Wind Project: Preliminary Environmental Information Report. Volume 4, annex 7.1: Benthic subtidal ecology technical report

Morgan Offshore Wind Limited (2023b). Morgan Offshore Wind Project: Preliminary Environmental Information Report. Volume 6, annex 6.1: Physical processes technical report.

Morgan Offshore Wind Limited and Morecambe Offshore Windfarm Limited (2022). Morgan and Morecambe Offshore Wind Farms: Transmission Assets. October 2022.

Natural England (2023). Physical processes technical note Natural England response. Discretionary Advice Service (DAS/UDS-A001761/364191). September 2023.

NRW (2013). Marine aggregate extraction Area 392/393, known as Hilbre Swash

Ocean Ecology Limited (2022). Morecambe Offshore Wind Farm Benthic Characterisation Survey Technical Report 2022. Ref: OEL_FLOMOR0222_SYR

Ørsted (2012). Walney Extension Offshore Wind Farm Environmental Statement.

OSPAR (2010). Quality Status Report. Available online at The Quality Status Report 2010 Available online at: The Quality Status Report 2010 (ospar.org) (Accessed December 2023)

OSPAR (2017). Intermediate Assessment Quality Status Report. Available online at: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/ (Accessed January 2024)

PINS (2018). Advice Note Nine: Rochdale Envelope.

PINS (2019). Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects.