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MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Environmental Statement

Volume 2, Chapter 1: Physical processes

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Glossary

Term	Meaning
Bathymetry	The measurement of depth of water in oceans, seas, or lakes.
Barchan Dunes	Crescent shaped sand feature.
Ebb tide	The tidal phase during which the water level is falling.
Erosion	Depletion of sediment in the intertidal region.
Fetch	Length in the wind direction of the marine area where water waves are generated by wind.
Flood tide	The tidal phase during which the water level is rising.
Intertidal zone	An area of a shoreline that is covered at high tide and uncovered at low tide.
Lee	Shelter from tidal currents, wind or weather given by an object.
Littoral currents	Flow derived from tide and wave climate.
Mean High Water	The highest water level reached during and average tide.
Mean High Water Spring	The most inshore level location reached by the sea at high tide during mean high water spring tide. This is defined as the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest.
Mean Sea Level	The average tidal height over a long period of time.
Metocean	Refers to the syllabic abbreviation of meteorology and (physical) oceanography.
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 Offshore Substation Platforms (OSPs), interconnector cables, Morgan offshore booster station, offshore export cables, landfall site, onshore export cables, onshore substations, 400kV grid connection cables and associated grid connection infrastructure such as circuit breaker infrastructure (as defined in the Morgan and Morecambe Offshore Wind Farms: Transmission Assets PEIR).
Morgan Offshore Wind Project	The Morgan Offshore Wind Project is comprised of both the generation assets and offshore and onshore transmission assets and associated activities.
Neap tide	Tide that occurs when the sun and moon are at right angles to each other and the gravitational pull of the sun partially cancels out the pull of the moon on the ocean.
Residual current	The net flow over the course of the tidal cycle. This is effectively the driving force of the sediment transport.
Sandwave	A lower regime sedimentary structure that forms across from tidal currents.
Scour protection	Measures to prevent loss of seabed sediment around any structure placed in or on the seabed (e.g. by use of protective aprons, mattresses, rock and gravel placement).
Sedimentation	The process of settling or being deposited as a sediment.
Significant wave height	Mean wave height (trough to crest) of the highest third of the waves.

Term	Meaning
Slack tide	Tidal phase at which the current turns from flood to ebb (high-water slack tide) or from ebb to flood (low-water slack tide).
Spring tide	Tide that occurs when the sun and moon are directly in line with the Earth and their gravitational pulls on the ocean reinforce each other.
Suspended Particulate Matter	Particles that are suspended in the water column.
Turbidity	The quality of being cloudy, opaque, or thick with suspended matter.
Wave height	The distance from trough to crest of a wave.

Acronyms

Acronym	Description
2D UHRS	2D Ultra High Resolution Seismic
BEIS	Department for Business, Energy & Industrial Strategy
BGS	British Geological Survey
BODC	British Oceanographic Data Centre
CEA	Cumulative Effect Assessment
Cefas	Centre for Environment Fisheries and Aquaculture Science
COWRIE	Collaborative Offshore Wind Energy Research into the Environment
CMS	Construction Method Statement
CSIP	Cable Specification and Installation Plan
DCO	Development Consent Order
DECC	Department of the Environment, Climate and Communications
DEFRA	Department for Environment Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
DML	Deemed Marine Licence
DSV	Digital Sound Velocity
ECMWF	European Centre for Medium-range Weather Forecast
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
EWG	Expert Working Groups
Hmax	The largest wave height recorded
HRA	Habitats Regulations Assessment
ISAA	Information to Support the Appropriate Assessment
JNCC	Joint Nature Conservation Committee
MBES	Multi-Beam Echo Sounder

Acronym	Description
MCA	Maritime Coastguard Agency
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MEDIN	Marine Environmental Data Information Network
MHWS	Mean High Water Springs
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSL	Mean Sea Level
NIS	Natura Impact Statement
NOAA	National Oceanic and Atmospheric Administration
NRW	Natural Resources Wales
OSP	Offshore Substation Platforms
PSA	Particle Size Analysis
PEIR	Preliminary Environmental Information Report
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiler
SCI	Sites of Community Importance
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Areas
SPM	Suspended Particulate Matter
SSC	Suspended sediment concentrations
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded ordnances
ZoI	Zone of Influence

Units

Unit	Description
º	Degrees (angle from true north)
%	Percentage
cm	Centimetres (distance)
cm/s	Centimetres per second (speed)
km	Kilometres (distance)
km^2	Square kilometres (distance)
m	Metres (distance)
m^2	Square metres (area)
m^3	Cubic metres (volume)
m^3/d	Cubic metres per day (flow)
m^3/h	Cubic metres per hour (discharge rate)
mg/l	Milligrams per litre (concentration)
mm	Millimetres (distance)
m/h	Metres per hour (rate)
m/s	Metres per second (speed)
m^3/h/m	Cubic metres per hour per metre perpendicular to direction of transport (total load)
m^3/s/m	Cubic metres per second per metre perpendicular to direction of transport (total load)
nm	Nautical mile (distance)
MW	Megawatt (power)
PSU	Practical Salinity Unit equivalent to ‰

1 Physical processes

1.1 Introduction

1.1.1 Overview

1.1.1.1 This chapter of the Environmental Statement presents the assessment of the potential impact of the Morgan Offshore Wind Project Generation Assets (hereafter referred to as the Morgan Generation Assets) on physical processes. Specifically, this chapter considers the potential impact of the Morgan Generation Assets seaward of Mean High Water Springs (MHWS) during the construction, operations and maintenance, and decommissioning phases.

1.1.1.2 The assessment presented also informs and is informed by the following technical chapters and reports:

- Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement
- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 4: Marine mammals of the Environmental Statement
- Volume 2, Chapter 8: Marine archaeology of the Environmental Statement
- Volume 2, Chapter 9: Other sea users of the Environmental Statement
- Information to Support an Appropriate Assessment (ISAA) (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5)
- Marine Conservation Zone (MCZ) Assessment Report (Document reference E.2).

1.1.1.3 This chapter also draws upon information contained within Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Previous experience in offshore wind developments has indicated that changes in physical processes as a result of the construction and operation of offshore wind farms are generally limited in magnitude and scale. For the purposes of identifying significant impacts a comparative study was undertaken which assessed potential changes in physical process drivers (i.e. tidal currents and waves using numerical modelling techniques). These changes were not found to be significant therefore further detailed studies were not required. A full detailed study was not undertaken from the outset, rather reference made to published characteristics and noted sensitivities.

1.1.1.4 The physical processes modelling that has been undertaken to support this chapter is presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, is based on the Morgan Potential Array Area presented at Preliminary Environmental Information Report (PEIR), (Morgan Offshore Wind Ltd, 2023), as illustrated in Figure 1.1. The Morgan Environmental Statement boundary (also presented in Figure 1.1) has been reduced from the boundary presented in the PEIR for the application stage, within the proposed range of wind turbine infrastructure lies within the envelope of the project description presented within the PEIR, both in terms of turbine numbers and size of infrastructure. This is described in Volume 1, Chapter 3: Project description of the Environmental Statement. This chapter presents and assesses up to date parameters for the Environmental Statement and explains if and when the modelling differs from the PEIR parameters.

1.1.1.5 In some cases, modelling of construction activities extended beyond the Environmental Statement boundary which has been reduced by approximately 10%

since the PEIR. Due to the close proximity of the modelled Morgan Array Area presented at PEIR, and the Morgan Array Area presented for the Environmental Statement, illustrated in Figure 1.1, these areas display bathymetry, tidal currents and sediment classifications which are consistent with those within the updated Morgan Array Area for the Environmental Statement. It is considered that, given these similarities and that the revised layout represents a modest change in terms of the physical processes assessment, the modelling undertaken for the Morgan Proposed Array Area presented at PEIR and associated layout remains valid. It has therefore been used to inform the physical processes Environmental Statement assessment presented in this chapter.

1.1.1.6 Additional sensitivity testing has been undertaken to support variations from the Morgan Potential Array Areas for PEIR to Environmental Statement application project description. This is presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Where disparities occur between the modelled and assessed parameter, they are cited within this chapter with reference to the applicability of the modelled data and how it is used to support the assessment.

1.1.1.7 In addition, Figure 1.1 demonstrates how the Morgan Array Area has been reduced in size since the publication of the PEIR. However, to ensure a precautionary approach, the physical processes study area remains unchanged. This is discussed in detail in section 1.4.4.

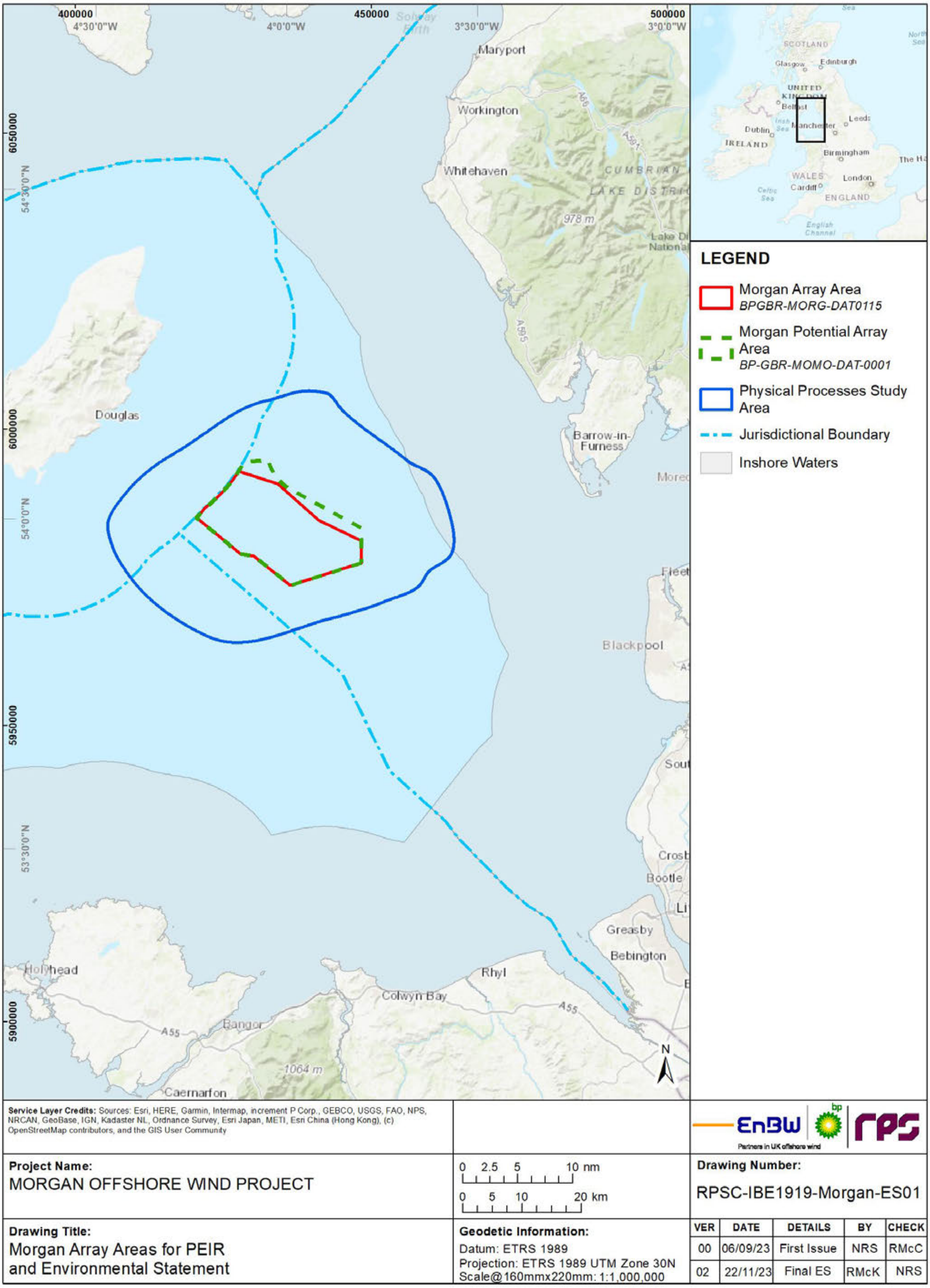

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Figure 1.1: Morgan Array Area for PEIR and Environmental Statement.

1.2 Legislative and policy context

1.2.1 Legislation

1.2.1.1 The policy context for the Morgan Generation Assets is set out in Volume 1, Chapter 2: Policy and legislative context of the Environmental Statement.

1.2.2 Planning policy context

1.2.2.1 The Morgan Generation Assets will be located in English offshore waters (beyond 12 nm from the English coast). As set out in Volume 1, Chapter 1: Introduction of this Environmental Statement, as the Morgan Generation Assets is an offshore generating station with a capacity of greater than 100 MW located in English waters, it is a Nationally Significant Infrastructure Project (NSIP) as defined by Section 15(3) of the Planning Act 2008 (as amended) (the 2008 Act). As such, there is a requirement to submit an application for a Development Consent Order (DCO) to the Planning Inspectorate to be decided by the Secretary of State for the Department for Energy Security and Net Zero (DESNZ).

1.2.3 National Policy Statements

1.2.3.1 There are currently six energy National Policy Statements (NPSs), three of which contain policy relevant to offshore wind development and the Morgan Generation Assets, specifically:

- Overarching NPS for Energy (NPS EN-1) which sets out the UK Government's policy for the delivery of major energy infrastructure (Department for Energy Security & Net Zero, 2023a)
- NPS for Renewable Energy Infrastructure (NPS EN-3) (Department for Energy Security & Net Zero, 2023b)
- NPS for Electricity Networks Infrastructure (NPS EN-5) (Department for Energy Security & Net Zero, 2023c).

1.2.3.2 NPS EN-1 and NPS EN-3 include guidance on what matters are to be considered in the physical processes assessment. These are summarised in Table 1.1. NPS EN-1 and NPS EN-3 also highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 1.2.

Table 1.1: Summary of the NPS EN-1 and EN-3 provisions relevant to physical processes.

NPS EN-1 and EN-3 provisions	How and where considered in the Environmental Statement
NPS EN-1	
Where relevant, applicants should undertake coastal geomorphological and sediment transfer modelling to predict and understand impacts and help identify relevant mitigating or compensatory measures (Section 5.6, paragraph 5.6.10).	Assessment of sediment dynamics undertaken using the hydrodynamic and spectral wave modelling, together with an understanding of the sediment regime is presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.
The Environmental Statement should include an assessment of the effects on the coast, tidal rivers and estuaries. In particular, applicants should assess: • The impact of the proposed project on coastal processes and geomorphology, including by taking account of potential impacts from climate change. If the development will have an impact on coastal processes the applicants must demonstrate how the impacts will be managed to minimise adverse impacts on other parts of the coast. The effects of the proposed project on marine ecology, biodiversity and protected sites • How coastal change could affect flood risk management infrastructure, drainage and flood risk • The effects of the proposed project on maintaining coastal recreation sites and features • The vulnerability of the proposed development to coastal change, taking account of climate change, during the project's operational life and any decommissioning period (Section 5.6, paragraph 5.6.11).	Baseline and post-construction physical processes were compared alongside extreme storm conditions to consider the wave climate detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, whilst climate change is discussed in section 1.5.3. The modelling study confirmed that there are no impacts on the coast, tidal rivers or estuaries; this was scoped out of the assessment. Climate change and the future baseline scenario with respect to the proposed development is discussed in section 1.5.3. A Cumulative Effects Assessment (CEA) has been undertaken and is outlined in section 1.11. The effects of the proposed project on the range of offshore receptors are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement, Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement, Volume 2, Chapter 4: Marine mammals of the Environmental Statement and Volume 2, Chapter 8: Marine archaeology of the Environmental Statement. Whilst coastal recreation is addressed in Volume 2, Chapter 9: Other sea users of the Environmental Statement.
For any projects involving dredging or deposit of any substance or object into the sea, the applicants should consult the Marine Management Organisation (MMO), Historic England, or Natural Resources Wales (NRW) in Wales. Where a project has the potential to have a major impact in this respect, this is covered in the technology specific NPSs (Section 5.6, paragraph 5.6.12).	The provisions for dredging activities are considered within Volume 1, Chapter 3: Project description of the Environmental Statement. Best practice techniques will be employed to ensure sediment mobilisation is minimised. Consultation was undertaken with the appropriate statutory bodies under the evidence plan through Expert Working Groups (EWG) as detailed in section 1.3. Assessment of sediment dynamics undertaken using the hydrodynamic and spectral wave modelling, together with an understanding of the sediment regime, as presented in section 1.5.1. Refer to Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement for further detailed information. Predicted changes to the tidal current, wave climate, littoral currents and sediment transport are quantified in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.
The applicants should be particularly careful to identify any effects of physical changes on the integrity and special features of Marine Protected Areas (MPAs). These could include Marine Conservation Zones (MCZs), habitat sites including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) with marine features, Ramsar sites, Sites of Community Importance (SCIs) and potential SCIs and	Designated sites and features of importance within and surrounding the physical processes study area have been identified in section 1.5.2. Further information is also provided in the ISAA (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5) and MCZ Screening Assessment (Document reference E.2).

NPS EN-1 and EN-3 provisions	How and where considered in the Environmental Statement
Sites of Special Scientific Interest (SSSIs). Applicants should also identify any effects on the special character of Heritage Coasts (Section 5.6, paragraph 5.6.13).	Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section1.9. Additionally, the integrity of special features are also assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement and Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement.
NPS EN-3	
Where requested by the Secretary of State applicants are required to undertake environmental monitoring (e.g., ornithological surveys, geomorphological surveys, archaeological surveys) prior to and during construction and operation (Section 2.8, paragraph 2.8.83).	Whilst the Morgan Generation Assets did not identify any potential significant effects on physical processes, pre-construction and post installation surveys will be undertaken for engineering purposes may be utilised to monitor these processes. Monitoring will be undertaken to observe the effect of sediment transport and sediment transport pathways on cable burial with specific reference to physical processes, as discussed in section 1.9.7.
This will enable an assessment of the accuracy of the original predictions and improve the evidence base for future mitigation and compensation measures, enabling better decision-making in future EIAs and HRAs (Section 2.8, paragraph 2.8.85).	
Applicant assessments are expected to include predictions of physical effects arising from modifications to hydrodynamics (waves and tides), sediments and sediment transport, and seabed morphology that will result from the construction, operation and decommissioning of the required infrastructure (Section 2.8, paragraph 2.8.102).	Assessment of the significance of effects on physical processes receptors is detailed in section 1.9. This includes the potential impacts on tide, waves and sediment transport through the lifetime of the project. The assessment of sediment dynamics presented in section 1.9 was underpinned using the hydrodynamic and spectral wave modelling (Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement), together with an understanding of the sediment regime detailed in section 1.5.1.
Assessments should also include effects such as the scouring that may result from the proposed development and how that might impact sensitive species and habitats (Section 2.8, paragraph 2.8.103).	Scour protection is a measure which will be adopted as part of the projected as detailed in Table 1.14 and defined by the project description outlined in Volume 1, Chapter 3: Project description of the Environmental Statement. Development and adherence to an Offshore Construction Method Statement (CMS) will include details of scour protection management to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour and therefore any impacts would relate only to residual/secondary scour which would be very localised and of negligible magnitude, as discussed in section 1.9.5. The assessment of sensitive species is presented in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.
Applicants should undertake geotechnical investigations as part of the assessment, enabling the design of appropriate construction techniques to minimise any adverse effects (Section 2.8, paragraph 2.8.104).	Geophysical surveys and other site-specific surveying have been carried out to support modelling and assessment, as described in Table 1.8.
The applicant should demonstrate compliance with mitigation measures identified by The Crown Estate in any plan-level HRA produced as part of its leasing round (Section 2.8, paragraph 2.8.113).	Mitigation measures have been considered during consultation as shown in section 1.8, and included within the assessment. This includes scour/cable protection techniques and cable burial techniques as listed in Table 1.14.

NPS EN-1 and EN-3 provisions	How and where considered in the Environmental Statement
Applicant assessment of the effects on the subtidal environment should include: • Loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes, e.g. sandwave/boulder/UXO clearance • Environmental appraisal of inter-array and other offshore transmission and installation/maintenance methods, including predicted loss of habitat due to predicted scour, and scour/cable protection and sandwave/boulder/ Unexploded Ordnances (UXO) clearance • Habitat disturbance from construction and maintenance/repair vessels' extendible legs and anchors • Increased suspended sediment loads during construction and from maintenance/repairs • Predicted rates at which the subtidal zone might recover from temporary effects • Potential impacts from electromagnetic fields (EMF) on benthic fauna • Potential impacts upon natural ecosystem functioning • Protected sites • Potential for invasive/non-native species introduction (Section 2.8, paragraph 2.8.116).	The assessment of potential construction, operations and maintenance, and decommissioning impacts are described in section 1.9 and includes the impact of increased suspended sediment loads and subsequent deposition. Hydrodynamic modelling undertaken for physical processes assessment (refer to Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement). It is noted that changes to bathymetry due to depressions left by jack-up vessels will be very limited and are scoped out of the assessment with justification presented in Table 1.6. Volume 1, Chapter 3: Project description outlines that boulder clearance is anticipated to take the form of side casting. Therefore, boulders may be picked up one by one and moved to the side of the construction area. For the inter-array and interconnector cabling, this would be at least 10 m either side from the centre line of each cable, or removed using a plough where boulders will be pushed out of the way. Therefore the activity will not result in significant increases in SSC. All boulders will remain in the marine environment within the boundary of the Morgan Array Area therefore the activity will not result in changes to the seabed characteristics or physical processes. Although UXO clearance can cause increased SSCs these effects would be local, temporary and recoverable and, as such, effects are negligible and were not considered within the physical processes assessment. The scale and extent of any potential craters and the recoverability of the seabed are captured in Table 1.13 and assessed in Section 1.9.5 Habitat loss and invasive/non-native species are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement, which also includes and assessment of the potential impacts from electromagnetic fields (EMF) on benthic fauna. The potential impacts on natural ecosystem in terms of the physical environment, (i.e. external factors) and protected sites are assessed in section 1.9 whilst ecological features are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.
Where a potential offshore wind farm is proposed close to existing operational offshore infrastructure or has the potential to affect activities for which a licence has been issued by Government, the applicants should undertake an assessment of the potential effect of the proposed development on such existing or permitted infrastructure or activities (Section 2.8, paragraph 2.8.187). The assessment should be undertaken for all stages of the lifespan of the proposed wind farm in accordance with the appropriate policy and guidance for offshore wind farm Environmental Impact Assessment (EIAs) (Section 2.8, paragraph 2.8.188). Applicants should use marine plans (paragraph 2.8.7 of this NPS and Section 4.5 of EN-1) in considering which activities may be most affected by their proposal and	The assessment of potential construction, operations and maintenance, and decommissioning impacts are described in section 1.9 and includes the impact of increased suspended sediment loads and subsequent deposition. Legislative requirements for offshore wind farms are considered within Volume 1, Chapter 2: Policy and legislative context of the Environmental Statement. The CEA was carried out in accordance with these procedures as detailed in section 1.10. The projects identified from the screening processes are presented in Table 1.15 with the CEA assessment presented in section 1.11.

NPS EN-1 and EN-3 provisions	How and where considered in the Environmental Statement
thus where to target their assessment (Section 2.8, paragraph 2.8.189).	
Applicants should engage with interested parties in the potentially affected offshore sectors early in the pre-application phase of the proposed offshore wind farm, with an aim to resolve as many issues as possible prior to the submission of an application (Section 2.8, paragraph 2.8.190).	Key issues have been raised and discussed during consultation activities and engagement specific to physical processes. This has been undertaken through an evidence plan process with a series of EWG meetings through the course of the project development and application process. A summary of the key issues and responses have been provided in Table 1.4.
Applicants are expected to have considered the best ecological outcomes in terms of potential mitigation. These might include: • Avoidance of areas sensitive to physical effects • Consideration of micro-siting of both the array and cables • Alignment and density of the array • Design of foundations • Ensuring that sediment moved is retained as locally as possible • The burying of cables to a necessary depth • Using scour protection techniques around offshore structures to prevent scour effects or designing turbines to withstand scour, so scour protection is not required or is minimised (Section 2.8, paragraph 2.8.214). Applicants should consult the statutory consultees on appropriate mitigation and monitoring (Section 2.8, paragraph 2.8.215).	During the design process a range of parameters have been considered and following the mitigation hierarchy to avoid, minimise and mitigate potential impacts measures will be adopted within the context of the projects as detailed in Table 1.14. Mitigation measures have been considered during consultation as shown in section 1.8, and included within the assessment. This includes scour/cable protection techniques and cable burial techniques as listed in Table 1.14.

Table 1.2: Summary of NPS EN-1 and NPS EN-3 policy on decision making relevant to physical processes.

NPS EN-1 and EN-3 policy	How and where considered in the Environmental Statement
NPS EN-1	
The Secretary of State should be satisfied that the proposed development will be resilient to coastal erosion and deposition, taking account of climate change, during the project's operational life and any decommissioning period. (Section 5.6 paragraph 5.6.16).	Details of the project design criteria are detailed in Volume 1, Chapter 3: Project description of the Environmental Statement, whilst climate change is discussed in section 1.5.3. Project-wide aspects of climate change are presented in Volume 2, Chapter 12: Climate change of the Environmental Statement.
The Secretary of State should not normally consent new development in areas of dynamic shorelines where the proposal could inhibit sediment flow or have an adverse impact on coastal processes at other locations. Impacts on coastal processes must be managed to minimise adverse impacts on other parts of the coast. Where such proposals are brought forward consent should only be granted where the Secretary of State is satisfied that the benefits (including need) of the development outweigh the adverse impacts (Section 5.6 paragraph 5.6.17).	Assessment of sediment dynamics undertaken using the hydrodynamic and spectral wave modelling, together with an understanding of the sediment regime. Refer to Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Predicted changes to the tidal current, wave climate, littoral currents and sediment transport are assessed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

NPS EN-1 and EN-3 policy	How and where considered in the Environmental Statement
	Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9.
In addition to this NPS the Secretary of State must have regard to the appropriate marine policy documents in taking any decision which relates to the exercise of any function cable of affecting any part of the UK marine area (Section 5.6 paragraph 5.6.21). The Secretary of State may also have regard to any relevant SMPs (Section 5.6 paragraph 5.6.22).	Legislative requirements for offshore wind farms are considered within Volume 1, Chapter 2: Policy and legislative context of the Environmental Statement.
The Secretary of State should examine the broader context of coastal protection around the proposed site, and the influence in both directions, i.e., coast on site, and site on coast (Section 5.6 paragraph 5.6.19).	The project design detailed in Volume 1, Chapter 3: Project description of the Environmental Statement takes consideration of the impacts of physical processes on the infrastructure whilst this chapter considers the effect of the Morgan Generation Assets on physical processes.
NPS EN-3	
The Secretary of State should be satisfied that activities have been designed considering sensitive subtidal environmental aspects and discussions with the relevant conservation bodies have taken place (Section 2.8 paragraph 2.8.307).	Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9. Designated sites and features of importance within and surrounding the physical processes study area have been identified in section 1.5.2. Consultation with relevant bodies is summarised in Table 1.4.
Where adverse effects on site integrity/conservation objectives are predicted the Secretary of State should consider the extent to which the effects are temporary or reversible, and the timescales for recovery. The Secretary of State should also consider the extent to which the effects may impede achievement of the MPA target (including any interim target) set under the Environmental Act 2021 (Section 2.8 paragraph 2.8.295).	Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9. This includes both the temporal and spatial magnitude of effects. Further information is also provided in the ISAA (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5) and MCZ Screening Assessment (Document reference E.2).
As set out in paragraphs 2.8.125 of this NPS, the direct effects on the physical environment can have indirect effects on a number of other receptors (Section 2.8 paragraph 2.8.297). Where indirect effects are predicted, the Secretary of State should refer to relevant sections of the NPS and EN-1 (Section 2.8 paragraph 2.8.298.	Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9.
The Secretary of State should be satisfied that the design of the wind farm, offshore transmission and methods of construction, including use of materials, are such as to reasonably minimise the potential for impact on the physical environment. This could involve, for instance, the exclusion of certain foundations because of their impacts or minimising quantities of rock that are used to protect cables whilst taking into account other relevant considerations such as safety (Section 3.8 paragraph 3.8.327).	The provision of construction material and methods are considered within Volume 1, Chapter 3: Project description of the Environmental Statement. Best practice techniques will be employed to ensure sediment mobilisation is minimised.

1.2.4 North West Inshore and North West Offshore Coast Marine Plans

1.2.4.1 The assessment of potential changes to physical processes has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). Key provisions are set out in Table 1.3 along with details as to how these have been addressed within the assessment.

Table 1.3: North West Inshore and North West Offshore Marine Plan policies of relevance to physical processes.

Policy	Key provisions	How and where considered in the Environmental Statement
NW-CAB-1	Preference should be given to proposals for cable installation where the method of protection is burial. Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures.	Details of the project design criteria are detailed in Volume 1 Chapter 3: Project description of the Environmental Statement. To minimise potential impact from the cables and removal of cables a commitment to bury cables where possible has been made as outlined in Table 1.14 which details measures that will be adopted within the context of the project.
NW-MPA-1	Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate – adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	Designated sites and features of importance within the physical processes study area have been identified in section 1.5.2. Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9. The effects of the proposed project on the MPA are also assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. During the design process a range of parameters have been considered and following the mitigation hierarchy to avoid, minimise and mitigate potential impacts measures will be adopted within the context of the project as detailed in Table 1.14.
NW-MPA-4	Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate – adverse impacts so they are no longer significant.	Designated sites and features of importance within the physical processes study area have been identified in section 1.5.2. Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9. During the design process a range of parameters have been considered and following the mitigation hierarchy to avoid, minimise and mitigate potential impacts measures will be adopted within the context of the project as detailed in Table 1.14.
NW-BIO-1	Proposals that may have significant adverse impacts on the distribution of priority habitats and priority species must demonstrate that they will, in order of preference: a) avoid b) minimise	Sites identified as Habitats Directive Annex I habitats within the physical processes study area have been identified in section 1.5.2. Additionally, the effects of the proposed project are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement, Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement and Volume 2, Chapter 4: Marine mammals of the Environmental Statement. Further

Policy	Key provisions	How and where considered in the Environmental Statement
	c) mitigate – adverse impacts so they are no longer significant d) compensate for significant adverse impacts that cannot be mitigated.	information is also provided in the ISAA (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5). Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.9.
NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	A CEA has been undertaken and is outlined in section 1.10. Potential impacts from the CEA have also been identified and the significance of the effects on physical processes receptors has been assessed in section 1.11.

1.3 Consultation

1.3.1 Evidence plan

1.3.1.1 A summary of the key issues raised during consultation activities undertaken to date specific to physical processes is presented in Table 1.4 below, together with how these issues have been considered in the production of this Environmental Statement chapter.

1.3.1.2 The purpose of the Evidence Plan process is to agree the information the Morgan Generation Assets needs to supply to the Secretary of State, as part of a DCO application for the Morgan Generation Assets. The Evidence Plan seeks to ensure compliance with the HRA and EIA. The development and monitoring of the Evidence Plan and its subsequent progress is being undertaken by the Steering Group. The Steering Group comprises the Planning Inspectorate, the Applicant, NRW, Natural England, the Joint Nature Conservation Committee (JNCC) and the MMO as the key regulatory bodies and Statutory Nature Conservation Body (SNCBs). To inform the EIA and HRA process during the pre-application stage of the Morgan Generation Assets, EWGs were also set up to discuss and agree topic specific issues with the relevant stakeholders.

Table 1.4: Summary of key consultation issues raised during consultation activities undertaken for the Morgan Generation Assets relevant to physical processes.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
17 February 2022	Benthic ecology, fish and shellfish and physical processes EWG Attendees: Natural England, MMO, JNCC, Environment Agency, NRW, Cefas	An overview of the physical processes modelling and assessment strategy was presented. This included data requirements and sources, model development, calibration and application. The available project specific surveys and datasets were also presented. The need to consider stratification was noted with additional reference material provided by NRW post meeting. No significant issues or concerns were raised.	The baseline environment and stratification is presented in section 1.5 whilst the assessment of impacts due to the Morgan Generation Assets is presented in section 1.9.6.
14 July 2022	Natural England: Scoping Opinion	It is vital that the marine and coastal physical processes within, and in the vicinity of, the proposed development are well understood in order to provide robust estimates of the temporal and spatial scale of changes to hydrodynamic and sediment transport regimes. This should describe both contemporary conditions as well as longer-term historical change.	Physical processes baseline conditions (without wind farm infrastructure) such as tidal regime, wave climate and sediment transport, and comparisons to post – construction are outlined in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Storm conditions have also been assessed for 1 in 1 and 1 in 20 year storm events.
14 July 2022	Natural England: Scoping Opinion	We advise that secondary scour protection impacts on seabed habitats are scoped in until further detailed methods and impacts can be assessed, and justification provided to scope out of the Environmental Statement.	There is a commitment to provide scour protection, as outlined in section 1.8, development and adherence to an Offshore CMS will include details of scour protection management to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour and therefore any impacts would relate only to residual/secondary scour as discussed in section 1.9.5.
14 July 2022	Natural England: Scoping Opinion	Little information is provided on seabed preparation activities (e.g., sandwave clearance, material disposal) and the impacts on sediment transport patterns and morphological change, due to the early stage of the project. Natural England reserve the right to make future detailed	Seabed preparation such as sandwave clearance involves movement of material along the trenching corridor, no material will be disposed of beyond the Morgan Array Area. Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement includes the dredging and fate of material mobilised in sandwave clearance. Secondary impacts due

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		comments once further information is known, this could include scoping in of additional impacts.	to seabed preparation are not included in the modelling of post construction bathymetry for two reasons, firstly in areas of active sediment transport this is a temporary condition, and secondly the uncertainty on scale & location of preparation activities.
14 July 2022	Natural England: Scoping Opinion	It will be important for any assessment to consider the potential cumulative effects of this proposal, including all supporting infrastructure, with other similar proposals and a thorough assessment of the 'in combination' effects of the proposed development with any existing developments and current applications. A full consideration of the implications of the whole scheme should be included in the Environmental Statement. All supporting infrastructure and activities should be included within the assessment. An impact assessment should identify, describe, and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment (subject to available information): existing completed projects; approved but uncompleted projects; ongoing activities; plans or projects for which an application has been made and which are under consideration by the consenting authorities; and plans and projects which are reasonably foreseeable (i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects).	A tiered approach has been applied to capture different stages of development of other projects which may cause a cumulative impact, as outlined in section 1.10. A CEA is undertaken for physical processes with screening for all relevant projects in section 1.11. The CEA assessment was undertaken by examining three scenarios the Morgan Offshore Wind project as a whole, in combination with the Morecambe Offshore Wind Farm project as a whole and also other projects and plans identified. In this way full consideration was taken of the scheme.
14 July 2022	Natural England: Scoping Opinion	The Environmental Statement should thoroughly assess the potential for the proposal to affect designated sites. Internationally designated sites	Designated sites within the physical processes study area are identified as discussed in section 1.5.2. Designated sites with features of importance that can be considered a

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		(e.g., designated SACs and SPAs) fall within the scope of the Conservation of Habitats and Species Regulations 2017 (as amended). Assessment should include a full assessment of the direct and indirect effects of the development on the features of special interest within these sites and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects.	receptor of physical processes are then assessed in section 1.9, with reference to the construction, operations and maintenance and decommission activities of the Morgan Generation Assets. Additional information on the potential effects on designated sites for a range of receptors is provided in the ISAA (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5) and MCZ Screening Assessment (Document reference E.2) reports.
14 July 2022	Natural England: Scoping Opinion	Increases in suspended sediment concentrations (SSC) during construction and operation (e.g., future dredging works) have the potential to smother sensitive habitats. The Environmental Statement 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 are likely to impact upon the interest features and supporting habitats of the designated sites.	The fate of mobilised material has been described within Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The impact of SSC and sedimentation on receptors such as features of interest is discussed within this chapter in section 1.9, whilst the impacts on the supporting habitats are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.
14 July 2022	Natural England: Scoping Opinion	It would be beneficial to have mapped display of the deployed metocean buoys, including both site-specific deployment as well as historic data from Ormonde offshore wind farm and the proposed Round 3 Irish Sea Offshore Wind Farm Development Zone.	A figure has been provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, Figure 1.8, to illustrate survey buoy locations and the location of data sources.
14 July 2022	Natural England: Scoping Opinion	The evidence presented set out variations in the tidal currents across the physical processes study area, further evidence on the tidal currents and current directions, for both flood and ebb currents would be beneficial. It would be beneficial to have a mapped display of this information. This would support a clear baseline of the hydrodynamics within the physical processes study area.	Further information has now been provided on tides, waves and sediment transport specific to the Morgan Generation Assets as part of the modelling both pre and post-construction in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
14 July 2022	Natural England: Scoping Opinion	We seek clarity on the presence of any sand wave features within the area. In understanding any potential impacts, it would be beneficial to have a clear understanding of sand wave height, wave lengths and migratory rates.	Geophysical surveys specific to the Morgan Generation Assets has been carried out with further information sourced from a number of resources as detailed in Table 1.7 and project specific datasets as detailed in Table 1.8. Details of sandwaves and seabed features illustrated in Figure 1.5 and Figure 1.6 respectively. Further detail is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.
14 July 2022	Natural England: Scoping Opinion	While we do not anticipate significant impacts resulting from the scour protection measures (as these will be subject to engineering design to ensure suitable for this project), it is our view that it is too early to scope out secondary scour protection impacts on the seabed at this stage. We advise that this is scoped in until further detailed methods and impacts can be assessed, and justification provided to scope out of the Environmental Statement.	There is a commitment to provide scour protection, as outlined in section 1.8, development and adherence to an Offshore CMS will include details of scour protection management to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour and therefore any impacts would relate only to residual/secondary scour as discussed in section 1.9.5.
14 July 2022	Natural England: Scoping Opinion	If a modelling approach is to be adopted, early engagement with the SNCBs is recommended. We advise that the model is discussed and agreed through the Evidence Plan process via the EWG.	The modelling methodology, software and datasets were presented in the first Benthic ecology, fish and shellfish and physical processes EWG held in February 2022, whilst preliminary modelling outcomes were presented in the second EWG meeting, November 2022. The MIKE modelling software was utilised as described in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Furthermore, a modelling strategy note was issued in August 2023 outlining the use of PEIR modelling to support Environmental Statement in view of changes to the project description and agreement on the application was secured.
14 July 2022	Natural England: Scoping Opinion	Consideration of the Mersey Tidal Power Project in the cumulative effects assessment is advised. Currently this project is only at early concept planning stage.	The Mersey Tidal Power Project is included within the CEA long list (see Volume 3, Annex 5.1: Cumulative effects screening matrix of the Environmental Statement) and was subsequently screened out of the physical processes assessment as there is no physical effect pathway due to distance from the Morgan Generation Assets.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
15 June 2022	The Planning Inspectorate: Scoping Opinion	The Environmental Statement should provide further detail on the proposed seabed preparation activities and identify the worse-case scenario assessed in relation to seabed disturbance. The need for dredging, quantities of material and likely disposal location should be identified, and likely significant effects assessed in the Environmental Statement.	The fate of mobilised material has been described within Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The impact of SSC and sedimentation on receptors such as features of interest is discussed within this chapter in section 1.9. The dredging quantities, types of sediment and disposal plumes are identified in Volume 1, Chapter 3: Project description of the Environmental Statement, noting that, following the publication of Scoping and PEIR, project refinement has been undertaken; corridor widths have been refined and the volumes of sandwave clearance have been significantly reduced.
15 June 2022	The Planning Inspectorate: Scoping Opinion	Drilling arisings disposal site. The Environmental Statement should identify the likely site for disposal of drilling arisings and include an assessment of effects from these activities.	No material will be disposed of beyond the Morgan Array Area. Supporting studies, Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, include the fate of material mobilised from drilling activities.
15 June 2022	The Planning Inspectorate: Scoping Opinion	No justification is provided to scope out impacts from jack- up vessel spud-cans and footprints on the sedimentary regime. There is also no evidence that additional scour from depressions would not give rise to significant effects. The Inspectorate therefore does not agree this matter can be scoped out.	The bathymetry and sediment transport parameters are intrinsically linked, and further information is provided to justify scoping out of effects of depression on sediment regime in Table 1.6.
15 June 2022	The Planning Inspectorate: Scoping Opinion	Scoping Report paragraph 3.4.4.1 states that seabed levelling may be required but this is not mentioned in the physical processes chapter. The Environmental Statement should assess any likely significant secondary effects that this may have on changes to the current/flow regime, wave regime and sediment transport regime and any morphological changes.	Supporting studies and assessment include the dredging and fate of material mobilised in sandwave clearance operations undertaken during the construction phase of the project. Secondary impacts due to seabed preparation are not included in the modelling (i.e., with post seabed preparation bathymetry prior to the installation of the infrastructure) for two reasons, principally because in areas of active sediment transport this is a temporary condition and secondly the precise location of preparation activities would be determined during detailed design stages and micro-siting.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
29 November 2022	Benthic ecology, fish and shellfish and physical processes EWG Attendees: MMO, Natural England, JNCC, NRW, Cefas, Isle of Man	The physical processes study objectives and approach were presented. Baseline modelling of tides, waves and sediment transport was shown, along with preliminary modelling output. A discussion included potential use of cable protection. It was noted that the parameters included within PEIR did not consider engineering considerations which were included within the modelling. No additional significant issues or concerns were raised.	Further to the discussions held in the context of the EWG details of the measures to be adopted have been defined and clarified. These include development and adherence to an Offshore CMS which includes a commitment to bury cables if possible, the provision of scour protection to reduced scour and to minimise sandwave clearance, as outlined in section 1.8.
30 May 2023	North West Wildlife Trusts: S42 response	Transboundary. Given the proximity to Welsh waters and Isle of Man, we expect there to be full consideration of transboundary effects and cumulative impacts across borders. The Irish Sea is a busy regional sea, under significant pressure and the cumulative and in-combination effects on the marine environment from building offshore infrastructure on such a large scale could have significant impacts on the marine environment if not managed correctly.	A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to physical processes upon the interests of other states. This is presented in Volume 3, Annex 5.2: Transboundary impacts screening of the Environmental Statement.
31 May 2023	MMO: S42 response	The MMO notes that during the decommissioning methodology, it is said that the wind turbines will be cut below seabed level. As this plan involves leaving infrastructure in place, impacts should be assessed for post-decommissioning.	The assessment undertaken for physical processes, presented in section 1.9, includes the decommissioning phase with proposed infrastructure remaining *in situ*.
02 June 2023	Isle of Man Department of Infrastructure: S42 response	PEIR 6.4.14 Designated sites Chapter 7 (Benthic Ecology) outlines consideration of all designated sites in the study area and then identifies two MCZ as being relevant and confirms that others are not for further consideration. This is clear. However, in this Chapter (6) (physical processes) only the two MCZs are indicated, but not that other sites have been identified or assessed. For continuity and demonstrated consideration, it is	The Marine Conservation Zone (MCZ) Assessment (Document reference E4), Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement and this, physical processes, chapter have been updated and aligned with respect to designated areas.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		recommended that a similar approach is taken for Chapter 6.	
02 June 2023	Natural England: S42 response	We acknowledge that a matrix approach to determining the significance of effects on ecological features, is commonly used. We also note that any effect that is concluded to be of moderate or major significance in the PEIR, is deemed to be 'significant' in EIA terms, whereas effects concluded to be of negligible or minor significance, are deemed 'not significant' in EIA terms. This cut-off could exclude any effect concluded to be less than moderate, in turn, this could lead to errors in assessing cumulative effects adequately.	Expert judgement is applied in evaluating the significance of impacts and it is noted that within the CEA, described in section 1.10, a cumulative impact is assessed by way of combined magnitude rather than excluding 'not significant' impacts due to the proposed development alone from the CEA.
02 June 2023	Natural England: S42 response	Natural England advises that the potential impacts of the project cannot be considered in isolation from its transmission assets and the associated Morgan Offshore Wind Farm project, and accordingly we will only consider a full, cumulative assessment of these projects as adequate to support the DCO application.	The physical processes CEA methodology has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement and is presented in section 1.11. The cumulative assessment considers two scenarios in relation to transmission assets; Morgan Generation Assets plus Morgan and Morecambe Offshore Wind Farms Transmission Assets, and Morgan Generation Assets plus Morgan and Morecambe Offshore Wind Farms Transmission Assets and the Morecambe Offshore Windfarm Generation Assets (hereafter referred to as the Morecambe Generation Assets). These cumulative scenarios are followed by the cumulative assessment of all projects, plans and activities considered alongside the Morgan Generation Assets.
02 June 2023	Natural England: S42 response	We note that further processing of geophysical surveys and particle size analysis is yet to be undertaken. We would therefore like to highlight that our comments provided in this Annex are subject to the outcome of further data analysis to validate conclusions of the physical processes modelling and assessment.	The sediment grading properties applied within the modelling study (Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement) was derived from British Geological Survey (BGS) datasets and included both generalised Folk classification from borehole logs and detailed particle analysis data. This data was verified against Particle Size

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
			Analysis (PSA) of sediment samples collected during site specific surveys the analysis of which was undertaken following completion of the modelling study.
02 June 2023	Natural England: S42 response	There is a considerable amount of sandwave clearance and seabed preparation footprint proposed. We advise that all efforts should be made to avoid areas of sandwaves or minimise the need for clearance by micro-routing cables. Therefore, we encourage refinement of the Maximum Design Scenario (MDS) as much as possible using project specific acoustic data.	Project refinement has been undertaken; corridor widths have been refined and the volumes of sandwave clearance have been significantly reduced, as detailed in the project description, Volume 1, Chapter 3: Project description of the Environmental Statement.
02 June 2023	Natural England: S42 response	We note that Westminster Gravels will be renewing their aggregate extraction licence in Area 457 in Liverpool Bay (please see: EIA/2023/00003). Currently this proposal is in early EIA scoping stages, the Environmental Statement is expected to be submitted in Q2 2024.	A revised CEA screening was undertaken to identify and assess projects and plans within the physical processes CEA study area as presented in section 1.11.
02 June 2023	Natural England: S42 response	Whilst some parameters for sandwave clearance have been defined e.g., footprint of mega ripples, there is limited information on the existing sandwave features such as sandwave height. If possible, please provide further detail on sandwaves such as maximum sandwave height.	Geophysical surveys specific to the Morgan Generation Assets has been carried out with further information sourced from a number of resources as detailed in Table 1.7 and project specific datasets as detailed in Table 1.8. Details of sandwaves and seabed features illustrated in Figure 1.5 and Figure 1.6 respectively.
02 June 2023	Natural England: S42 response	Can the developer please confirm if concurrent multiple activities will take place (e.g., drilling, dredging and cable installation)? If they are, the model doesn't seem to assess concurrent multiple activities and potential overlapping sediment plumes. Please clarify and provide outputs and maps showing release of all sediments and fines from concurrent drilling and dredging activities, if possible.	Modelling, presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement and assessment (section 1.9) was undertaken for two concurrent and adjacent drilling operations as outlined in Volume 1, Chapter 3: Project description of the Environmental Statement. It is recognised that multiple activities may be undertaken at the same time. However programme phasing and logistics would limit coincident activities. It is not realistic or practical to provide combined outputs as there is an infinite number of potential scenarios depending on the activity, location and phasing. However, the modelling study undertaken and

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
			presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement included a comprehensive range of the potential impacts due to both construction activities and the presence of the infrastructure. In each case a maximum design scenario was applied providing a precautionary approach to quantifying impacts. The assessment presented in section 1.9 demonstrated that impacts on designated sites would be negligible in the case of each and combined activities.
02 June 2023	Natural England: S42 response	We advise that further justification is provided for scoping out jack-up vessels i.e. inclusion in the modelling. The data from Barrow offshore wind farm is <15 years old and parameters are project specific, therefore not comparable to this project.	Justification of the scoping out of jack-up vessels is provided in Table 1.6. Noting that due to the limited scale of the indentations these features would not be evident within the model.
02 June 2023	Natural England: S42 response	Disagree that scour protection measures should be scoped out of the assessment. Scour protection measures should be included in the assessment.	Scour protection is provided within the project infrastructure. The project description, Volume 1, Chapter 3: Project description of the Environmental Statement, details that the provision made is adequate/proportionate. The physical processes assessment includes provision of scour protection as an integral part of the design. Development and adherence to an Offshore CMS will include details of scour protection management to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour and therefore any impacts would relate only to residual/secondary scour as discussed in section 1.9.5.
02 June 2023	Natural England: S42 response	We note that suction hopper dredging has been identified as the primary dredging method for sandwave clearance. It has been noted that the dredged material will be deposited along the cable corridor or in the adjacent trough area. We welcome the return of cleared material to the system from which it was removed and advise that it should be intelligently placed so that excavated material quickly infills the excavated	This is noted. It should be clarified that sandwaves will not be flattened – sand waves will be reduced in height and material side-cast in the vicinity of the sandwave therefore making this material readily available for redistribution and sandwave recovery. This is discussed further and assessed in section 1.9.2 and section 1.9.5.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		depression. This should be done using a fall pipe.	
02 June 2023	Natural Resource Wales: S42 response	With respect to Marine Physical Processes, NRW (A) advise that cumulative impacts from the large spatial extent of sand wave clearance at Morgan, Mona and Morecambe should be assessed, and we raise concerns regarding the large areas of seabed that will be flattened. The proposed works infer that the seabed will be flattened i.e. sand wave crests lowered and sediment deposited in adjacent troughs. Whilst NRW (A) understands that the sand will remain locally within the same sediment cell, we are concerned that the seabed morphology will not be able to recover and regenerate its migratory pattern of bedload sediment transport for many years if the seabed features are flattened to ground level and the troughs filled in over a large spatial area.	Project refinement has been undertaken; corridor widths have been refined and the volumes of sandwave clearance have been significantly reduced. This is also the case for Mona Offshore Wind Project and Morgan and Morecambe Offshore Wind Project: Transmission Assets. It should be clarified that sandwaves will not be flattened – sand waves will be reduced in height and material side-cast in the vicinity of the sandwave therefore making this material readily available for redistribution and sandwave recovery. This is discussed further and assessed in section 1.9.2 and section 1.9.5.
02 June 2023	Natural Resource Wales: S42 response	It is important to understand the relevance of the migrating sandwaves to the regional sediment budget and sediment transport system offshore of the North Wales coast. The Morgan and Mona sand wave clearance activities should not be treated in isolation but in-combination, given the close proximity of both sites.	Project refinement has been undertaken; corridor widths have been refined and the volumes of sandwave clearance have been significantly reduced. It should be clarified that sandwaves will not be flattened – sand waves will be reduced in height and material side-cast in the vicinity of the sandwave therefore making this material readily available for redistribution and sandwave recovery. The cumulative effects assessment presented in section 1.11 considers all relevant projects and considers both the extent and magnitude of potential impacts.
02 June 2023	Natural Resource Wales: S42 response	There is a significant amount of cable protection proposed for both the Morgan and Mona Array sites which will lead to long term habitat loss and change of seabed substrate and supporting habitat for other receptors (i.e. birds, benthic). Given the intention to leave the rock in situ upon	Cable protection will only be used where sufficient trenching depths cannot be achieved and project refinements has reduced the length of cable protection required, as outlined by the measures adopted in Table 1.14. The maximum design parameters for cable protection are presented in Volume 1, Chapter 3: Project

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		decommissioning, permanent presence of the rock will potentially alter the seabed sediment transport processes leading to permanent alterations to the seabed morphodynamics. This could have potential cumulative impacts to the sediment transport systems of the North Wales coast, causing further impacts to receptors within Welsh waters and Welsh protected sites. It is essential to consider these combined impacts from the large amount of cable protection proposed across this vast area. NRW (A) therefore strongly advise that cable protection measures are minimised as much as possible for both sites.	description of the Environmental Statement. The cumulative effects assessment considers all relevant projects and considers both the extent and magnitude of potential impacts including both SSC and sediment transport pathways.
05 June 2023	Ørsted: S42 response	It is important to ensure that all environmental impacts of your project are properly and fully assessed including any potential cumulative or in combination effects with the Mooir Vannin Offshore Wind Farm.	A revised CEA screening was undertaken to identify and assess projects and plans within the physical processes CEA study area as presented in section 1.11.
	S42 response: Reference number 1766	I'm unsure as to whether the "physical process" referred to in this point refers to the physical process of construction and maintenance or the physical process of the actual consultation.	Physical processes in this context cover impacts on marine and coastal processes and are defined as encompassing the following elements: • Tidal elevations and currents • Waves • Bathymetry • Seabed sediments • Suspended sediments • Sediment transport.
	S42 response: Reference number 1894	With the construction and mass movement of sediment from the seabed, will you contribute to the resulting dredging operation what will occur at surrounding ports?	The physical processes assessment, detailed in section 1.9, includes the dispersion and fate of material mobilised during construction activities and is supported by a numerical modelling study presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
11 July 2023	Benthic ecology, fish and shellfish and physical processes EWG Attendees: JNCC, Natural England, NRW, Isle of Man, MMO, Cefas	The S42 consultation responses were summarised. Discussions focussed on the use of cable protection, noting that the parameters presented in the PEIR were maximum values. The modelling encompassed a realistic scenario taking into account engineering considerations. Noting the Applicant's has a commitment to minimise cable protection which will be detailed within the Environmental Statement. No additional significant issues or concerns were raised.	Measures adopted as part of the Morgan Generation Assets include a commitment to bury cables where possible and minimise the sandwave clearance undertaken. This is discussed further in section 1.8.
14 August 2023	Technical Note issued to the Benthic ecology, fish and shellfish and physical processes EWG:	Technical Note detailing the physical processes modelling strategy was issued. It outlined the use of PEIR modelling to support Environmental Statement in view of changes to the project description. The technical note entitled "Physical Processes Environmental Statement Modelling Strategy" is included within the Consultation Report (Document Reference E.3).	No issues were raised with the application of the existing PEIR numerical modelling study as supporting evidence for Volume 1, Chapter 3: Project description of the Environmental Statement. No further modelling or revised assessment is required, provided the PEIR modelling assumptions are reflected in Volume 1, Chapter 3: Project description of the Environmental Statement as detailed in the S42 response.
18 August 2023	NRW meeting: follow up to Advice note	A follow up meeting was held with NRW to discuss the physical processes modelling Technical Note where the project refinement and commitments on reducing cable protection. It was agreed that no re-modelling would be required provided the PEIR modelling assumptions (i.e. relating to those commitments) are reflected in the revised project description as detailed in the S42 responses.	Further project design, definition and commitments have been made with regards to cable installation methods and on reducing cable protection. These are detailed in section 1.8 and are in line with those engineering considerations included with the modelling study presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.
7 December 2023	Benthic ecology, fish and shellfish and physical processes EWG Attendees: Wildlife Trust, JNCC, Natural England, NRW, Isle of Man, MMO, Cefas	The physical processes modelling strategy review was presented. This included clarification of how outstanding Section 42 responses are being addressed.	The project refinements and commitments are detailed in Table 1.14. Section 1.9.5 includes methodology and assessment of the potential impact of harvesting material for ballast.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		The project refinements and commitments were presented. The potential harvesting of site preparation material for ballast in gravity base foundations was discussed.	
7 December 2023	NRW: Benthic ecology, fish and shellfish and physical processes EWG	It was reiterated that the impacts of sandwave clearance on the system should be considered in the assessment both in terms of recovery and in combination with both Morgan Generation Assets and Mona Offshore Wind Project. It was stated that secondary scour should be scoped into the assessment. Further information should be provided with respect to the impact of harvesting ballast for gravity foundations.	The potential impact of sandwave clearance is discussed in section 1.9.5 whilst cumulative impacts are presented in section 1.11.5. Secondary scour is discussed and assessed in section 1.9.5 which also includes an assessment of the potential impact of harvesting material for ballast.

1.4 Baseline methodology

1.4.1 Relevant guidance

1.4.1.1 Specific to the physical processes baseline, the following guidance documents have also been considered:

- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards, Natural England, (Natural England and Defra, 2022)
  - Part 1: Baseline characterisation surveys
  - Part 2: Pre-application engagement and the evidence plan process
  - Part 3: Data and evidence expectations at examination
  - Part 4: Post-consent monitoring and other environmental requirements
- Nature considerations and environmental best practice for subsea cables in English inshore and UK offshore waters, (Natural England and JNCC, 2022)
- Guidelines in the use of metocean data through the lifecycle of a marine renewable's development (Cooper *et al*., 2008)
- Physical processes guidance to inform EIA baseline survey, monitoring and numerical modelling requirements for major development projects with respect to marine, coastal and estuarine environments, GN041, Natural Resources Wales, Marine Programming Planning and Delivery Group (NRW, 2020)
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2, Department of the Environment, Climate and Communications, (DECC, 2018)
- Collaborative Offshore Wind Energy Research into the Environment (COWRIE) - Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment (Lambkin *et al*., 2009)
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments. NRW Report No 208, 139pp, Natural Resources Wales. (Pye *et al*., 2017)
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects, NRW Report No: 243, 119 pp, Natural Resources Wales, Cardiff. (Brooks *et al*., 2018).

1.4.2 Scope of the assessment

1.4.2.1 The scope of this Environmental Statement has been developed in consultation with relevant statutory and non-statutory consultees as detailed in Table 1.5. The potential effects scoped into the physical processes assessment can largely be broken down into two main groups; those related to the installation and maintenance of the infrastructure which are associated with increased SSC and those related to the presence of the infrastructure which are related to changes in physical processes, (e.g. tides, waves and sediment transport). During the construction phase the potential changes to physical processes will gradually increase as the site is built out.

1.4.2.2 Taking into account the scoping and consultation process, Table 1.5 summarises the issues considered as part of this assessment.

Table 1.5: Issues considered within this assessment.

Activity	Potential effects scoped into the assessment
Construction phase	
Site preparation and sandwave clearance Foundation installation Cable installation	Increase in SSC and subsequent deposition
Presence of infrastructure • Wind turbines • OSPs • Cable protection • Scour protection	Change to the tidal regime Change to the wave regime Change to sediment transport and sediment transport pathways Change to temperature and salinity stratification
UXO clearance	Change to sediment transport and sediment transport pathways
Harvest material for gravity base foundation ballast	Change to sediment transport and sediment transport pathways
Operations and maintenance phase	
Cable repair and reburial	Increase in SSC and subsequent deposition
Presence of infrastructure • Wind turbines • OSP • Cable protection • Scour protection	Change to the tidal regime Change to the wave regime Change to sediment transport and sediment transport pathways Change to temperature and salinity stratification
Decommissioning phase	
Cable removal Foundation removal • Suction caisson jackets • Gravity base foundations	Increase in SSC and subsequent deposition
Presence of infrastructure • Cable protection • Scour protection	Change to the tidal regime Change to the wave regime Change to sediment transport and sediment transport pathways Change to temperature and salinity stratification

1.4.2.3 Effects which are not considered likely to be significant have been scoped out of the assessment. A summary of the effects scoped out, together with justification for scoping them out is presented in Table 1.6. The approach has been discussed and agreed with key stakeholders through either scoping or consultation as outlined in section 1.8.

Table 1.6: Impacts scoped out of the assessment for physical processes.

Potential impact	Justification
Changes to bathymetry due to depressions left by jack-up vessels.	The potential for jack-up vessel feet to affect the sediment regime has been scoped out of the assessment. Jack-up footprint depressions would occur in sandy/loose material as the equipment is installed. The maximum area per foot is 350 m^2 where the vessel may have four to six legs. The penetration range is 2 m to 10 m. On removal the depression would be partially infilled by gravity and then, over time, be infilled by the mobile seabed sediments. The extent of temporary depressions, following completion of jack-up operations, would be limited to the immediate area of the jack-up footprint therefore, short term changes to bathymetry would have negligible impacts on tidal currents and sediment transport regimes. Monitoring at the Barrow offshore wind farm showed depressions were almost entirely infilled 12 months after construction (BOWind, 2008). Although the monitoring study was undertaken during the first year of operation of Barrow Offshore Wind Farm (post construction monitoring initiated 1July 2006) it included oceanography, seabed morphology (scour etc.) and bathymetry. The wind farm is located in the eastern Irish Sea near Barrow-in Furness and therefore provides relevant, applicable datasets in compliance with regulatory standards.
Changes to sediment transport due to depressions left by jack-up vessels.	Changes to bathymetry and hydrography are intrinsically linked to sediment transport. When jack-up barges are removed the source of scour is also eradicated. The gradual infilling is not anticipated to significant implications for the sediment regime, due to the scale and nature. It is also noted that although the impact of jack-up vessels is scoped out of the physical processes assessment it is assessed in terms of benthic ecology in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.
Scour of seabed sediments during the construction and operations and maintenance phases (i.e. without the provision of scour protection).	Interaction between the waves, current and the Morgan Generation Assets infrastructure has the potential to cause localised scouring of seabed sediment. Scour protection will be a measure adopted as part of the project to prevent scour from occurring, as detailed in Table 1.14. The Applicant has commitment to development of and adherence to an Offshore CMS which will include details of scour protection management to be used around offshore structures and foundations to reduce scour. Scour protection will be installed at the same time as the infrastructure. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour and therefore any impacts would relate only to residual/secondary scour which is considered in section 1.9.5. The volume and extent of scour protection material outlined within Volume 1, Chapter 3: Project description is based on conservative values. For example, scour protection is extended to 3.5 times the external diameter of the structure and the scour protection height of 2.5 m includes a 10% contingency. The assessment of impacts with scour protection absent was therefore scoped out, and this was with the agreement stakeholders through scoping and consultation via the EWG, (Consultation Report - Consultation Report Appendices). It is noted that consented offshore wind farm developments such as Awel y Môr (RWE, 2022) and Hornsea Three (Orsted, 2018) undertook a similar approach to that adopted for Morgan Generation whereby scour protection was included as standard within modelling studies and impact assessments as part of the in-built mitigation.

1.4.3 Methodology to inform baseline

1.4.3.1 The baseline environment was established by undertaking a desktop study utilising existing studies and datasets as described in the following section.

1.4.4 Study area

1.4.4.1 The Morgan physical processes study area is illustrated in Figure 1.2 and encompasses the:

- Morgan Array Area (i.e. the area within which the wind turbines, foundations, inter-array cables, interconnector cables and Offshore Substation Platforms (OSPs) forming part of the Morgan Generation Assets will be located)
- Morgan Potential Array Area (which is the area presented within the PEIR, and also the area used for the Morgan modelling)
- Seabed that may be influenced by changes to physical processes due to the Morgan Generation Assets defined as one spring tidal excursion which is the distance suspended sediment is transported prior to being carried back on the returning tide.

1.4.4.2 It is however noted that the Morgan physical processes study area forms the focus for the assessment and that the numerical modelling study undertaken to support the assessment is not limited to this region, as detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The physical processes modelling study therefore also identifies any potential impacts beyond the Morgan physical processes study area. The Morgan physical processes study area for the CEA presented in section 1.10 is defined as two spring tidal excursions which represents where study areas for adjacent projects and developments, defined in a similar way, may intersect.

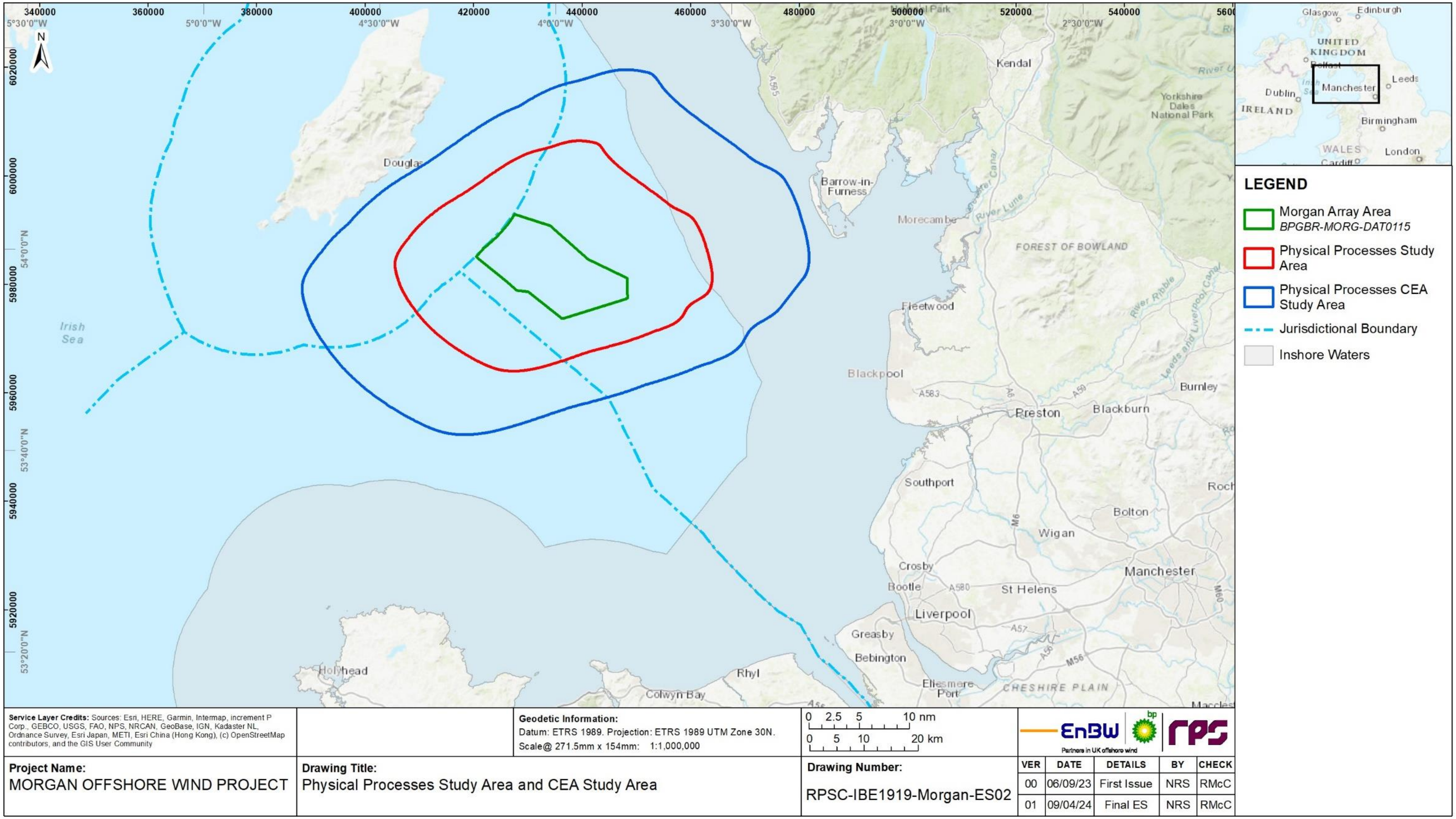


Figure 1.2: Physical processes study area and CEA study area.

1.4.5 Desktop study

1.4.5.1 Information on physical processes within the physical processes study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 1.7 below. The baseline was characterised by a combination of literature review of the reports and numerical modelling using the datasets. Full details of the analysis undertaken to develop the physical processes baseline is provided in the Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

Table 1.7: Summary of key desktop reports.

Title	Source	Year	Author
Mona Offshore Wind Project. PEIR.	https://www.morganandmona.com/en/	2023	Mona Offshore Wind Limited
Morgan Offshore Wind Project. PEIR.	https://morecambeandmorgan.com/morgan/	2023	Morgan Offshore Wind Limited
Geological Ground Model Morgan: Morgan Windfarm Development Irish Sea	Morgan Offshore Wind Limited	2023	bp/EnBW
Assessment of Seabed Level Vertical Variability for Morgan Offshore Wind Farm, Morphodynamic Characterisation, Morphological Analysis and Prediction of Future Seabed Levels	Morgan Offshore Wind Limited	2023	ABPmer
European Marine Observation and Data Network (EMODnet) – Seabed classification	https://www.emodnet-geology.eu/	2022	EMODnet
EMODnet – Bathymetry data	https://www.emodnet-bathymetry.eu/	2022	EMODnet
EMODnet – Metocean data	https://map.emodnet-physics.eu/	2022	EMODnet
Department for Environment Food and Rural Affairs (DEFRA) – Bathymetry data	https://environment.data.gov.uk/DefraDataDownload	2022	DEFRA
The Environment Agency National LiDAR Programme	National LIDAR Programme – http://data.gov.uk	2022	Environment Agency
National Oceanic and Atmospheric Administration (NOAA) – Atmospheric data	DHI Metocean Data Portal	2022	NOAA
National Network of Regional Coastal Monitoring Programmes	https://coastalmonitoring.org/cco/	2022	Coastal Channel Observatory
Centre for Environment, Fisheries and Aquaculture Science (CEFAS) – wave data	https://wavenet.cefas.co.uk/map	2022	CEFAS
ABPmer Data explorer	https://www.seastates.net/explore-data/	2022	ABPmer
Hydrography of the Irish Sea, SEA6 Technical Report	UK Government	2005	Howarth M.J.

Title	Source	Year	Author
Manx Marine Environmental Assessment: Chapter 2 – Physical Environment	https://www.gov.im/about-the-government/departments/infrastructure/harbours-information/territorial-seas/manx-marine-environmental-assessment/	2018	Kennington, K. and Hiscott, A. Department of Environment, Food and Agriculture: Isle of Man
Atlas of UK Marine Renewable Energy Resources	https://www.renewables-atlas.info/	2022	ABPmer
Geology of the seabed and shallow subsurface: The Irish Sea.	BGS	2015	Mellett *et al.*
British Geological Survey – sediment sample data	https://mapapps2.bgs.ac.uk/geoindex_offshore	2022	BGS
Suspended Sediment Climatologies around the UK.	Department for Business, Energy & Industrial Strategy (BEIS)	2016	Cefas
Metocean Data collection for the Ormonde offshore wind project.	Marine Data Exchange	2011	Geotechnical Engineering and Marine Surveys (GEMS)
Irish Sea Zone R3 Hydrodynamic measurement campaign	Marine Data Exchange	2010 to 2013	EMU Ltd (now Fugro Ltd)
Rhiannon Wind Farm Preliminary Environmental Information – Volume 2 – Technical Appendices Appendix 7: Physical Processes	Marine Data Exchange	2011	Centrica Energy / Dong Energy
Admiralty Tide Tables	United Kingdom Hydrographic Office (UKHO)	2022	UKHO
Marine Environmental Data Information Network (MEDIN) Seabed Mapping Programme	Admiralty Marine Data Portal	2022	MEDIN
Integrated Mapping for the Sustainable Developments of Ireland's Marine Resource (INFOMAR) Seabed Mapping Programme	Geological Survey Ireland (GSI) and Marine Institute	2022	INFOMAR
Long term wind and wave datasets	European Centre for Medium-range Weather Forecast (ECMWF)	2022	ECMWF
UK tide gauge network and database of current observation	British Oceanographic Data Centre (BODC)	2021	BODC
UK Climate Projections (UKCP)	Met Office	2018	Met Office
A user-friendly database of coastal flooding in the UK from 1915-2014	Scientific Data (journal)	2015	Haigh *et al.*
British Oceanographic Data Centre	National Oceanography Centre	Various	National Oceanography Centre
Designated sites (SPAs and SACs)	JNCC mapping data https://jncc.gov.uk/mpa-mapper/	2022	JNCC
Designated sites (SSSIs)	Defra Spatial Data Download	2022	DEFRA

Title	Source	Year	Author
Designated Ramsar sites	Map (https://www.ramsar.org/)	2022	Ramsar

1.4.6 Identification of designated sites

1.4.6.1 All designated sites within the physical processes study area and qualifying interest features that could be affected by the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the physical processes study area were identified using a number of sources. Using the JNCC website (https://jncc.gov.uk/mpa-mapper/), the Ramsar website (ramsar.org) and DEFRA website (https://environment.data.gov.uk/)
- Step 2: Information was compiled on the relevant geomorphological/coastal features for each of these sites
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Morgan Array Area therefore has the potential to be directly affected by the Morgan Generation Assets; or
  - Sites and associated qualifying interests were located within the potential Zone of Influence (ZoI) for impacts associated with the Morgan Generation Assets.

1.4.7 Site specific surveys

1.4.7.1 In order to inform this chapter, site-specific surveys were undertaken, as agreed with the JNCC and Natural England. A summary of the surveys undertaken to inform the physical processes impact assessment is outlined in Table 1.8 below.

Table 1.8: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Environmental Baseline Surveys and Habitat Assessments	Morgan Array Area	Geophysical, geotechnical and environmental survey to determine characteristics of seabed sediment, characterise benthic communities (infauna and epifauna) and identification of any environmentally significant habitats (e.g., potential Habitats Directive Annex I and priority marine features). The geophysical survey elements consisted of multi-beam echo sounder (MBES), digital sound velocity (DSV) sensor, side scan sonar system (SSS), Sub-Bottom Profiler (SBP) & 2D Ultra High Resolution Seismic (2D UHRS) sensor.	Gardline Ltd	2021	Gardline (2022)

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Geophysical survey	Morgan Array Area	Geophysical survey to establish bathymetry, seabed sediment and identify seabed features. Deployment included MBES with multibeam backscatter.	XOCEAN Ltd	2022	XOcean (2022)
Metocean survey	Morgan and Mona Array Area	Metocean and floating lidar deployments to ascertain wind, wave and tidal currents.	Fugro	2022	Fugro (2022)
Environmental Baseline Surveys and Habitat Assessments	Morgan and Mona Array Areas and Mona Offshore Cable Corridor and Access Areas	Deployment included multi-beam echo sounder (MBES), digital sound velocity (DSV) sensor, side scan sonar system (SSS), Sub-Bottom Profiler (SBP) & 2D Ultra High Resolution Seismic (2D UHRS) sensor. Additionally, seabed imagery was collected along with grab samples and Particle Size Analysis (PSA) undertaken.	Gardline Ltd	2022	Ocean Ecology (2023)

1.5 Baseline environment

1.5.1 Overview

1.5.1.1 A summary of the physical processes baseline environment is provided in the following sections. Full details of the analysis undertaken to develop the physical processes baseline for the supporting modelling study is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, which includes information on model development, resolution, calibration and the modelling techniques implemented to develop the baseline characteristics.

Bathymetry

1.5.1.2 Seabed levels across the Morgan Array Area range from depths of 32 m to 54 m Mean Sea Level (MSL) with a deeper corridor travelling across the Morgan Array Area from the southwest to the northeast, as illustrated in Figure 1.3. Shallower depths are observed in the north and the south of the Morgan Array Area.

Hydrography

1.5.1.3 The Morgan Array Area has an average tidal range of 3.65 m as published by Admiralty UKHO at Holyhead and a mean tidal range of 4.55 m at the standard port of Douglas. These ports are one of a number in the proximity of the physical processes study area and were used as a calibration point alongside several other reference points taken across the model domain, as detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

1.5.1.4 Semi-diurnal tides are the dominant physical process in the Irish Sea coming from the Atlantic Ocean through both the North Channel and St Georges Channel. The tidal range in the Irish Sea is highly variable with a range greater than 10 m on the largest spring tides, the second largest in Britain.

1.5.1.5 Across the Morgan Array Area, the tidal current floods to the eastnortheast and ebbs to the westsouthwest. A flood dominance is more evident and pronounced during spring tides (Fugro, 2022). The tidal flow is characterised by relatively strong flows during spring tides; with tidal current speeds typically between 0.8 m/s and 0.9 m/s during flood tide and slightly weaker ebb tide currents between 0.7 m/s and 0.8 m/s. Tidal flow fields for the east Irish Sea are presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

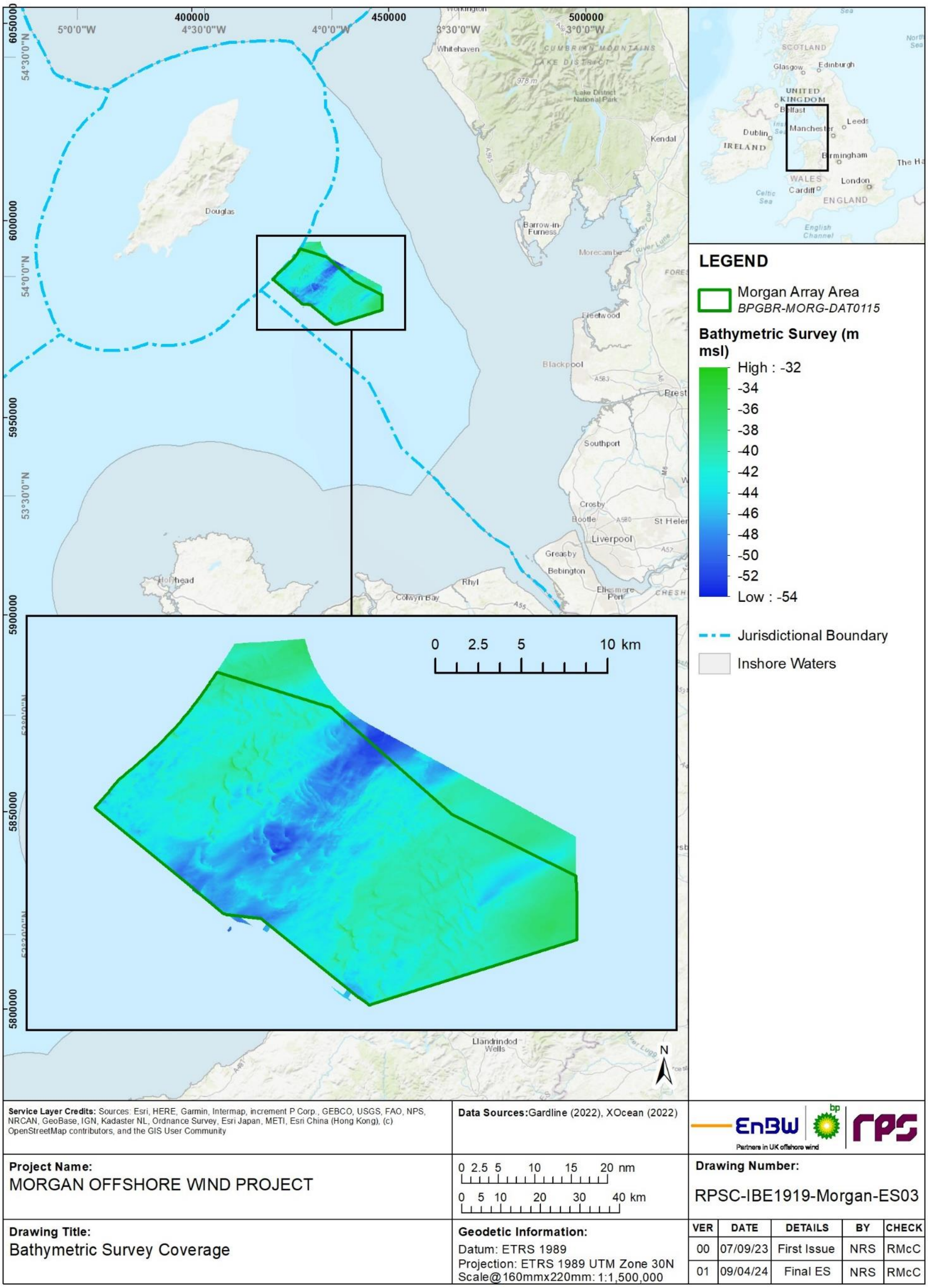


Figure 1.3: Bathymetric surveys coverage undertaken by Gardline (2022) and XOCEAN (2022).

Wave climate

1.5.1.6 Characteristic of the east Irish Sea, waves are generated by either local winds or from remote winds (swell waves). At the centre of the Morgan Array Area, the largest proportion of waves approach from southwest sectors, typically combined wind and swell for the Irish Sea. However, a wave field can also develop from the north of the Morgan Array Area as there is a sufficient fetch length.

1.5.1.7 The wave climate in the Morgan Array Area is described as having dominant short period, southwest direction waves. During the metocean buoy deployment the largest wave height recorded was 8.92 m (Hmax) during Storm Franklin (Fugro, 2022).

1.5.1.8 The highest mean annual significant wave height of 1.39 m was recorded between the Isle of Man and Anglesey with the significant wave height reducing closer to the coast with a low of 0.73 m recorded to the west of the Dee Estuary (ABPmer, 2008).

1.5.1.9 Within the Morgan Generation Assets mean annual wave height ranges from 1.1 m to 1.3 m. Over 50% of waves arise from the southwest and all significant wave heights greater than 4 m originate from the southwest, as illustrated in Figure 1.4 (ABPmer, 2018).

1.5.1.10 Further detail on the wave climate analysis is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

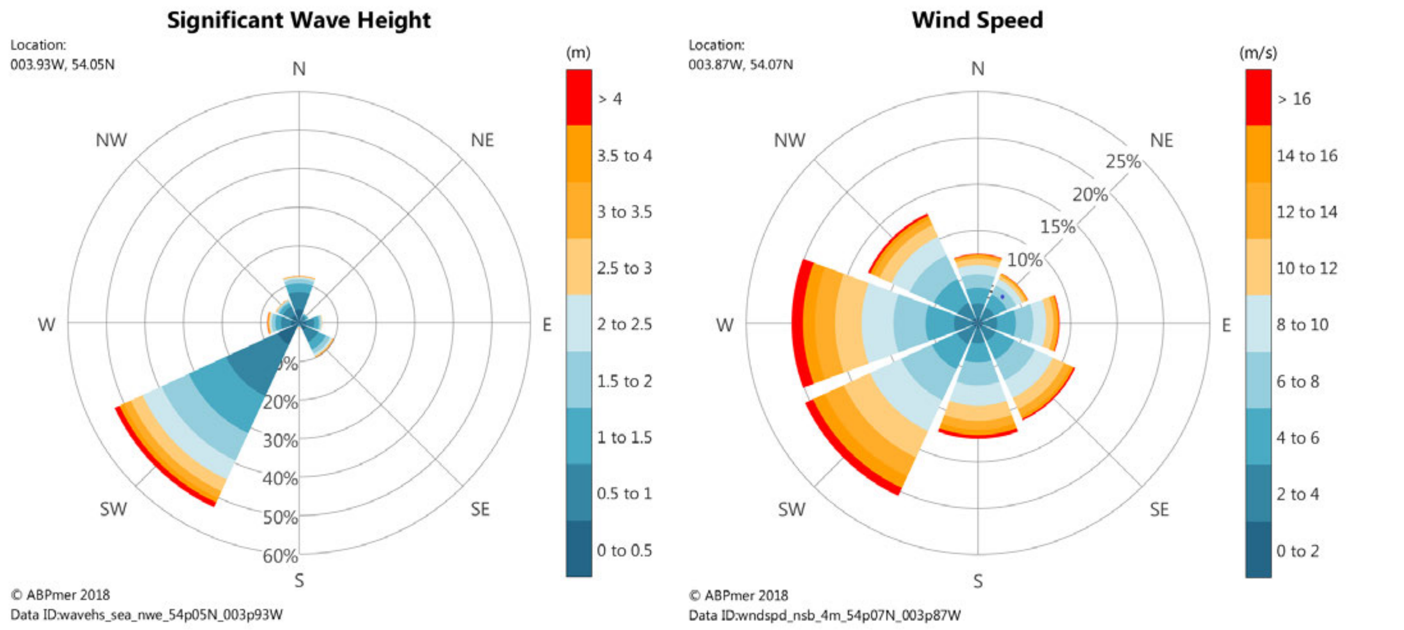


Figure 1.4: Significant wave height (left) and wind speed (right) Morgan Array Area.

Littoral currents

1.5.1.11 Littoral currents are driven by tides, waves, and meteorological events. The littoral currents were modelled from the westerly sector (270°) during a 1 in 1 year storm event, resulting in the increase of currents on the peak flood tide to circa 0.8 to 0.9 m/s and reducing to 0.7 to 0.8 m/s during the peak ebb within the Morgan Array Area. With the largest and most prevalent waves approaching from the southwest, these waves cause an increase in currents during the flood tide and a decrease on the ebb tide.

Sedimentology

1.5.1.12 Across the Morgan Array Area, the underlying geology consists of Triassic and Carboniferous sandstone and mudstone bedrock lithologies (Mellett *et al*., 2015). The geophysical features and sediment characteristics are evidenced of the glacial activity in the Celtic Sea, (Van Landeghem *et al.*, 2020). Potential weathering during the last glacial period may have weakened the uppermost surface of underlying bedrock (Mellett *et al.,* 2015). Quaternary sediment thickness in the central Irish Sea is <20 m although in short distances this can increase to >100 m due to the presence of glacial valleys. However, in the east and west of the Irish Sea sediment thickness is circa 50 m (Mellett *et al.,* 2015).

1.5.1.13 In the Irish Sea, there is a high variability in the bedforms ranging from very small ripples (5 cm high) to very large sediment waves (>10 m high). Within the Morgan Array Area areas of megaripples <2.5 m are largely concentrated to the east with a belt of Barchan Dunes, >2.5 m and, in some locations up to 8 m, in the central and north section. Figure 1.5 presents the bathymetry for a section to the north of the Morgan Array Area, which clearly indicates the range and scale of sandwaves and dunes.

1.5.1.14 The seafloor morphology of the Morgan Array Area also includes several distinct features such as sandwaves, megaripples and sediment waveforms (XOCEAN, 2022 and Gardline, 2022), as illustrated in Figure 1.6. Seabed substrate within the Morgan Array Area ranged from sand, sandy gravel, and gravelly sand as illustrated in Figure 1.7, where both seabed classification and PSA sample data is presented.

1.5.1.15 A detailed analysis was undertaken of the geophysical and geotechnical data collected during the site-specific surveys undertaken for the project (bp/EnBW, 2023a and bp/EnBW, 2023b). Several glacial features were observed, particularly in the west and central section of Morgan Array Area. Generally, the composition of these features is expected to be highly variable, but gravels and boulders expected to be very common. These features highlight that the seabed substrate would be derived from glacial origins and would be termed moraines which are comprised of glacial till. This is consistent with the Devensian Glacial which has been developed and verified by the BGS as being consistent with the Regional Glacial Model.

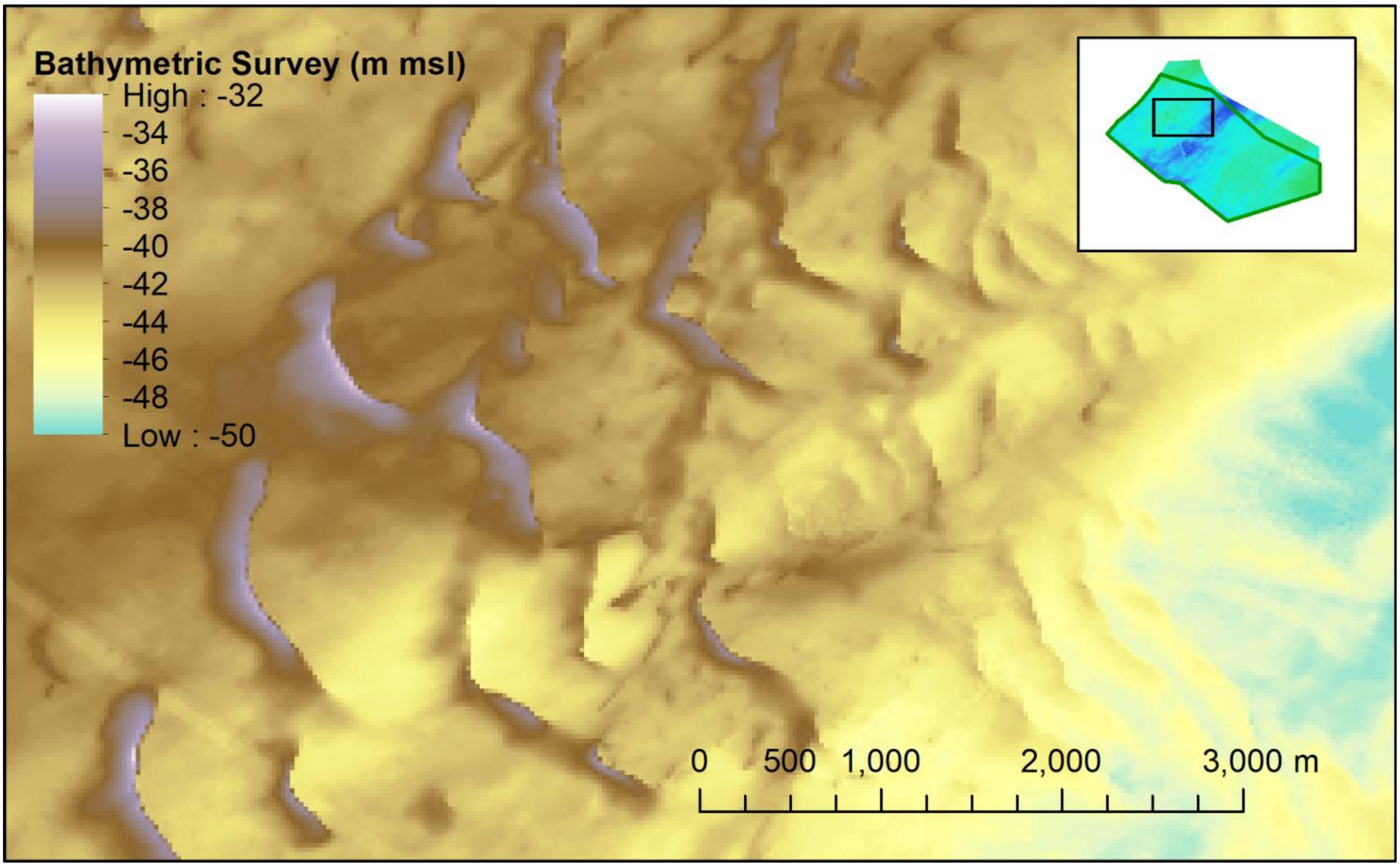


Figure 1.5: Area of sandwave features Morgan Array Area Gardline Ltd. (2022) and XOCEAN (2022).

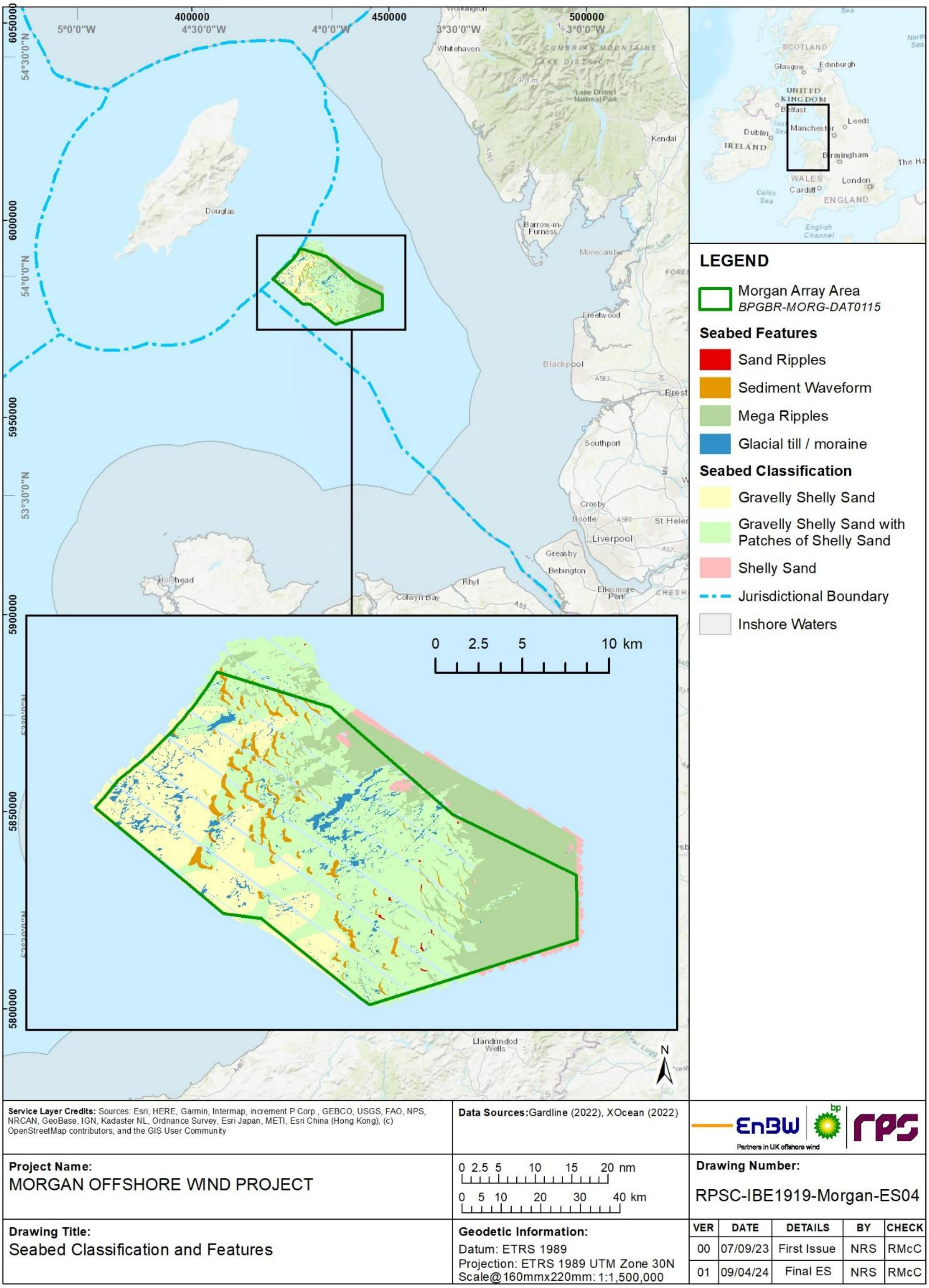
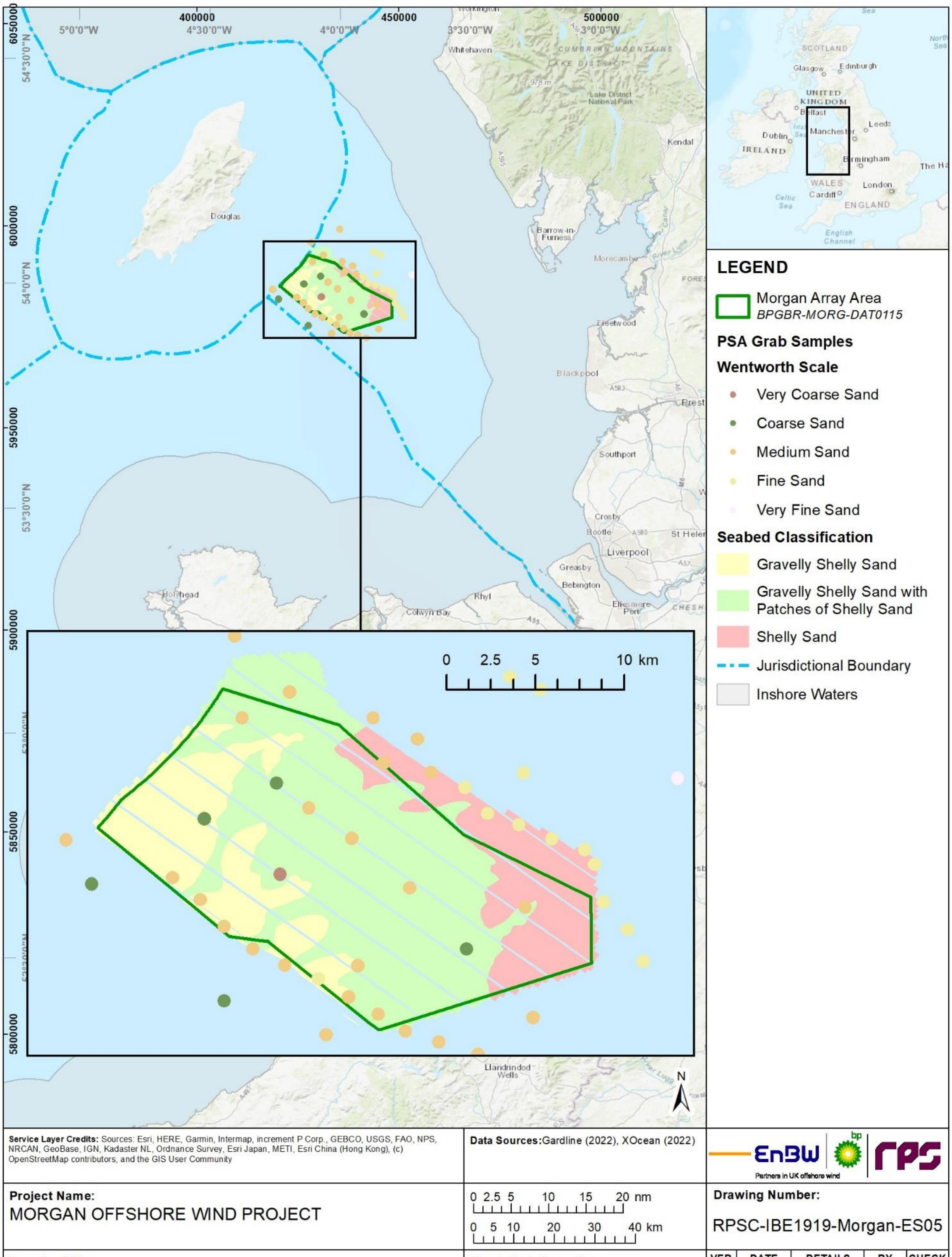


Figure 1.6: Sediment classification and seabed features characterised by Gardline Ltd. (2022) and XOCEAN (2022).



VER	DATE	DETAILS	BY	CHECK
00	07/09/23	First Issue	NRS	RMcC
01	09/04/24	Final ES	NRS	RMcC

Figure 1.7: Sediment classification and PSA sample locations by Gardline Ltd. (2022) and XOCEAN (2022).

Stratification

1.5.1.16 The temperature distribution of the east Irish Sea is dominated by vertical exchanges and heat input at the sea surface leading to seasonal cycles. The water is coolest in February or March with temperature decreasing from the deeper channel towards the coasts (Howarth, 2005). The coolest water is located towards the coast in the east Irish Sea – between the Solway Firth and Liverpool Bay where the temperature is below 5ºC (Howarth, 2005). The temperatures are highest in August with the warmest water close to the coasts, exceeding 16ºC in Liverpool Bay (Howarth, 2005).

1.5.1.17 The annual mean salinity decreases from south to north and from the centre of the channel to the edges. In the east Irish Sea there is often a marked change in salinity, running approximately north/south at the east Irish front at the west side of the Isle of Man (Foster *et al*, 1985). Seasonal variations are much less pronounced than for temperature, especially away from the coasts (Howarth, 2005).

1.5.1.18 Across the east side of the Irish Sea region most of the water column becomes thoroughly mixed due to the occurrence of sufficiently intense tidal mixing throughout the year (Howarth, 2005). To the east of Isle of Man marginal stratification occurs during hot, calm conditions yet can be mixed away with easily by storms or spring tides (Howarth, 2005). Within the physical processes study area, the difference between the salinity at the bed and surface may reach 1 PSU and is generally semidiurnal in nature but may persist for up to three days during neap tides when lower current speeds reduce mixing, (Simpson *et al*, 1991). Stratification of the water column can occur in estuaries and especially in Liverpool Bay and the Dee Estuary as fresh water is lighter than salty water. These conditions are mostly characteristic of neap tides with calm conditions and river discharges (Howarth, 2005).

Sediment transport

1.5.1.19 There are strong circulatory currents in the east Irish Sea where tidal flows interact with headlands and embayments. The greatest sediment transport rates are evident in estuaries and at headlands where finer sand fractions are present and where tidal currents are strongest. The littoral currents and dominant flood tide subsequently increase sediment transport during storm conditions.

1.5.1.20 Within the Morgan Array Area, the residual current speeds are several orders of magnitude smaller than those along the coastline. Residual currents are the net flow over a full tidal cycle and drive the sediment transport. Residual currents flow into the east Irish Sea from the north of the Isle of Man and also west around Anglesey. This correlates with this region being a sediment sink. In the Morgan Array Area, sediment transport rates are highest during springs on the flood tide, with total sediment loads of up to 0.0001 $m^3/s/m$ and 0.00005 $m^3/s/m$ on the peak of the flood and ebb tides respectively. Net sediment transport rates are circa 0.4 $m^3/d/m$ to 1.5 $m^3/d/m$ within the Morgan Array Area. Net sediment transport occurs in a north easterly direction with bed load in the order of 15,000 m^3 per day through the Morgan Array Area.

1.5.1.21 The sediment transport may give rise to changes in bed levels if sediment supply is not maintained and also the potential migration of seabed features. Studies of undertaken of both bathymetric data collected for this project and historic data indicated no significant short term (i.e. <1 year) or long term variation in bed level. In the short term there was little or no significant evidence of net migration whilst in the longer term the larger known (barchan dune and sandwave) bedforms are mobile and responsible for a proportional magnitude of bed level variation, with migration rates of *circa* 1 m per year, (ABPmer, 2023).

1.5.1.22 Modelling undertaken for the Morgan Seabed Mobility Study (ABPmer, 2023) examined sediment transport patterns over the course of a spring-neap tidal period and confirmed the findings of the shorter period refined modelling undertaken and presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Typically, net sediment transport occurs in an easterly direction with bed load in the order of 0.75 m^3/d/m. The Morgan Seabed Mobility Study examines the variation of sediment transport patterns over a longer spring-neap tidal period however with a model resolution of 500 m in this area it would not encompass the variations across individual barchan dunes and megaripples features. The detailed model indicated that localised net transport across these features may be two or three times the magnitude of the surrounding environment.

1.5.1.23 The physical processes study area largely coincides with the Solway Firth sediment cell and sub-cell 11a Great Orme's Head to Southport Pier. In the sub-cell 11a the general direction of sediment transport is west to east. This direction of travel supplies the southeast shoreline with sediment (Price *et al.*, 2010).

Suspended sediments

1.5.1.24 Turbidity and SSC are regulated by tidal currents and intensify during wind-driven storm events. SSC levels have a seasonal pattern due to the seasonality of storm events. Offshore monitoring within the proposed Morgan Generation Assets recorded typical SSC levels of 3 mg/l, however as expected during a storm event this increased to circa 20 mg/l corresponding with increased wave heights (Fugro, 2022).

1.5.1.25 Cefas records SSC as non-algal suspended particulate matter (SPM). Within the Morgan Array Area, this was estimated to be on average 0.9 mg/l to 3 mg/l between 1998 and 2015 (Cefas, 2016). These values display a seasonal pattern with heightened levels during winter months and are regulated by tidal currents.

1.5.2 Designated sites

1.5.2.1 Using the JNCC database (https://jncc.gov.uk/mpa-mapper/), all designated sites within the physical processes study area that could be affected by the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets were identified for the physical processes chapter and are described in Table 1.9 and illustrated in Figure 1.8.

Table 1.9: Designated sites and relevant qualifying interests for the physical processes chapter.

Designated site	Closest distance to the Morgan Array Area (km)	Relevant qualifying interest
West of Copeland MCZ	8.8	Protected feature: • Subtidal sand • Subtidal coarse sediment • Subtidal mixed sediments.
West of Walney MCZ	9.3	Protected feature: • Subtidal sand • Subtidal mud • Sea-pen and burrowing megafauna communities.

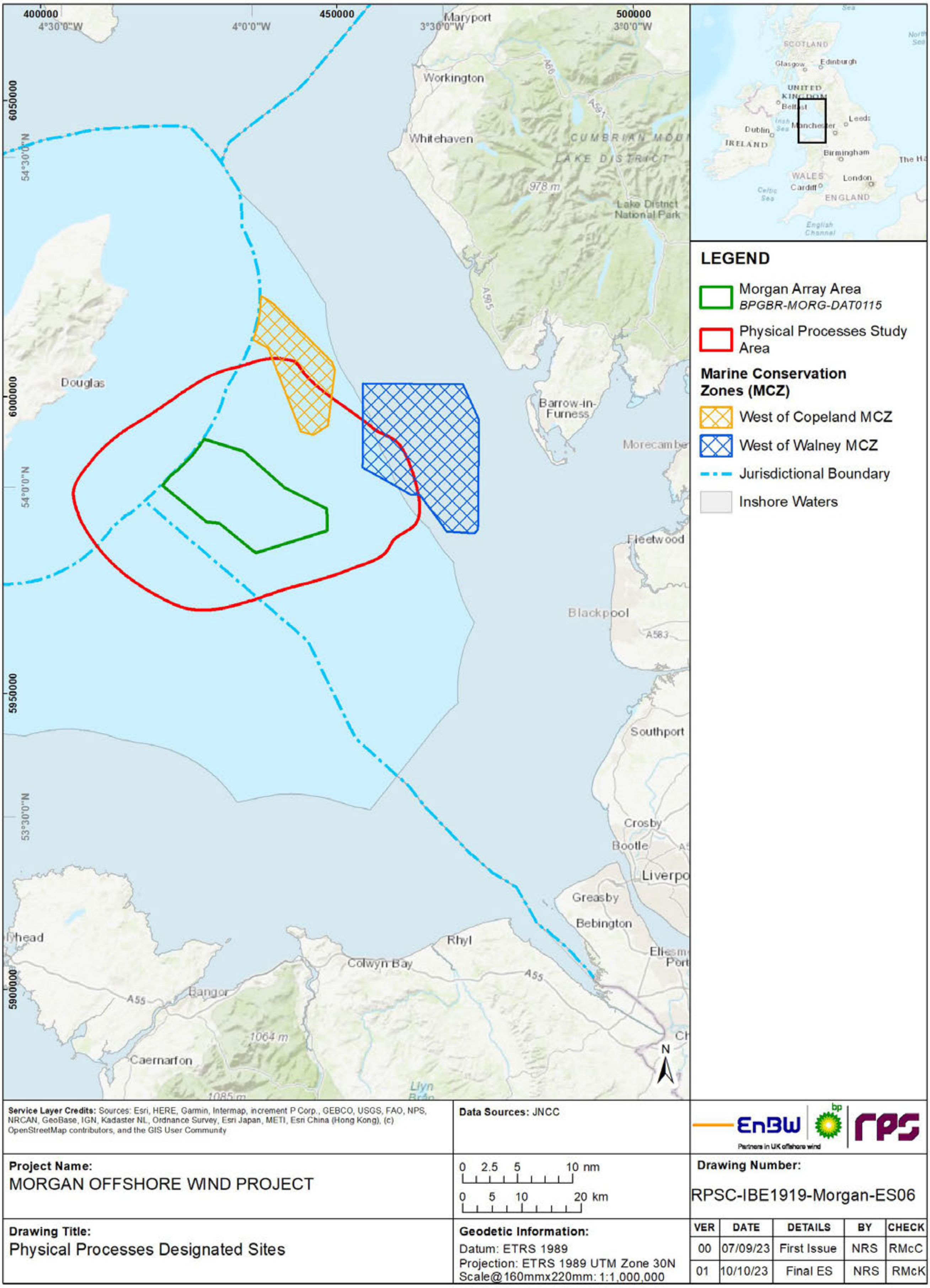


Figure 1.8: **Designated sites relevant to the Morgan Generation Assets physical processes chapter.**

1.5.3 Future baseline scenario

1.5.3.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that "*an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*" is included within the Environmental Statement. In the event that Morgan Generation Assets does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

1.5.3.2 The baseline environment for physical processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the Morgan Generation Assets in place due to natural variability. It is noted that the scale of the present day bedforms is small in comparison to the depth of the non-mobile layer, therefore current processes would continue within the lifetime of the project, (ABPmer, 2023).

1.5.3.3 Future baseline conditions would be altered by climate change resulting in sea level rise and increased storminess. This is unlikely to have the effect of significantly altering tidal patterns and sediment transport regimes offshore at the Morgan Array Area. The return period of the wave climates would be altered (e.g. what is currently defined as a 1 in 50 year event may become a 1 in 20 year event) as deeper water would allow larger waves to develop.

1.5.3.4 Although increased water depth would potentially increase the wave climate, sandwave migration is driven by tides and sediment source rather than waves (Kenyon *et al*, 2005). Therefore, features such as the sandwaves and megaripples found in the Morgan Array Area would continue to develop regardless of wave climate. There is, however, a notable degree of uncertainty regarding how future climate change will impact prevailing wave climates within the Irish Sea and beyond.

1.5.4 Data limitations

1.5.4.1 The physical processes study area has been the focus of study for both academic and government institutions. Additionally, significant data collection campaigns have been undertaken by the Applicant and other offshore wind farm developers in the locality. Although some physical processes are complex and inter-related, there is a significant amount of data available. It is therefore considered that the data used in this assessment are robust and sufficient for the purposes of the impact assessment presented.

1.5.4.2 The geophysical survey for the Morgan Generation Assets was undertaken in summer 2022 and preliminary data was utilised in the physical processes modelling study presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. A review of the finalised datasets determined that the use of the preliminary data was legitimate. Similarly, the open source datasets used for sediment grading in the modelling study (BGS, 2022) were found to be consistent with PSA undertaken on the site specific sample data (Ocean Ecology, 2023).

1.6 Impact assessment methodology

1.6.1 Overview

1.6.1.1 The physical processes impact assessment has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement. Specific to the physical processes impact assessment, the following guidance documents have also been considered:

- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards, Natural England, (Natural England and Defra, 2022)
  - Part 1: Baseline characterisation surveys
  - Part 2: Pre-application engagement and the evidence plan process
  - Part 3: Data and evidence expectations at examination
  - Part 4: Post-consent monitoring and other environmental requirements
- Nature considerations and environmental best practice for subsea cables in English inshore and UK offshore waters, (Natural England and JNCC, 2022)
- Collaborative Offshore Wind Energy Research into the Environment (COWRIE) - Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment (Lambkin *et al*.,2009)
- Guidelines in the use of metocean data through the lifecycle of a marine renewable's development (Cooper *et al*., 2008)
- Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA) (NRW, 2020)
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2, Department of the Environment, Climate and Communications, (DECC, 2018)
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments. NRW Report No 208, 139pp, Natural Resources Wales. (Pye *et al*., 2017)
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects, NRW Report No: 243, 119 pp, Natural Resources Wales, Cardiff. (Brooks *et al*., 2018)
- Guidance on EIS and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects, Department of Communications, Climate Action and Environment, (Barnes, 2017).

1.6.1.2 In addition, the physical processes impact assessment has considered the legislative framework as defined by:

- Overarching NPS for Energy (EN-1; DESNZ, 2023a)
- NPS for Renewable Energy Infrastructure (EN-3, DESNZ, 2023b)
- North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021).

1.6.2 Impact assessment criteria

1.6.2.1 Physical processes are not generally receptors in themselves; they may be a pathway by which coastal features may be impacted or a pathway for indirect impacts on other receptors. For example, increases in suspended sediments during the construction phase may lead to the deposit of these sediments and smothering of benthic habitats. For this impact, the magnitude of the potential changes has been assessed, with the sensitivity of the receptors to these changes and the significance of effects assessed within Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.

1.6.2.2 A full impact assessment has however been provided within this chapter, section 1.9, for the hydrodynamic regime and the sediment transport regime, which have been identified as potentially sensitive physical processes receptors.

1.6.2.3 The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 1, Chapter 5: EIA methodology of the Environmental Statement.

1.6.2.4 The criteria for defining magnitude in this chapter are outlined in Table 1.10 below.

Table 1.10: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
High	Change in physical processes which results in the loss of a coastal feature (e.g. blockage of sediment pathway resulting in loss of spit (Adverse)).
	Change in physical processes which results in the creation of a coastal feature (e.g. reduction in wave climate giving rise to dune formation (Beneficial)).
Medium	Alteration of physical processes which effects the rate at which a coastal feature is maintained (e.g. reduction in accretion rate (Adverse)).
	Alteration of physical processes which effects the rate at which a coastal feature is developing (e.g. reduction in erosion rate (Beneficial)).
Low	Variation in physical processes which maintains the coastal feature (e.g. localised change in sediment pathway which does not destabilise bank).
Negligible	Imperceptible variation in physical process (e.g. in the order of natural variability). No observable impact either adverse or beneficial.

1.6.2.5 The criteria for defining sensitivity in this chapter are outlined in Table 1.11 below.

Table 1.11: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Coastal feature forms vital part of a wider scale system which is scarce and non-recoverable.
High	Coastal feature forms part of a wider scale system and is non-recoverable.
Medium	Coastal feature has limited potential for re-creation.
Low	Coastal features of local scale and recoverable.
Negligible	Coastal feature adaptable to changes in physical processes.

1.6.2.6 The significance of the effect upon physical processes is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 1.12. Where a range of significance of effect is presented in Table 1.12, the final assessment for each effect is based upon expert judgement.

1.6.2.7 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

Table 1.12: Matrix used for the assessment of the significance of the effect.

Sensitivity of Receptor	Magnitude of Impact			
	Negligible	**Low**	**Medium**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or Moderate	Moderate or Major	Major
Very High	Minor	Moderate or Major	Major	Major

1.7 Key parameters for assessment

1.7.1 Maximum design scenario

1.7.1.1 The MDS identified in Table 1.13 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the project description provided in Volume 1, Chapter 3: Project description of the Environmental Statement. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within Volume 1, Chapter 3: Project description of the Environmental Statement (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

1.7.1.2 The results of the physical processes study, particularly the numerical modelling output detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement, will be used to support and inform the following Environmental Statement chapters and reports:

- Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement
- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 4: Marine mammals of the Environmental Statement
- Volume 2, Chapter 8: Marine archaeology of the Environmental Statement
- Volume 2, Chapter 9: Other sea users of the Environmental Statement
- ISAA Report (Document reference E.1.1, E.1.2, E.1.3, E1.4 and E1.5)
- MCZ Screening Assessment Report (Document reference E.2).

Table 1.13: Maximum Design Scenario considered for the assessment of potential impacts on physical processes.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	**Construction phase** <u>Site preparation</u>: Sandwave clearance: • Sandwave clearance activities undertaken over an approximate 12-month duration (a nine month duration associated with wind turbines and OSP foundations and a three month duration associated with inter-array cables) within the wider four-year construction programme. • Wind turbines and OSP foundations: sandwave clearance has been calculated on the basis of wind turbine generator foundations and an assumption of clearance at up to 60% of locations. Spoil volume per location has been calculated on the basis of 41 locations supporting the largest suction bucket four-legged jacket foundation with an associated base diameter of 205 m to an average depth of 7.5 m. This equates to a total spoil volume of 10,149,455 m^3 and a volume of 247,548 m^3 per location. • Inter-array cables: sandwave clearance along 156 km of cable length, with a width of 80 m, to an average depth of 3 m. Total spoil volume of 5,026,651 m^3. • Interconnector cables: sandwave clearance along 36 km of cable length, with a width of 80 m, to an average depth of 3 m. Total spoil volume of 518,500 m^3. • Removal of up to 46 km of disused cables. <u>Foundation installation:</u> • Undertaken over an approximate 12-month duration. • Wind turbines:	**Construction phase** <u>Site preparation</u>: • The volume of material to be cleared from individual sandwaves will vary according to the local dimensions of the sandwave (height, length, and shape) and the level to which the sandwave must be reduced. These details are not fully known at this stage, however based on the available data, it is anticipated that the sandwaves requiring clearance in the array area are likely to be in the range of up to 8 m in height. This will be confirmed pre-construction. In all cases the material cleared from the sandwave will be sidecast, (i.e. placed in close proximity to the breach) in order that the sediment is readily available to supply for sandwave recovery. The exception to this will be if the material is used for ballast within the foundation structure (see foundation installation below). For gravity based foundations, sandwave clearance volumes are a maximum of 110,992 m^3 per foundation therefore less than those for the suction bucket foundations even when it is assumed all locations require clearance. • Site clearance activities may be undertaken using a range of techniques. The suction hopper dredger will result in the greatest increase in suspended sediment and largest plume extent as material is released near the water surface during the relocation of material. In reality plough dredging may be implemented however the volume of material brought into suspension would be reduced as material is ploughed along the bed. • Volume 1, Chapter 3: Project description outlines that boulder clearance is anticipated to take the form of side casting. Therefore, boulders may be picked up one by one and moved to the side of the construction area. For the inter-array and interconnector cabling, this would be

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				– installation of 45 with three-legged jacket piles of 5.5 m diameter, drilled to a depth of 75 m at a rate of up to 1.45 m/h, with maximum spoil volume of 2,107 m^3 per pile. – installation of 23 conical gravity base foundations with a caisson diameter of 37 m and a sea surface diameter 15 m. Installation requires dredging of a maximum area of 32,761 m^2 to a maximum depth of 10 m. • OSPs: installation of one OSP with six legs with three piles per leg, each 5.5 m drilled to a depth of 75 m at a rate of up to 1.45 m/h, with maximum spoil volume of 2,107 m^3 per pile. • Two drilled piles installed concurrently at adjacent sites. Cable installation: • Inter-array cables: Installation via trenching of up to 390 km of cable, with a trench width of up to 3 m and a depth of up to 3 m. Total maximum spoil volume of 1,755,000 m^3. Installed over a period of approximately 12 months. • Interconnector cables: installation via trenching of up to 60 km of cable, with a trench width of up to 3 m and a depth of up to 3 m with a V-shaped cross-section. Total spoil volume of 270,000 m^3. Installed over a period of approximately four-months. **Operations and maintenance phase** Project lifetime of 35-years. • Inter-array cables: repair of up 8 km of cable in one event every three years, with a volume of up to 36,000 m^3 displaced material per event. Footprint of seabed disturbed during cable repair is up to 160,000 m^2 per event. Reburial of up to 20 km of cable in one event every five years, with a volume of up to 90,000 m^3 displaced material per event. Footprint of seabed	at least 10 m either side from the centre line of each cable, or removed using a plough where boulders will be pushed out of the way. Boulder clearance activities will therefore result in minimal increases in suspended sediment concentrations and have therefore not been considered in the assessment. Foundation installation: • The dredging and site preparation associated with conical gravity base foundations may involve the use of up to 7,000 m^3 of this material as ballast within the structure. The remaining material will be sidecast in close proximity to be available within the sediment cell for transport and sandwave regeneration • Installation of foundations via augured (drilled) operations results in the release of the largest volume of sediment unrestrained through the water column. The greatest volume of sediment disturbance by drilling at individual locations is associated with the largest diameter pile for wind turbines. It is noted that it is unlikely that drilling would be required to the full depth and the most likely scenario is that piles would be driven, with no drilling required. This would give rise to minimal increases in SSC, however the most arduous scenario has been assessed as the MDS • The maximum number of three legged jacket pile foundations to be installed for the largest wind turbine generators is 45 out of an array of 68 wind turbine generators. Therefore, for the holistic approach of SSC assessment the remaining 23 foundations are conical gravity based foundations with associated dredging activities. • The selected OSP scenario represents the greatest volume of sediment to be released for a drilling event • The greatest drilling rate associated with the largest pile diameter represents the maximum level of increase in suspended sediment concentration.

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				disturbed during cable reburial is up to 400,000 m^2 per event. • Interconnector cables: repair of up to 19.63 km of cable in each of three events every 10 years, with a volume of up to 88,335 m^3 displaced material per event. Footprint of seabed disturbed during cable repair is up to 400,000 m^2 per event based on 19.63 km rounded to 20 km. Reburial of up to 3 km of cable in one event every five years, with a volume of up to 13,500 m^3 displaced material per event. Footprint of seabed disturbed during cable reburial is up to 60,000 m^2 per event. **Decommissioning phase** • Scour and cable protection will remain *in situ*. If suction caissons are removed using the overpressure to release them then suspended sediment concentration will be temporarily increased. • Inter-array and interconnector cables will be removed and disposed of onshore.	Cable installation: • Cable routes inevitably include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential • Cables may be buried by ploughing, trenching or jetting with trenching or jetting mobilising the greatest volume of material to increase suspended sediment concentrations. **Operations and maintenance phase** • The greatest foreseeable number of cable reburial and repair events is considered to the MDS for sediment dispersion. **Decommissioning phase** • The removal of cables may be undertaken using similar techniques to those employed during installation, therefore the potential increases in SSC and deposition would be in-line with the construction phase. • Decommissioning of gravity bases would involve the removal of ballast, including sand sequestered during construction. There is a commitment that this material, which may also include rock will be disposed of off-site (Table 1.14) and therefore only a small proportion of sediment may be released during the removal process.
Impacts to the tidal regime due to presence of infrastructure and the associated potential impacts along adjacent shorelines.	✓	✓	✓	**Construction phase** • During the construction phase the potential changes to receptor pathways will be gradually introduced as the presence of infrastructure increases; reaching the MDS outlined below in the operations and maintenance	Physical processes are comprised of tides, waves and sediment transport and these aspects are integrated (i.e., without the influence of tides and waves there would be no sediment transport) as outlined below:

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Impacts to the wave regime due to presence of infrastructure and the associated potential impacts along adjacent shorelines. Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry. Impacts to temperature and salinity stratification due to the presence of infrastructure.				phase. The MDS in terms of the presence of infrastructure would be on the completion of construction, during the operations and maintenance phase. **Operations and maintenance phase** Holistic MDS for tides, waves and sediment transport • Wind turbines: 68 installations with four-legged suction bucket foundations, each jacket leg with a diameter of 5 m, spaced 48 m apart, and each bucket with a diameter of 16 m. Scour protection to a height of 2.5 m and extending 20 m from the bucket. Total footprint of 10,816 m^2 per wind turbine. • OSPs: one installation with a rectangular gravity base foundation, with an 80 m by 60 m dimension at the surface, a slab base dimension of 100 m by 80 m and with scour protection to a height of 2.6 m and extending 25 m from the base. Total footprint of 19,500 m^2. • Inter-array cables: cable protection along 39 km of the cable, with a height of up to 3 m and up to 10 m width. Up to 10 cable crossings, each crossing has a height of up to 4 m, a width of up to 36 m and a length of up to 80 m. • Interconnector cables: cable protection along 12 km of the cable, with a height of up to 3 m and up to 10 m width. Cable crossings are subject to further survey work. Assessments are carried out on the basis of up to ten crossings as a precautionary measure. Each cable crossing has a height of up to 3 m, a width of up to 20 m and a length of up to 50 m. • Maximum volume of cable protection (inter-array and interconnector) 852,600 m^3. Maximum total seabed footprint area for cable protection 548,800 m^2. Sediment budget • The dredging and site preparation associated with conical gravity base foundations may involve the use of	• The tidal regime is influenced by changes in bathymetry due to the placement of scour protection and the obstruction of tidal flow due to foundation structures within the water column • The wave climate is influenced by obstruction within the water column however changes in bathymetry would only cause effects in shallow water • The sediment transport regime is affected by obstructions in the sediment transport pathways and also potential changes to the littoral currents which drive this process (i.e. those factors which also affect tide and wave climate) • Stratification is governed by the factors controlling mixing therefore the effects on tide and wave climate are common to stratification. As no single parameters occurs in isolation a holistic approach has therefore been applied to compile the MDS. The greatest surface blockage to influence wave climate is from the wind turbines with the largest four-legged suction bucket foundations. The four legs provide a slightly smaller obstruction to tidal flows at each wind turbine site than gravity base foundations however the gravity base obstruction is concentrated towards to the lower section of the water column where tidal currents are weaker and influence of conveyance is therefore reduced. Suction bucket foundations have the largest footprint at each wind turbine in terms of scour protection and provide the greatest influence on bathymetry. The devices also have a greater footprint over the site as a whole rather than the more numerous smaller design options. Sensitivity testing was examined on a single foundation of each of these types, as presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. It was seen that although there were differences in influences in the immediate vicinity of each

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
				up to a total of 490,000 m^3 of this material as ballast in structures at up to 96 locations. Up to 7,000 m^3 of material may be harvested from site preparation activities at any given site. UXO removal • Clearance of up to 13 UXOs within the Morgan Array Area ranging from 25 kg up to 907 kg with 130 kg the most likely (common) maximum. **Decommissioning phase** • During the decommissioning phase the potential changes to the receptor pathway would gradually decrease from the operational MDS as structures are removed and cut below the seabed. • Scour and cable protection will remain in situ and continue to influence tidal regime. • Decommissioning of gravity bases would involve the removal of ballast, including sand sequestered during construction and disposed of off-site.	foundation they would not give rise to a different magnitude of impact. The greatest overall in-water column blockage to influence tidal flow and wave climate from the OSPs is the maximum number of OSPs (four) with gravity base foundations. These parameters also present the largest overall footprints to affect changes in bathymetry and sediment transport pathways. However, the greatest single site influence in terms of OSP structures is the rectangular gravity based structure, which is larger than other foundation options. This was demonstrated in modelling of this single foundation under sensitivity testing presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The volume of material which may harvested from site preparation activities for ballast in gravity based foundations is up to 7,000 m^3 for each location where suitable material is located, up to a total of 490,000 m^3. Less than 7,000 m^3 or indeed no material would be required at a number of locations. Therefore the MDS differs from the holistic assessment applied to tides, waves and sediment transport when sediment budget and the potential impact on sediment transport is considered. Similarly, with regards to UXOs the potential impact on sediment transport is considered. Maximum number and maximum size of UXOs encountered in the Morgan Array Area. Due to uncertainties in size of UXOs the assessment presents a range, highlighting the most likely size (common) to be encountered.

1.8 Measures adopted as part of the Morgan Generation Assets.

1.8.1.1 For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design envelope of the Morgan Generation Assets which are integrated into the application for consent. These measures are secured through the consent itself through the description of the development and the parameters secured in the DCO and/or marine licences (referred to as primary mitigation in IEMA, 2016)
- Measures required to meet legislative requirements, or actions that are generally standard practice used to manage commonly occurring environmental effects and are secured through the DCO requirements and/or the conditions of the marine licences (referred to as tertiary mitigation in IEMA, 2016).

1.8.1.2 A number of measures adopted as part of the Morgan Generation Assets have been proposed to reduce the potential for impacts on physical processes (see Table 1.14). As there is a secured commitment to implementing these measures, they are considered inherently part of the design of the Morgan Generation Assets and have therefore been considered in the assessment presented in section 1.9 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 1.14: Measures adopted as part of the Morgan Generation Assets.

Measures adopted as part of the Morgan Generation Assets	Justification	How the measure will be secured
Primary measures: Measured included as part of the project design		
Development and adherence to an Offshore Construction Method Statement (CMS), which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour as much as is practical. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.	There is the potential for scouring of seabed sediments to occur due to interactions between metocean regime (waves and currents) and foundations or other seabed structures. This scouring can develop into depressions around the structure. The use of scour protection around offshore structures and foundations will be employed, as described in detail in Volume 1, Chapter 3: Project description of the Environmental Statement. The scour protection has been included in the modelled scenarios used within the impact assessment.	The Offshore CMS is secured within the deemed marine licences of the draft DCO.
Development and adherence to an Offshore CMS including a Cable Specification and Installation Plan (CSIP) which will include cable burial where possible and cable protection. Consideration will be given for the use of cable protection which is of such a nature that it may be more readily removable at decommissioning.	To minimise potential impact from the cables and removal of cables a commitment to bury cables where possible has been made in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). The Applicant recognises that the best form of cable protection is achieved through cable burial to the required depths, according to the results of a Cable Burial Risk Assessment and Burial Assessment Study which will be included within the CSIP.	The Offshore CMS is secured within the deemed marine licences of the draft DCO.

Measures adopted as part of the Morgan Generation Assets	Justification	How the measure will be secured
	The burial methodology should select the appropriate tools to endeavour to achieve burial to the required depth of lowering in a single pass, seeking to avoid burial methods that require multiple passes with a burial tool in order to achieve lowering of the cable.	
No more than 5% reduction in water depth (referenced to Chart Datum) will occur without prior written approval from the Licensing Authority in consultation with the Maritime Coastguard Agency (MCA).	As per the standard navigation requirements, the cable protection will cause no more than a 5% reduction in water depth (referenced Chart Datum) without prior written approval from the Licensing Authority in consultation with the MCA. This will ensure any cable protection is sufficiently low profile to cause minimal changes to wave, tide and sediment transport.	A CSIP as part of the Offshore CMS secured within the deemed marine licences within the draft DCO (Document Reference C1).
Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works and within the licenced disposal area applied for (which is the Morgan Array Area).	To retain material within sediment cell and maintain sediment transport regimes.	The Offshore CMS is secured within the deemed marine licences of the draft DCO.
Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	Following the publication of Scoping and PEIR, project refinement has been undertaken to identify opportunities to reduce clearance volumes. Inter-array cable corridor widths and areas have been refined and the volumes of sandwave clearance have been significantly reduced. The commitment to minimise sandwave clearance volumes is included in the project design presented in Volume 1, Chapter 3: Project description of the Environmental Statement.	The Offshore CMS is secured within the deemed marine licences of the draft DCO.
Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: • Avoid UXO • Clear UXO with low order techniques • Clear UXO with high order techniques.	Low order techniques generate less underwater sound than high order techniques and therefore primarily present a lower risk to sound-sensitive receptors such as marine mammals and fish during UXO clearance but would also result in reduced crater depth and smaller areas of seabed disturbance therefore reducing potential impacts of sediment transport regimes.	MMMP secured in the deemed marine licences within the draft DCO.
The decommissioning of gravity bases and the removal of ballast material will not be released back into the local system and beneficial-use of the material will be considered.	There are a range of potential disposal options including onshore disposal outside the marine environment or offshore disposal at a licenced site i.e. ensuring there are no significant impacts on designated sites.	Decommissioning activities secured through separate standalone marine licences and will be determined by the relevant legislation and guidance at the time of decommissioning. The specific approach will be set

Measures adopted as part of the Morgan Generation Assets	Justification	How the measure will be secured
		out in a decommissioning programme as secured within Requirement 10 under Schedule 2 of the draft DCO.
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004.	A decommissioning programme will be submitted to, and approved, by the Secretary of State prior to the commencement of decommissioning works.	Legal obligation of the Energy Act 2004 and secured through condition 5 of the Draft DCO.

1.8.1.3 No effects which are significant in EIA terms have been identified, therefore no further mitigation measures (referred to as secondary mitigation in IEMA, 2016) are proposed.

1.9 Assessment of significant effects

1.9.1 Overview

1.9.1.1 The impacts of the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets have been assessed on physical processes. The potential impacts arising from the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets are listed in Table 1.13, along with the MDS against which each impact has been assessed.

1.9.1.2 A description of the potential effect on physical processes receptors caused by each identified impact is given in the following sections. The assessment is focussed on, but not limited to, areas designated for features related to physical processes, (i.e. the West of Walney MCZ and the West of Copeland MCZ). Further information on the MCZs is provided in Marine Conservation Zone (MCZ) Assessment Report (Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement) whilst impact assessments relating to important habitats are detailed in the respective chapters, particularly:

- Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement
- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 4: Marine mammals of the Environmental Statement.

1.9.2 Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features

1.9.2.1 Increased suspended sediment concentrations may arise due to seabed preparation involving sandwave clearance, the installation of the wind turbines and OSP foundations, the installation and/or maintenance of cables and associated decommissioning activities. This impact is relevant to the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets and may cause indirect impacts to receptors.

1.9.2.2 The following scenarios were investigated:

- Site preparation activities – sand wave clearance and dredging to facilitate wind turbine, OSP and cable installation
- Drilled pile installation – across the range of hydrodynamic conditions
- Inter-array and inter-connector cable installation – for a zone of sandy seabed sediment

1.9.2.3 Modelling was undertaken related to the MDS as outlined in Table 1.13 with the detail of the assessment provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

<u>Construction phase</u>

Magnitude of impact

1.9.2.4 The project design includes the provision of site preparation/sandwave clearance activities which have the potential to increase suspended sediment concentrations in the construction phase with associated deposition. Sandwave clearance was calculated for 60% of the wind turbine and OSP foundations at a width of 205 m and a depth of 7.5 m. For the largest conical gravity bases the maximum dredging area per foundation may be 32,761 m^2 whilst the average area is 14,641 m^2, similarly the maximum dredging depth may be 10 m with an average depth of 3 m.

1.9.2.5 It is proposed that a small proportion of the dredged material from site preparation, 7,000 m^3 per foundation, may be sequestered as ballast within the gravity base foundation with a maximum total volume of 490,000m^3. Within the Morgan Array Area the seabed sediment is comprised largely of medium to coarse sand, as illustrated in Figure 1.7, and is therefore suited to augment with rock infill to provide ballast. This material typically represents a depth of *circa* 95cm below the slab foundation and scour protection extent and <8% of the seabed preparation volume. At the site of each of the largest wind turbine gravity base foundation an average of 41,337 m^3 of gravel may be placed to underlie the installation. Therefore, although the sequestered material will be removed from the sediment budget, the sediment in question represents a smaller volume than that occupied by the gravity base foundation within the seabed and the installation processes will not result in a void which could potentially interrupt transport processes by intercepting sediment. This is discussed further and assessed in section 1.9.5.

1.9.2.6 The MDS for sandwave clearance for cable installation was along a 156 km length of the inter array cable and a 36 km length of the interconnector cable with a width of 80 m, to an average depth of 3 m. Sandwave clearance modelling assumed more conservative values from the PEIR with sandwaves clearance at the 5.1 m depth and 104 m width along 36 km of the interconnector. With modelling assuming a clearance dredging rate of 10,000 m^3/h and a 3% spill of material during the dredging phase.

1.9.2.7 The installation of infrastructure within the Morgan Array Area may lead to increased suspended sediment concentrations and associated deposition. The MDS is for the drilled installation of 45 wind turbine foundations each with three-legged piles of 5.5 m diameter drilled to 75 m and the remaining 23 foundations being conical gravity base foundation with a caisson diameter of 37 m. Included is the installation of one OSP with foundations consisting of six legs with three 5.5 m piles per leg, drilled to a depth of 75 m. Up to two piles may be installed concurrently. For the installation of inter-array cables (390 km) and interconnector cables (60 km) a trench of up to 3 m in width and typical maximum depth 3 m in depth with a triangular cross section may be excavated.

1.9.2.8 The modelled scenarios examined a range of locations across the Morgan Array Area with two concurrent drilling operations at adjacent locations. The modelled scenarios examined drilling of larger 16 m diameter piles at a similar drilling rate. These drilled pile installations are anticipated to generate plumes with a suspended sediment level of <50 mg/l, therefore the smaller diameters piles would be expected to produce lower SSC. These levels would be localised and only persist for a short period. Concentrations within the wider plume envelope are much lower, typically <1 mg/l a short distance from the discharge locations. Following the cessation of drilling the turbidity levels reduce within a few hours as tidal currents reduce. Some of the finer material associated with the drilling process is re-suspended during successive tides as it is redistributed but turbidity levels remain low. The sedimentation beyond the immediate drilling location is indiscernible (less than 0.1 mm). This is due to the relatively slow drilling rate (0.73 m/h), allowing the fine sediment to be widely dispersed while the larger material settles at the release point due to the limited current speed.

1.9.2.9 For the installation of inter-array cables (390 km) and interconnector cables (60 km) a trench of up to 3 m in width and 3 m in depth with a triangular cross section may be excavated. For the inter-array cable installation, the sediment plumes are much larger than those for the pile installation. The reason for this is twofold, firstly there is a large amount of sediment mobilised (98,400 m^3 of material was mobilised during the two day simulation along the 21.9 km modelled route) and secondly there was elevated tidal currents on successive tides which remobilised material over the extended period of installation. Peak plume concentrations are highest at around 500 mg/l (at the release site) with the sediment settling during slack water becoming resuspended in the form of an amalgamated plume. Sedimentation of 50 mm occurs at the trench site, with the sediment thickness reducing with increased distance from the trench but remaining in the sediment cell and retained in the sediment transport system.

1.9.2.10 Following the completion of the works the turbidity levels return to baseline within a couple of tidal cycles. It would however be anticipated that spring tides following the works may mobilise and redistribute unconsolidated seabed material deposited at the end of the construction phase; this material will therefore be incorporated into the existing transport regime. Following installation, the native seabed material settles close to where it is mobilised and remains *in situ*. This would be expected as the baseline modelling indicated that sediment transport potential is limited across the Morgan Array Area. The sedimentation is concentrated along the installation route as material effectively returns to the vicinity from where it was disturbed. Sedimentation thicknesses of <0.5 mm arise beyond the immediate vicinity of the trench the day after drilling cessation and therefore would be indistinguishable from the existing seabed sediment.

1.9.2.11 The project design includes the provision of site preparation, (i.e. sandwave clearance and dredging activities) which have the potential to increase suspended sediment concentrations in the construction phase with associated sedimentation. Sandwave clearance was calculated for 60% of the wind turbine and OSP foundations at a width of 205 m and a depth of 7.5 m and similar dredging parameters for gravity base foundations. For cable installation, sandwaves will be reduced in height in order to allow passage of the burial tool to enable cable burial to a sufficient target depth. Modelling was undertaken for representative areas of sandwave clearance, with clearance of a 104 m wide corridor to facilitate cable installation with an average depth of 5.1 m, with modelling assuming a clearance dredging rate of 10,000 m^3/h and a 3% spill of material during the dredging phase. The sample stretches modelled were 5 km in length and therefore represent much greater volumes than those at individual wind turbine or OSP locations.

1.9.2.12 In practice, plough dredging which mobilises a much smaller amount of sediment into suspension at the seabed and has reduced sediment plume concentrations and extents compared to other types of dredging activities may be undertaken. However, the modelling simulated the use of a suction hopper dredger with a phasing representative of the scale of the sandwaves; dredging, and then depositing material within the cable corridor as it progressed along the route. This resulted in higher quantification of sedimentation compared to the plough dredging. It should be noted that when undertaking sandwave clearance, the sandwave will be reduced in height and the material will be sidecast to a location adjacent to the sandwave clearance to allow this material to be available for migration and sandwave recovery. At the site of gravity base foundations, a proportion of the dredged volume removed to place the foundation will be used as ballast. This volume is less than the volume of the bed occupied by the installed foundation.

1.9.2.13 Refinement of the project description has subsequently reduced the length of cable route requiring sandwave clearance, the height of sandwave clearance to 3.0 m and also minimised the corridor width to 80 m for both inter-array and interconnector cables. In terms of suspended sediment concentrations during sandwave clearance, these will remain unchanged from the modelled scenario as the same activity is being undertaken. Whereby the rate at which sandwave clearance is undertaken and the associated material is mobilised into the water column remain the same, giving rise to the equivalent instantaneous SSC, however the clearance will occur for a shorter period over a smaller area. There will therefore be a reduction in both the spatial extent and duration of the sediment plumes due to the reduction in the footprint of the activities and the reduced volume of material being relocated. The reduction in spatial extent will be equal to the reduction in the area over which the sandwave clearance takes place. Therefore, the magnitude of impacts would be reduced from those presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement and also reducing the sandwave recovery period. It is also noted that the refinement of the array area for the Environmental Statement means that some of the modelled clearance and cable routes lie beyond the revised array area. However, these locations are comparable with those within the Morgan Array Area in terms of sediment grading and hydrodynamic conditions, and therefore, it can be assumed that the modelled data is applicable to the revised scheme.

1.9.2.14 The impact is predicted to be of local spatial extent, short term duration, intermittent and with high reversibility. West of Walney MCZ and the West of Copeland MCZ are both designated for seabed sediment type, therefore direct impacts would be related to changes resulting wholly from construction activities such as sandwave clearance or trenching within designated areas which could potentially change the nature of the seabed. Indirect impacts would be defined as those occurring via the pathways by which the nature of the seabed may be changed. For example, deposition of sediment during slack tide as a result of activities which mobilise sediment within the tidal excursion from the designation.

1.9.2.15 It is predicted that the impact won't affect any designations or features of importance directly as construction activities will not be undertaken within the West of Walney MCZ or the West of Copeland MCZ. There is the potential during certain conditions, namely flood tides coupled with wind from the southwest, that during construction activities in the east of the Morgan Array Area, sediment plumes may extend to the west edge of the West of Walney MCZ and south tip of the West of Copeland MCZ. However, prior to reaching these locations, significant dispersion will have occurred with concentrations being well below 1 mg/l and the deposition arising from these levels of concentration is *de minimis*. Therefore, the Morgan Generation Assets construction may affect receptors indirectly within two MCZs. The magnitude is considered to be negligible for the receptors within the West of Walney MCZ and the West of Copeland MCZ.

1.9.2.16 Overall, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptors indirectly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

1.9.2.17 The Morgan Generation Assets does not directly overlap with designated sites, but two MCZs do overlap within the physical processes study area, as illustrated in Figure 1.8. These are active seabed features which are not sensitive to SSC and have low sensitivity to deposition due to natural exposure to sediment redistribution.

1.9.2.18 The West of Copeland MCZ is designated for protected features such as, subtidal coarse sediment, subtidal sand and subtidal mixed sediments. These subtidal sediments may provide habitats which support a wide range of associated biological communities. The assessment of impacts on these communities is presented in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement.

1.9.2.19 The sedimentation identified as part of the Morgan Generation Assets assessment is localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be **low**.

1.9.2.20 The protected features within the West of Walney MCZ are subtidal sand, subtidal mud and sea-pen and burrowing megafauna communities. The assessment of impacts on the communities is presented in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. The physical processes sediment features would recover from sedimentation as it is localised and composed of native material therefore the composition and function of the features is of low vulnerability and recoverable. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be **low**.

Significance of the effect

1.9.2.21 During the installation of the wind turbines in the Morgan Array Area, the peak SSC of sediment plumes is <50 mg/l. Plumes do not persist or result in discernible sedimentation. These increased sediment concentrations do not extend as far east as the West of Walney MCZ and the West of Copeland MCZ.

1.9.2.22 Inter-array cable and inter-connector cable installation creates plumes with SSCs on average <50 to 500 mg/l, highest during the release (of material) phase however these plume concentrations do not persist in the designated sites due to their distance from construction activities. Sedimentation is typically <50 mm beyond the immediate vicinity of the installation and less than one tenth of this value in the wider domain and would therefore not affect features beyond the development area (i.e. limited to the Morgan Generation Assets). The SSC plumes may extend to the two neighbouring designated sites on the flood tide however sediment concentrations are dispersed to well below background levels at these locations and sedimentation levels are *de minimis*.

1.9.2.23 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering a negligible magnitude of impact combined with a low sensitivity of the receptor where impacts are limited in both temporal and spatial extent the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.2.24 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the indirect limited extent of the **negligible** magnitude. For intertidal and coastal areas, the magnitude of impacts are **negligible** giving rise to effects of negligible significance.

Operations and maintenance phase

Magnitude of impact

1.9.2.25 Operations and maintenance activities within the Morgan Generation Assets may lead to increases in SSC and associated sediment deposition.

1.9.2.26 The MDS for cable maintenance is for up to 8 km of inter-array cable repair comprising one event every three years, with a volume of up to 36,000 m^3 displaced material associated with a footprint of disturbance of up to 160,000 m^2 per event, and a reburial event of up to 20 km once every five years, with a volume of up to 90,000 m^3 displaced material associated with a footprint of disturbance of up to 400,000 m^2 per event (Table 1.13). For the interconnector cable, the MDS is repair of 19.63 km of cable, with a volume of up to 88,335 m^3 displaced material associated with a footprint of disturbance of up to 400,000 m^2 (based on 19.63 km rounded to 20 km) per event, with three events every ten years and reburial events of up to 3 km of cable in one event every five years, with a volume of up to 13,500 m^3 displaced material associated with a footprint of disturbance of up to 60,000 m^2 per event. This is the greatest foreseeable number of cable reburial and repair events. Repairs would be undertaken using similar methods as those for cable installation activities (i.e. trenching/jetting, with trench width up to 3 m and trench depth up to 3 m with a V-shaped cross-section).

1.9.2.27 The MDS for the length of the repair or reburial activity may be up to 20 km; therefore, the magnitude of the impacts would be a fraction of those for the construction phase. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired however the entire length has been quantified under the construction phase scenario discussed above.

1.9.2.28 The impact is predicted to be of local spatial extent, short term duration, intermittent and with high reversibility. As, seen in the construction phase assessment, it is predicted that the impact won't affect any designations or features of importance directly whilst affecting other receptors within two MCZs indirectly to a much lesser degree than the construction phase. The magnitude is, therefore, considered to be **negligible** for the receptors within the West of Walney MCZ and the West of Copeland MCZ.

Sensitivity of receptor

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

1.9.2.30 The West of Walney MCZ and West of Copeland MCZ would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered **low** and is impacted to a much lesser degree than the construction phase.

Significance of effect

1.9.2.31 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering a negligible magnitude of impact combined with a low sensitivity of the receptor where impacts are limited in both temporal and spatial extent the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.2.32 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the indirect limited extent of the **negligible** magnitude. For intertidal and coastal areas, the magnitude of impacts are negligible giving rise to effects of negligible significance

Decommissioning phase

1.9.2.33 Following decommissioning, increases in suspended sediments and potential impact on the physical features would be of lesser magnitude than both the construction phase and the operations and maintenance phase with scour and cable protection remaining *in situ*. In the case of piled foundations, there is no significant disturbance of the seabed during decommissioning as piles are cut off.

1.9.2.34 Increases in SSC due to the removal of inter-array and interconnector cables would be similar to those experienced during the construction phase, as retrieval would be undertaken using similar techniques to installation. Decommissioning of gravity bases would involve the removal of ballast, including sand sequestered during construction. There is a commitment that this material, which may also include rock will be disposed of off-site (Table 1.14) and therefore only a small proportion of sediment may be released during the removal process; noting the ballast material derived from offsite sources would be tested for contamination prior to use. There are a range of potential disposal options including onshore disposal outside the marine environment or offshore disposal at a licenced site i.e. ensuring there are no significant impacts on designated sites. Depending on the timing of the decommissioning there may also be opportunities for reuse of the ballast. Types of repurposing may include beneficial use in the marine environment such as coastal protection schemes, infill for land reclamation/port development or reuse as ballast at an alternate offshore location. Beneficial use in the onshore environment could include projects for habitat creation and restoration such as wetland islands for birds and other wildlife. In all cases the disposal scheme will ensure there are no significant impacts on designated sites. As per the MDS (Table 1.13), SSC would also increase temporarily if suction caissons were removed using overpressure to release. The increase in suspended sediments and the potential impact on physical features may persist during decommissioning, however they are localised in nature.

1.9.3 Impacts to the tidal regime due to presence of infrastructure

1.9.3.1 The presence of infrastructure may lead to changes to the tidal regime during the operations and maintenance phase of the Morgan Generation Assets. This impact is also relevant to the construction phase and following decommissioning associated with residual infrastructure. Modelling was undertaken using the MDS as outlined in Table 1.13 including the presence of scour protection as outlined in the project description (Volume 1, Chapter 3: Project description of the Environmental Statement). The detail of the numerical modelling underpinning the assessment is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The magnitude of the impact is detailed in this section along with the assessment of the effect of changes to physical processes on relevant receptors.

Construction phase

1.9.3.2 As the assessment was carried out with and without the presence of infrastructure, it can be inferred that during the construction phase there will be gradual changes to tidal regime as infrastructure is introduced into the environment. This would result in changes and therefore potential impacts, ranging from the baseline environment (no presence of infrastructure) to the operations and maintenance phase (MDS), which are assessed in the following section.

Operations and maintenance phase

Magnitude of impact

1.9.3.3 The presence of infrastructure within the Morgan Array Area may lead to changes in tidal regime and the associated potential impacts along adjacent shorelines during the operations and maintenance phase of the Morgan Generation Assets. The MDS in terms of hydrographic impacts is for up to 68 wind turbines with four-legged suction bucket foundations for each jacket leg at 5 m diameter spaced 48 m apart, and each bucket with a diameter of 16 m. Scour protection at each bucket foundation of 2.5 m in height and extending 20 m covering a total footprint of 10,816 m^2.

1.9.3.4 Additionally, the MDS includes one OSP, with a rectangular gravity base foundation each with an 80 m by 60 m dimension at the surface and a slab base dimension of 100 m by 80 m. Associated scour protection extends from the slab base by 25 m at a height of 2.6 m giving rise to 19,500 m^2 footprint per foundation. The modelled scenario presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement used an alternate arrangement array layout and also for the inclusion of the OSPs within the modelled scenario. The physical processes modelling study undertaken included cable protection with a height of 3 m and cable crossings with a height of 4 m across the Morgan Array Area. This was aligned with the maximum volume of cable protection (inter-array and interconnector) of 852,600 m^3 and the maximum total seabed footprint area for cable protection of 548,800 m^2. The locations were selected to represent the MDS for changes to physical processes particularly with regards to considering the potential for impacts on neighbouring MCZ, i.e. modelled cable crossings were concentrated in the northern half of the Morgan Array Area and along the north and northeast boundary closest to the MCZ (illustrated in Figure 1.65 of Volume 4, Annex 1.1: Physical processes technical report).

1.9.3.5 The modelled array comprised of the same number of foundations and dimensions as those described by the MDS, however, following the modelling study the Morgan Array Area has been reduced in size primarily to address navigation issues. The influence of each foundation quantified by the modelling study remains applicable for the assessment. This is outlined in section 1.1 and agreed with stakeholders as detailed in Table 1.4. The influence of the rectangular gravity base foundation was quantified in supplemental modelling detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

1.9.3.6 The results of the modelling indicated that peak tidal flows are redirected in the immediate proximity of structures by a maximum variation of 4 cm/s which constitutes as less than 3% of the peak flow and reduces significantly with distance from the structures. These changes are also limited to the immediate Morgan Generation Assets which may have a direct impact on the hydrodynamic regime and persist for the entire lifecycle of the Morgan Generation Assets. However, they would be imperceptible from natural variations beyond the immediate vicinity of the Morgan Array Area and would be reversible on decommissioning. The limited nature of these changes would not significantly influence the tidal regime which underpins sediment transport.

1.9.3.7 The use of a single rectangular gravity base OSP forms a greater obstruction to tidal flow. Currents accelerate at the exposed face of the structure and along the sides, whilst decreasing on the sheltered lee side. The variation is a maximum of circa 20% of the tidal current within 50 m of the structure and decreases rapidly with distance. Variations may extend to the proximity of the smaller wind turbine structures but typically less than 1 cm/s. This is a much larger foundation than the previous suction bucket foundation types considered with respect to wind turbine structures, however, it would be implemented as a single OSP structure to serve the entire wind project, with other adjacent wind turbines comprised of the smaller foundation types. Therefore the overall combined effect of a single rectangular gravity base OSP and wind turbine structures with smaller foundation types would be far lower across the Morgan Array Area than the use of multiple rectangular gravity base foundation structures.

1.9.3.8 The modelling of the range of wind turbine and OSP foundation structures has demonstrated that changes in tidal flows are spatially limited and localised in the immediate vicinity of the structures in the form of a water wake. This may potentially result in increased mixing in close proximity to the infrastructure but would not influence tidal flow significantly. The potential influence on stratified conditions is discussed in section 1.9.6.

1.9.3.9 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. West of Walney MCZ and the West of Copeland MCZ are designated for seabed sediment characteristics therefore in terms of changes to tidal flow they are not directly affected. However, if changes to tidal flow form a pathway by which these sediments are altered, for example by changes to sediment supply or erosion, then they may be indirectly affected. Under certain circumstances, namely at times of peak current speeds during flood tides with storms approaching from the southwest, changes in littoral currents may extend to the west edge of the West of Walney MCZ and the West of Copeland MCZ. However, these values amount to changes of less than ±0.022% of the preconstruction tidal current speed and would be indistinguishable from natural variations, and the resulting influence on sediment transport characteristics would be very slight. The West of Walney MCZ and the West of Copeland MCZ may potentially be impacted indirectly and the magnitude is considered to be **negligible**.

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

Sensitivity of the receptor

1.9.3.11 No overlap occurs between designated sites and Morgan Generation Assets however the West of Walney MCZ and the West of Copeland MCZ are designated for several protected features such as subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. The potential impacts on the benthic communities are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. Due to the localised and limited changes in tidal regime and the inherent natural variability of baseline conditions, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability and recoverable. The sensitivity of the receptor to changes in tidal regime infrastructure is therefore considered to be **low**.

Significance of the effect

1.9.3.12 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering both a negligible magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.3.13 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the indirect limited extent of the **negligible** magnitude.

Decommissioning phase

Magnitude of impact

1.9.3.14 Following decommissioning, changes to tidal regime would be of lesser magnitude than the operations and maintenance phase, as no structures would remain in the water column to influence tidal currents, with only the scour and cable protection retained within the context of the MDS. Decommissioning activities will be secured through separate standalone marine licences and determined by the relevant legislation and guidance at the time of decommissioning. Noting that consideration will be given for the use of cable protection which is of such a nature that it may be more readily removable at decommissioning (Table 1.14).

1.9.3.15 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

1.9.3.16 As with the operations and maintenance phase, in response to localised changes in tides, the West of Walney MCZ and West of Copeland MCZ features are deemed to be of low vulnerability and recoverable. The sensitivity of this is therefore, considered to be **low**.

Significance of effect

1.9.3.17 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering both a negligible magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.3.18 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the limited extent of the **negligible** magnitude.

1.9.4 Impacts to the wave regime due to presence of infrastructure

1.9.4.1 Introducing infrastructure may lead to changes to the wave regime principally during the operations and maintenance phase of the Morgan Generation Assets. Also, relevant to a lesser degree is the construction phase and decommissioning associated with residual infrastructure. Modelling was undertaken using the MDS as outlined in Table 1.13 including the presence of scour protection as outlined in the project description (Volume 1, Chapter 3: Project description of the Environmental Statement). The detail of the numerical modelling underpinning the assessment is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The magnitude of the impact is detailed in this section along with the assessment of the effect of changes to physical processes on relevant receptors.

Construction phase

1.9.4.2 Similar to the above assessment on the tidal regime, modelling was carried out with and without the presence of infrastructure. During the construction phase there will be gradual changes to the wave regime as infrastructure is introduced into the environment. This would result in changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operations and maintenance phase (MDS), which are assessed in the following section.

Operations and maintenance phase

Magnitude of impact

1.9.4.3 The presence of infrastructure within the Morgan Array Area may lead to changes in wave regime during the operations and maintenance phase of the Morgan Generation Assets. The MDS in terms of hydrographic impacts is for up to 68 wind turbines with four-legged suction bucket foundations for each jacket leg at 5 m diameter spaced 48 m apart, and each bucket with a diameter of 16 m. Scour protection at each bucket foundation of 2.5 m in height and extending 20 m covering a total footprint of 10,816 m^2.

1.9.4.4 Additionally, the MDS includes one OSP with a rectangular gravity base foundation, with an 80 m by 60 m dimension at the surface and a slab base dimension of 100 m by 80 m at the bed. Associated scour protection extends from the slab base by 25 m at a height of 2.6 m giving rise to 19,500 m^2 footprint per foundation. The modelled scenario presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement used an alternate array arrangement and OSPs within the modelled scenario. The physical processes modelling study undertaken included cable protection with a height of 3 m and cable crossings with a height of 4 m across the Morgan Array Area. This was aligned with the maximum volume of cable protection (inter-array and interconnector) of 852,600 m^3 and the maximum total seabed footprint area for cable protection of 548,800 m^2. The locations were selected to represent the MDS for changes to physical processes particularly with regards to considering the potential for impacts on neighbouring MCZ, i.e. modelled cable crossings were concentrated in the northern half of the Morgan Array Area and along the north and northeast boundary closest to the MCZ (illustrated in Figure 1.65 of Volume 4, Annex 1.1: Physical processes technical report).

1.9.4.5 The modelled array comprised of the same number of foundations and dimensions as those described by the MDS however following the modelling study the array area has been reduced in size to accommodate navigation issues. As agreed with stakeholders, (Table 1.4), the influence of each foundation quantified by the modelling study remains applicable for the assessment. The influence of the rectangular gravity base foundation was quantified in supplemental modelling detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement.

1.9.4.6 Examination of a 1 in 1 year storm from the west (of greatest influence of approaching storms) shows the deflection of waves by the structures result in a reduction in the lee and increases where the waves had been deflected either side of each structure. Changes in the wave height were in the order of 3 cm equating to <1% of the baseline significant wave height. For a 1 in 20 year storm event, the pattern is similar however the change in wave height at the structures during a storm event is 3.5 cm and due to the larger baseline associated with the return period the overall impact on the wave climate is less obvious.

1.9.4.7 In the case of the single rectangular gravity base OSP during a 1 in 20 year storm post construction waves may experience a change up to a maximum of 25 cm or c. 4% in the immediate vicinity. These changes reduce in magnitude with distance from the structure, c. 2.5% at 200 m. This is a much larger foundation than the previous foundation types considered, however, it would be implemented as a single OSP structure to serve the entire wind project, with other adjacent wind turbines comprised of the smaller foundation types.

1.9.4.8 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. West of Walney MCZ and the West of Copeland MCZ are designated for seabed sediment characteristics therefore in terms of changes to wave climate they are not directly affected. However, if the changes form a pathway by which these sediments are altered, for example by changes to sediment supply or erosion, then they may be indirectly affected.

1.9.4.9 Under certain circumstances changes in wave climate could potentially extend to the periphery of the neighbouring MCZs. For example, during in 1 in 20 year storm from the south west a significant wave height of 5.5 m may be reduced by 4 mm (0.07%) at the southern boundary of the West of Walney MCZ. Similarly, for a 1 in 20 year storm from 210º the change in significant wave height at the south end of the West of Copeland MCZ is circa 5 mm. In each case this represents a reduction of less than 0.1% from the preconstruction wave climate and would be indistinguishable from natural variations and the resulting influence on sediment transport characteristics would be *de minimis*. This therefore demonstrates how precautionary the assessment is given that both a maximum design scenario and extreme storm events were examined. The West of Walney MCZ and the West of Copeland MCZ may potentially be impacted indirectly and the magnitude is considered to be negligible.

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

Sensitivity of receptor

1.9.4.11 No overlap occurs between designated sites and Morgan Generation Assets however, within 10 km of the Morgan Array Area, are the West of Walney MCZ and the West of Copeland MCZ. These are designated for several protected features such as subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. The potential impacts on the benthic communities are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. Due to the localised and limited changes in wave climate and the inherent natural variability of baseline conditions, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability and recoverable. The sensitivity of the receptor to changes in wave regime because of the presence of infrastructure is therefore considered to be **low**.

Significance of effect

1.9.4.12 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering both a negligible magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.4.13 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the indirect limited extent of the **negligible** magnitude.

Decommissioning phase

Magnitude of impact

1.9.4.14 Following decommissioning, changes to wave regime would be of lesser magnitude than the operations and maintenance phase, as no structures would remain in the water column to influence wave climate, with only the scour and cable protection retained within the context of the MDS. Decommissioning activities will be secured through separate standalone marine licences and determined by the relevant legislation and guidance at the time of decommissioning. Noting that consideration will be given for the use of cable protection which is of such a nature that it may be more readily removable at decommissioning (Table 1.14).

1.9.4.15 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

1.9.4.16 As with the operations and maintenance phase, in response to localised changes in wave climate, the West of Walney MCZ and the West of Copeland MCZ features are deemed to be of low vulnerability and recoverable. The sensitivity of this is therefore, considered to be **low**.

Significance of effect

1.9.4.17 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering both a negligible magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.4.18 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the limited extent of the **negligible** magnitude.

1.9.5 Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry

1.9.5.1 During the operations and maintenance phase the presence of infrastructure may alter sediment transport and sediment transport pathways leading to changes in the Morgan Generation Assets physical processes study area and associated potential impacts to physical features and bathymetry. The construction and decommissioning phases will be impacted to a lesser degree. During the construction phase infrastructure is introduced gradually, whilst in the decommissioning phase, only those impacts associated with residual infrastructure are present. Modelling was undertaken using the MDS as outlined in Table 1.13 including the presence of scour protection as outlined in the project description (Volume 1, Chapter 3: Project description of the Environmental Statement). The detail of the numerical modelling underpinning the assessment is provided in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. The magnitude of the impact is detailed in this section along with the assessment of the effect of changes to physical processes on relevant receptors.

Construction phase

1.9.5.2 During the construction phase there will be gradual changes to sediment transport and sediment transport pathways as infrastructure is introduced into the environment, with changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operations and maintenance phase (MDS) assessed in the following section. Similarly, for conciseness construction activities which relate to bathymetry and sediment transport receptors have been assessed within the following sections; namely, the impacts of the use of seabed material as ballast within gravity based foundations and UXO clearance.

Operations and maintenance phase

Magnitude of impact

1.9.5.3 The presence of infrastructure within the Morgan Array Area may lead to changes in sediment transport and sediment transport pathways during the operations and maintenance phase of the Morgan Generation Assets. The MDS in terms of hydrographic impacts is for up to 68 wind turbines with four-legged suction bucket foundations for each jacket leg at 5 m diameter spaced 48 m apart, and each bucket with a diameter of 16 m. Scour protection at each bucket foundation of 2.5 m in height and extending 20 m covering a total footprint of 10,816 m^2.

1.9.5.4 Additionally, the MDS includes one OSP with a rectangular gravity base foundation with an 80 m by 60 m dimension at the surface and a slab base of 100 m by 80 m at the bed. Associated scour protection extends from the slab base by 25 m at a height of 2.6 m giving rise to 19,500 m^2 footprint per foundation. The modelled scenario presented in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement used an alternate array arrangement and OSPs within the modelled scenario. The physical processes modelling study undertaken included cable protection with a height of 3 m and cable crossings with a height of 4 m across the Morgan Array Area. This was aligned with the maximum volume of cable protection (inter-array and interconnector) of 852,600 m^3 and the maximum total seabed footprint area for cable protection of 548,800 m^2. The locations were selected to represent the MDS for changes to physical processes particularly with regards to considering the potential for impacts on neighbouring MCZ, i.e. modelled cable crossings were concentrated in the northern half of the Morgan Array Area and along the north and northeast boundary closest to the MCZ (illustrated in Figure 1.65 of Volume 4, Annex 1.1: Physical processes technical report).

1.9.5.5 The modelled array comprised of the same number of wind turbine foundations and dimensions as those described by the MDS however following the modelling study the array area has been reduced in size. The influence of each foundation quantified by the modelling study remains applicable for the assessment. One of the measures to be adopted as part of the project design, detailed in Table 1.14, is the provision of scour protection. An offshore construction method statement will be developed and include details of scour protection management to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. This will include an assessment of the magnitude of scour in comparison to the volumes of scour protection at the locations where it is proposed. Therefore any impacts would relate only to residual/secondary scour which would be very localised and of negligible magnitude; typically confined to within a few meters of the direct footprint of that scour protection material.

1.9.5.6 The volume and extent of scour protection material outlined within Volume 1, Chapter 3: Project description is based on conservative values. For example, scour protection is extended to 3.5 times the external diameter of the structure and the scour protection height of 2.5 m includes a 10% contingency. The need and potential extent of scour protection measures will be dependent on the foundation type, geometry and location (i.e. seabed and hydrographic conditions). The exact parameters will be site specific and related to both the infrastructure type and scour protection approach, e.g. separate filter and amour layers, provision of a falling apron, or a composite solution. At the detailed design stage the magnitude of potential scour in relation to the proposed measures will be balanced.

1.9.5.7 To minimise the potential impact from the cables and removal of cables there is a commitment to bury cables where possible. Where burial cannot be achieved to the required depth cable protection may be required. A Cable Burial Risk Assessment and Burial Assessment Study, which will be included within the CSIP, will establish these parameters. The detail of design and construction will be outlined within the CSIP and would also determine the likely extent of any potential scour and would aim to mitigate this through site specific detailed design of scour protection measures. It is therefore likely that any secondary scour effects associated with cable protection would be confined to within a few meters of the direct footprint of that scour protection material.

1.9.5.8 Where scour protection measures are to be utilised, they will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. Notwithstanding, during the operations and maintenance phase of the project routine inspections will be made of cable and scour protection in line with the Offshore Monitoring Plan. If secondary scour is identified remedial works may be undertaken to both mitigate environmental impacts and to provide asset security where mitigating measures may be developed in discussions with the regulatory authority and its statutory advisors.

1.9.5.9 Sediment transport is driven by a combination of tidal currents and wave conditions, the magnitude of these has been individually quantified as described above. For a 1 in 1 year storm approaching from 210°, during the flood tide the wave climate is in concert with tidal flow reducing the tidal flow on the lee side of the structure further. However, during the ebb flow, the wave climate and tidal flow are in opposition reducing the magnitude of the littoral current. With the presence of infrastructure, wave climate causes a small reduction in the magnitude of flow whilst there is little difference between the magnitude of littoral current flow and the tidal flows. Changes in magnitude compared to baseline current flow are ±5% within close proximity to the foundation structures which would not be sufficient to disrupt sediment features.

1.9.5.10 Residual currents are effectively the driver of sediment transport and therefore any changes to residual currents would have a direct impact on sediment transport which would persist for the lifecycle of the Morgan Generation Assets. However, if the presence of the foundation structures does not have a significant influence on either tide or wave conditions (see impact assessments presented above for changes in tidal and wave regime) they cannot therefore have a significant effect on the sediment transport regime. For completeness, the residual current and sediment transport was simulated with the foundations in place. The maximum change in residual current and sediment transport is circa ±10% which is largely sited within close proximity to the wind turbine foundation structures (i.e. as a result of the scour protection). Changes in the residual current and sediment transport reduce with increasing distance from the wind turbines towards baseline levels.

1.9.5.11 The use of a single rectangular gravity base OSP forms a greater obstruction to sediment transport than the suction bucket foundations considered for the wind turbine structures. The footprint of the foundation is 19,500 m^2, therefore, the orientation of the foundation and the detail of the scour protection design will determine the impact of sediment transport pathways. The influence of wave and tides and therefore the driving force of sediment transport, diminished rapidly from the foundation, therefore, the OSP being sited within the Morgan Array Area 71ouldd not induce changes to sediment transport beyond the immediate vicinity or extent to adjacent shorelines.

1.9.5.12 Sandwave clearance may be required at the site of turbine locations, particularly in the case of gravity base structures to accommodate a slab base. For the largest gravity base foundation proposed, the slab base has a diameter of 43 m with scour protection extending 22 m from the slab base. Dredging and sandwave clearance may be required up to a diameter of 173 m to accommodate seabed profiling; therefore, there may be localised disruption to sandwave features. As described in section 1.5.1, net sediment transport ranges from 0.4 m^3/d/m to 1.5 m^3/d/m with migration of larger sandwave features of circa 1 m per year. This occurs in a northeast direction which indicates that placement of dredged material to the southwest of clearance operations would aid in sandwave recovery.

1.9.5.13 Within the Morgan Array Area there are areas with sandwave features including megaripples in the east and northeast of the site and corridors of barchan dunes in the central and northern parts of the Morgan Array Area. These sandwaves will be reduced in height in order to allow passage of the burial tool to enable cable burial to a sufficient target depth. Significant reductions in sandwave clearance volumes have been identified, from those identified within the PEIR, by detailed analysis of survey data and refining the clearance parameters. Sandwave features are predominately aligned perpendicular to the net sediment transport which is to the east. These individual features are generally circa 1 to 2 km in length, however some barchan dunes meet to form longer features, (ABPmer, 2023).

1.9.5.14 The detailed requirements for sandwave clearance, particularly for inter-array cabling, will be dependent on the layout of the array and cable routing. The mean height of sandwaves is 8 m in the Morgan Array Area, with an average width of 400 m and spaced 750 m apart. To accommodate the passage of the trenching tool (30 m), incorporating side slopes (25 m either side) and passage through the sandwave an average trenching depth of 3 m is required. For context, the clearance of material for a crossing through a typical sandwave therefore represents less than 5% of the volume of the sandwave as a whole.

1.9.5.15 Up to 40% of the Morgan Generation Assets inter-array cable route may be affected by sandwave features. Considering the volume of sandwave clearance anticipated (5,026,651 m^3 for inter-array cables), this corresponds to circa 75 sandwave crossings across an area of 280 km^2, representing circa 0.85% of The Morgan Array Area. The material which is cleared from the sandwaves to allow passage of the burial tool will not be removed from the site, it will be relocated in close proximity to the sandwave such that it is readily available for sandwave recharge. The magnitude, extent and proposed methodology is therefore unlikely to affect the sandwave system as a whole.

1.9.5.16 The rate of reformation of sandwaves is dependent on a range of factors including the size, location and alignment of any breach with respect to the sediment transport pathways and available recharge material. It has been shown that the region has active sediment transport systems with net sediment transport rates of circa 0.75 m^3/d/m within Morgan Array Area and rates more than double this at sandwave crests. Indeed the use of pre-lay trenches is not recommended due to rapid infilling. Increases in littoral currents during storm events would also significantly increase transport rates. The sandwave features themselves are also mobile, typically moving 1 m in an easterly direction each year (ABPmer, 2023). Therefore, although it is not possible to quantify the reformation rate of sandwave breaches with certainty, given the number of variables and dependencies, in an areas of active sediment transport with rechange material available it is anticipated that in the months following installation infilling would become evident.

1.9.5.17 Post installation surveys, that will be undertaken for engineering purposes during the operations and maintenance phase may be utilised monitor these processes. Monitoring will be undertaken to observe the effect of sediment transport and sediment transport pathways on cable burial with specific reference to physical processes. The primary function of this monitoring is to examine changes to the sandwaves post-construction. The surveys will be expected to focus on areas where active mobile seabed features, such as sandwaves, have been identified and were subject to sandwave clearance during the construction phase. Asset integrity monitoring surveys together with the relevant data gathered, will be considered in the context of seabed mobility, seabed recovery and sandwave recovery, for information purposes.

1.9.5.18 It is proposed to sequester 7,000 m^3 of the dredged material to provide ballast, however the majority (92.8%) of the dredged material will be placed in the immediate vicinity of the seabed preparation activities. This material will be available for sediment transport under the revised transport pathways, which are altered by typically 10% in the immediate vicinity of the structures as flow and transport are redirected around the infrastructure. Within the Morgan Array Area the seabed sediment is comprised largely of medium to coarse sand, as illustrated in Figure 1.7, and is therefore suited to provide ballast. This, coupled with the diminutive volume, means the removal of coarser fractions would not alter either the local or regional sediment characteristics.

1.9.5.19 The coarse sand which is proposed for use as ballast in gravity base foundations would be drawn from site preparation at selected foundation locations. Where suitable material is located, up to 7,000 m^3 may be sourced from any single location with a total requirement of 490,000 m^3. Therefore, less than 7,000 m^3 or indeed no material would be required at a number of locations. Depending on each location, the area affected may vary given the requirement for sandwave clearance or dredging to prepare for the slab base. Typically the area affected corresponds with dredging an area 120 m by 120 m with the material harvested equivalent to 0.5 m in depth. Each of these discrete 120 m by 120 m areas are located a minimum of 1.4 km from each other and in total typically represent 0.36% of the Morgan Array area. In terms of sediment budget, 490,000 m^3 of the maximum 6,746,105 m^3 seabed preparation volume (which equates to 7.2%) would be used across the Morgan Array Area during the 12 month installation period. This will also equate to an average sediment ballast requirement of 5,104 m^3 per foundation location when 96 gravity base foundations are considered.

1.9.5.20 Typical net sediment transport, under tides alone, though the array area is circa 15,000 m^3 per day; the harvested material therefore represents a one-off 9% reduction in sediment budget during the construction phase and would therefore not significantly influence sediment transport across the Morgan Array Area. It is also noted that a more likely construction period for foundation installation may be up to 24 months and therefore influence due to the reduction in sediment budget would be less evident.

1.9.5.21 As discussed in section 1.9.2, dredging undertaken at the site of the gravity base foundations will be infilled with gravel, with the sequestered material representing a small proportion of this volume and will not result in a void which could potentially interrupt transport processes by intercepting sediment. It is predicted that the impact of sequestering dredged material to provide ballast will not affect the West of Walney MCZ and the West of Copeland MCZ receptors as the infilling with gravel during seabed preparation for the gravity base foundations will not give rise to an interruption in sediment supply.

1.9.5.22 The MDS for UXO removal relates to clearance of up to 13 UXOs within the Morgan Array Area ranging from 25 kg up to 907 kg with 130 kg the most likely (common) maximum. Data in the public domain was used to determine likely crater size for the most likely (common) maximum UXO size of 130 kg (a diameter of 12.61 m and a depth of *circa* 3 m (Ordtek, 2018)). Further data was also available for larger UXO up to 700 kg (Equinor, 2022). Data relating to the larger UXO indicates that crater sizes for 700 kg ordinance may be up to 5 m in depth (21 m in diameter), although observations of UXO in areas of sandy gravel, similar to those found in the Morgan Array, were typically half of this predicted diameter and less than 1.5 m in depth (Ordtek, 2018). Therefore, individual craters generated for clearance for a maximum

907 kg UXO in an area characterised by active sediment transport regime with seabed features such as sandwaves in excess of 8 m would not give rise to significant impacts on physical processes.

1.9.5.23 A commitment has been made to use low order detonation techniques where possible as a primary mitigation measure (Table 1.14), which would result in much smaller and shallower craters for all UXOs it is applied to. Low order deflagration is a new technique which has been successfully applied at the Moray West Offshore Windfarm, where 81 UXO ranging from 14 kg to 879 kg were all cleared using this technique (Ocean Winds, 2024). This example demonstrates the success of low order detonation techniques such as deflagration and demonstrates that it is highly likely the majority, if not all, of the UXO identified could be cleared using low-order deflagration methods with resulting crater sizes significantly smaller than those assessed for the MDS. Indeed, post-clearance visual inspections of the low order deflagration events at the Moray West Offshore Windfarm demonstrated a lack of any seabed crater for all clearance events (Ocean Winds, 2024) and no obvious seabed damage (Lepper *et al*., 2024). Therefore it is predicted that the clearance of UXO will not affect the West of Walney MCZ and the West of Copeland MCZ receptors.

1.9.5.24 Overall the impact due to presence of infrastructure on sediment transport regimes is predicted to be of local spatial extent, long term duration, continuous and high reversibility. West of Walney MCZ and the West of Copeland MCZ are both designated for seabed sediment type, therefore direct impacts would be related to changes resulting wholly from construction activities such as placement of infrastructure or scour protection within designated areas which could potentially change the nature of the seabed. Indirect impacts would be defined as those occurring via the pathways by which the nature of the seabed may be changed. For example, changes in sediment transport drivers or pathways which may affect sediment characteristics within the designated area.

1.9.5.25 It is predicted that the impact won’t affect any designations or features of importance directly as construction activities will not be undertaken within the West of Walney MCZ or the West of Copeland MCZ. Under certain circumstances, with more extreme storms approaching from the southwest, changes in residual currents may extend to west edge of the West of Walney MCZ and the south tip of the West of Copeland MCZ. However these values amount to changes of less than ±1% of the preconstruction values for a 1 in 20 year storm from 270º and would be indistinguishable from natural variations. The resulting influence on sediment transport characteristics would be minimal. The West of Walney MCZ and the West of Copeland MCZ may potentially be impacted indirectly and the magnitude is considered to be negligible.

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

Sensitivity of receptor

1.9.5.27 No overlap occurs between designated sites and Morgan Generation Assets, however, within 10 km of the Morgan Array Area are the West of Walney MCZ and the West of Copeland MCZ. These are designated for several protected features such as, subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. The potential impacts on the benthic communities are assessed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. Due to the localised and limited changes in the littoral currents which drives sediment transport and the natural exposure to sediment redistribution, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability and recoverable. The sensitivity of the receptor to changes in sediment transport pathways because of the presence of infrastructure is therefore considered to be **low**.

Significance of effect

1.9.5.28 Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **low**. Considering both a low magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.5.29 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the indirect limited extent of the **negligible** magnitude.

Decommissioning phase

Magnitude of impact

1.9.5.30 Following decommissioning, changes to the sediment transport and sediment pathways would be of lesser magnitude than the operations and maintenance phase, as no structures would remain in the water column to influence the littoral currents above bed level, with only the scour and cable protection remaining *in situ* in relation to the MDS. Decommissioning activities will be secured through separate standalone marine licences and determined by the relevant legislation and guidance at the time of decommissioning. Noting that consideration will be given for the use of cable protection which is of such a nature that it may be more readily removable at decommissioning (Table 1.14).

1.9.5.31 The effect of cable removal on sandwaves will depend on the method used to undertake decommissioning. The preferred method for cable removal is to cut cables and pull from the seabed which is also the least invasive in terms of seabed and sandwave disturbance. However, the MDS assumes for a worst case that this may not be possible, and that cables are removed using similar techniques to those employed during installation defining a realistic ‘worst case’ scenario. Therefore, the potential impacts on sandwaves with the associated recovery period would be in-line with the construction phase.

1.9.5.32 Decommissioning of gravity bases would involve the removal of ballast, including sand sequestered during construction. There is a commitment that this material, which may also include rock will be disposed of off-site (Table 1.14). There are a range of potential disposal options including onshore disposal outside the marine environment or offshore disposal at a licenced site i.e. ensuring there are no significant impacts on designated sites. Depending on the timing of the decommissioning there may also be opportunities for reuse of the ballast. Types of repurposing may include beneficial use in the marine environment such as coastal protection schemes, infill for land reclamation/port development or reuse as ballast at an alternate offshore location. Beneficial use in the onshore environment could include projects for habitat creation and restoration such as wetland islands for birds and other wildlife. In all cases the disposal scheme will ensure there are no significant impacts on designated sites.

1.9.5.33 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the West of Walney MCZ and the West of Copeland MCZ receptors. The magnitude is therefore, considered to be **negligible**.

Sensitivity of receptor

1.9.5.34 As with the operations and maintenance phase, in response to localised changes in the sediment transport pathways, the West of Walney MCZ and the West of Copeland MCZ features are deemed to be of low vulnerability and recoverable. The sensitivity of this receptor is therefore, considered to be **low**.

Significance of effect

1.9.5.35 Overall, the magnitude of the impact is deemed to be **negligible,** and the sensitivity of the receptor is considered to be **low**. Considering both a negligible magnitude of impact combined with a low sensitivity of the receptor coupled with the limited spatial extent of the impact the effect will, therefore, be of **negligible adverse** significance, which is not significant in EIA terms.

1.9.5.36 A significance of **minor** or **negligible** can be established from a **negligible** magnitude and **low** sensitivity receptor, in this case a **negligible adverse** significance is concluded due to the limited extent of the **negligible** magnitude.

1.9.6 Impacts to temperature and salinity stratification due to the presence of infrastructure

1.9.6.1 Within the physical processes study area most of the water column remains thoroughly mixed due to the occurrence of sufficiently intense tidal mixing throughout the year. There are short periods when marginal stratification occurs for example during hot, calm conditions however these are easily disrupted by storms or spring tides. Localised changes in tidal flow around infrastructure would be beneficial in providing additional mixing in the immediate vicinity.

1.9.6.2 It has been noted that stratification of the water column can occur in estuaries and specifically in Morecambe Bay, as fresh water associated with river discharge is less dense than the saline offshore environment. In order to disrupt temperature and salinity stratification in Morecambe Bay a change in hydrography would be required in this region, an example being increased tidal currents or wave climate resulting in additional mixing.

1.9.6.3 The modelling studies undertaken for the Morgan Generation Assets detailed in Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement demonstrated that potential changes in tidal currents and wave climate do not extend into these areas located beyond the physical processes study area therefore there will be no impact on thermal stratification.

1.9.7 Future monitoring

1.9.7.1 Overall, no effects which are significant in EIA terms have been identified therefore, in terms of physical processes, no specific monitoring is recommended beyond those related to undertaking maintenance activities outlined in the project description, Volume 1, Chapter 3: Project description of the Environmental Statement. These include routine inspections of inter-array and interconnector cables to ensure the cables are buried to an adequate depth and not exposed. We anticipate that geophysical surveys will be required as a condition of the marine licence(s).

1.9.7.2 Whilst the Morgan Generation Assets did not identify any potential significant effects on physical processes post installation surveys, that will be undertaken for engineering purposes during the operations and maintenance phase, may be utilised monitor these processes. Monitoring will be undertaken to observe the effect of sediment transport and sediment transport pathways on cable burial with specific reference to physical processes. The primary function of this monitoring is to examine changes to the sandwaves post-construction. The surveys will be expected to focus on areas where active mobile seabed features, such as sandwaves, have been identified and were subject to sandwave clearance during the construction phase. Asset integrity monitoring surveys together with the relevant data gathered, will be considered in the context of seabed mobility, seabed recovery and sandwave recovery, for information purposes. This will highlight any morphological changes to the seabed in areas directly impacted by construction activities, improving the evidence base for future mitigation in accordance with NPS EN-3 paragraphs 2.8.83 and 2.8.85 and best practice guidance and principles.

1.10 Cumulative effect assessment methodology

1.10.1 Methodology

1.10.1.1 The CEA takes into account the impact associated with the Morgan Generation Assets together with the Morgan and Morecambe Offshore Wind Farms Transmission Assets, the Morecambe Offshore Windfarm Generation Assets, and other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 3, Annex 5.1: Cumulative effects screening matrix of the Environmental Statement). Each project has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

1.10.1.2 The physical processes CEA methodology has followed the methodology set out in Volume 1, Chapter 5: EIA methodology of the Environmental Statement. The cumulative assessment considers three scenarios:

- Scenario 1: Morgan Generation Assets plus Morgan and Morecambe Offshore Wind Farms: Transmission Assets.
- Scenario 2: Morgan Generation Assets plus Morgan and Morecambe Offshore Wind Farms: Transmission Assets and the Morecambe Offshore Windfarm Generation Assets.
- Scenario 3: Morgan Generation Assets plus Morgan and Morecambe Offshore Wind Farms: Transmission Assets alongside all other projects, plans and activities. This assessment has been allocated into ‘tiers’ reflecting the current stage of the other projects, plans and activities within the planning and development process. This tiered approach is adopted to provide a clear assessment of the Morgan Generation Assets and Morgan and Morecambe Offshore Wind Farms: Transmission Assets alongside other projects, plans and activities.
  - Tier 1: includes projects, plans and activities at the following stages:
    - Under construction
    - Permitted application
    - Submitted application
    - Those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact (for example, with associated maintenance activities)
  - Tier 2: includes projects, plans and activities at the following stages:
    - Scoping report has been submitted and is in the public domain

- Tier 3: includes projects, plans and activities at the following stages:
  - Scoping report has not been submitted and is not in the public domain
  - Identified in the relevant Development Plan
  - Identified in other plans and programmes.

1.10.1.3 This approach to CEA has been developed to provide an assessment of the Morgan Generation Assets together with the Morgan and Morecambe Offshore Wind Farms: Transmission Assets (Scenario 1) and the Morecambe Offshore Windfarm: Generation Assets (Scenario 2) in order to identify, as far as possible, the combined effects of these three applications separately from the assessment that includes all other projects, plans and activities (Scenario 3).

1.10.1.4 The specific projects, plans and activities scoped into the CEA, are outline in Table 1.15.

Table 1.15: List of other projects, plans and activities considered within the CEA.

Project/plan	Status	Distance from the Morgan Generation Assets (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Tier 1- Offshore Cables						
Isle of Man to UK Interconnector Cable – Maintenance and Repair	Operational	0.3	Cable maintenance and repair	N/A	09 August 2018 to 08 August 2033	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases.
Tier 1- Offshore Wind Projects and Associated Cables						
Walney extension 3	Operational	8.1	Maintenance activities at Walney extension 3	N/A	28 November 2014 to 28 November 2039	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.
Walney extension 4	Operational	9.5	Maintenance activities at Walney extension 4	N/A	28 November 2014 to 28 November 2039	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Project/plan	Status	Distance from the Morgan Generation Assets (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Mona Offshore Wind Project	Environmental Statement submitted	11.1	Mona Offshore Wind Project	01/01/2026-31/12/2029	01 January 2030 to 31 December 2065	Project construction phase overlaps with proposed development construction phase. Project operations and maintenance phase overlaps with proposed development operations and maintenance phase. Project decommissioning phase overlaps with proposed development decommissioning phase.
Walney 2	Operational	13.3	Maintenance activities at Walney 2	N/A	01 November 2007 to 01 November 2032	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.
West of Duddon Sands	Operational	15.4	Maintenance activities at West of Duddon Sands	N/A	23 September 2008 to 23 September 2033	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Project/plan	Status	Distance from the Morgan Generation Assets (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Walney 1	Operational	16.3	Maintenance activities at Walney 1	N/A	01 November 2007 to 01 November 2032	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.
Ormonde Offshore Wind Farm	Operational	24.4	Maintenance activities at Ormonde Energy Limited	N/A	01 January 2011 to 01 January 2036	Project maintenance phase overlaps with proposed development construction and operations and maintenance phases. Project decommissioning phase overlaps with proposed development operations and maintenance phase.
Barrow Offshore Wind Limited	Operational	30.1	Maintenance activities at Barrow Offshore Wind Limited including export cable repairs.	N/A	01 March 2003 to 01 March 2028	Project maintenance phase overlaps with proposed development construction phases. Project decommissioning phase overlaps with proposed development construction phases.

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Project/plan	Status	Distance from the Morgan Generation Assets (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Tier 1- Infrastructure						
Millom West	Decommissioning	3.1	Decommissioning of the Millom West offshore platform.	N/A	To 2024	Project decommissioning phase overlaps with the proposed development construction phase.
Tier 1- Aggregate and Disposal						
Douglas Harbour Dredging	Operational	22.7	Douglas outer harbour, basin and fairway are plough dredged annually, normally in January/February. The inner harbour/marina is also dredged annually, and silt is deposited at a licensed site off Douglas Head.	N/A	N/A	Project operations and maintenance phase overlaps with the proposed development construction phase.
Tier 2- Offshore Wind Projects and Associated Cables						
Mooir Vannin Offshore Wind Farm	Pre- application Scoping submitted	4.8	Proposed Development will comprise 100 turbines for 80 MW to 100 MW of power generation to be supplied directly to the Isle of Man.	2030-2032	2032 onwards	Project construction, operations and maintenance phases overlap with proposed development operations and maintenance phase. Project operations and maintenance phase overlaps with proposed development decommissioning phase.

Project/plan	Status	Distance from the Morgan Generation Assets (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Morecambe Offshore Windfarm Generation Assets	Pre- application PEIR submitted	11.2	Morecambe Offshore Wind Farm	01/01/2028-31/12/2029	01 January 2030 to 31 December 2065	Project construction phase overlaps with proposed development construction phase. Project operations and maintenance phase overlaps with proposed development operations and maintenance phase. Project decommissioning phase overlaps with proposed development decommissioning phase.
Tier 3- Offshore Cables						
Isle of Man to UK Interconnector Cable 2	Pre- application	N/A	A new 70 MW to 100 MW HVAC interconnector to be deployed by 2030 between Pulrose substation and northwest England Distribution network.	2024-2030	2030 onwards	Project construction phase overlaps with proposed development construction phase. Project operations and maintenance phase overlaps with proposed development operations and maintenance phase.

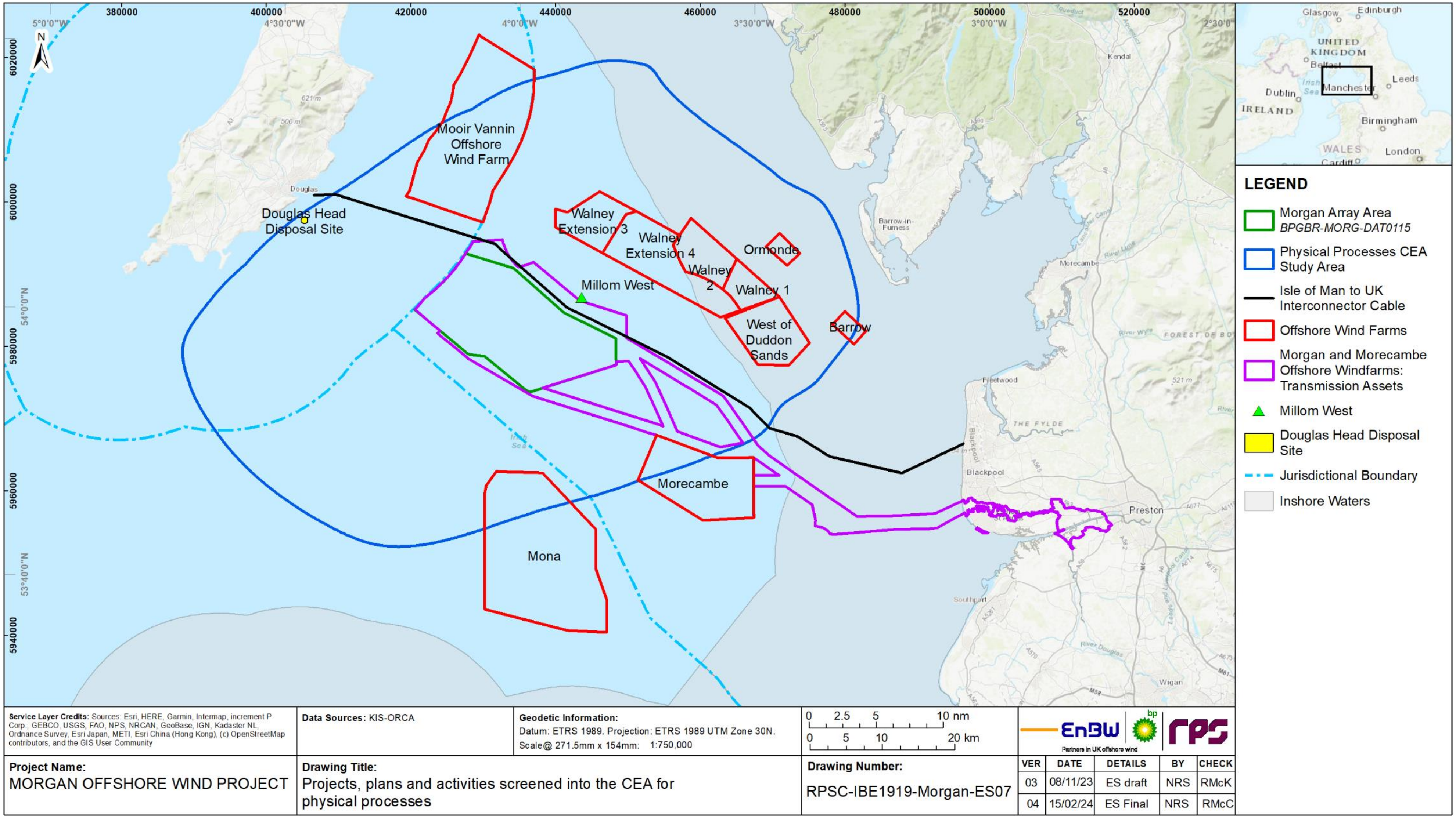


Figure 1.9: Other projects, plans and activities screened into the cumulative effects assessment for Morgan Generation Assets.

1.10.2 Maximum design scenario

1.10.2.1 The MDS identified in Table 1.16 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group for the projects screened into the cumulative effects assessment. The cumulative effects presented and assessed in this section have been selected from the Project Design Envelope provided in Volume 1, Chapter 3: Project description of the Environmental Statement as well as the information available on other projects and plans, in order to inform a ‘MDS’. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different wind turbine layout), to that assessed here, be taken forward in the final design scheme.

Table 1.16: Maximum design scenario considered for the assessment of potential cumulative effects on physical processes.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	MDS as described for the Morgan Generation Assets Table 1.13 assessed cumulatively with the following other projects/plans: **Tier 1** **Construction Phase** • Construction of Mona Offshore Wind Project • Maintenance of Isle of Man to UK Interconnector Cable • Maintenance of Walney Extension 3 offshore wind farm • Maintenance of Walney Extension 4 offshore wind farm • Maintenance of Walney 2 offshore wind farm • Maintenance of West of Duddon Sands offshore wind farm • Maintenance of Walney 1 offshore wind farm • Maintenance of Ormonde offshore wind farm • Maintenance of Barrow offshore wind farm • Disposal of Douglas Harbour Dredging material at Douglas Head Disposal Site. **Operations and Maintenance Phase** • Operations and maintenance of Mona Offshore Wind Project • Maintenance of Isle of Man to UK Interconnector Cable • Maintenance and decommissioning of Walney Extension 3 offshore wind farm • Maintenance and decommissioning of Walney Extension 4 offshore wind farm • Maintenance and decommissioning of Walney 2 offshore wind farm • Maintenance and decommissioning of West of Duddon Sands offshore wind farm	Outcome of the CEA will be greatest when the greatest number of other schemes are considered in combination. Including schemes and developments within the CEA study area to capture the potential overlap of impacts during the construction, operations and maintenance and decommissioning phases. Activities from schemes that potentially increase suspended sediment concentrations during the temporal overlap with the Morgan Generation Assets phases have been included as these may create a cumulative impact on physical features/ receptors.

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
				• Maintenance and decommissioning of Walney 1 offshore wind farm • Maintenance and decommissioning of Ormonde offshore wind farm • Maintenance and decommissioning of Barrow offshore wind farm. **Decommissioning Phase** • Mona Offshore Wind Project decommissioning **Tier 2** **Construction Phase** • Tier 1 Projects • Construction of Morecambe Offshore Windfarm Generation Assets **Operations and Maintenance Phase** • Tier 1 Projects • Operations and maintenance of Morecambe Offshore Windfarm Generation Assets • Operations and maintenance of Morgan and Morecambe Offshore Windfarms Transmission Assets • Construction and operations and maintenance of Mooir Vannin Offshore Wind Farm. **Decommissioning Phase** • Morecambe Offshore Windfarm Generation Assets decommissioning • Morgan and Morecambe Offshore Windfarms Transmission Assets decommissioning. **Tier 3** **Construction Phase** • Tier 1 + Tier 2 Projects • Construction of the Isle of Man to UK Interconnector Cable 2.	

Potential cumulative effect	Phase[a] C	O	D	Maximum Design Scenario	Justification
Impacts to the tidal regime due to presence of infrastructure. Impacts to the wave regime due to presence of infrastructure. Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	**Tier 1** **Construction Phase** • Construction of Mona Offshore Wind Project • Decommissioning of Millom West offshore platform **Operations and Maintenance Phase** • Operations and maintenance of Mona Offshore Wind Project **Decommissioning Phase** • Mona Offshore Wind Project residual structures. **Tier 2** **Construction Phase** • Tier 1 Projects • Construction of Morecambe Offshore Windfarm Generation Assets **Operations and Maintenance Phase** • Operations and maintenance of Morecambe Offshore Windfarm: Generation Assets • Operations and maintenance of Morgan and Morecambe Offshore Windfarms Transmission Assets • Construction and operations and maintenance of Mooir Vannin Offshore Wind Farm. **Decommissioning Phase** • Morecambe Offshore Windfarm Generation Assets residual structures • Morgan and Morecambe Offshore Windfarms Transmission Assets residual structures.	

1.11 Cumulative effects assessment

1.11.1 Overview

1.11.1.1 A description of the significance of cumulative effects upon physical processes receptors arising from each identified impact is given below.

1.11.1.2 The CEA for the Morgan Generation Assets is presented in a series of tables (one for each potential cumulative impact).

1.11.2 Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features

1.11.2.1 Increased suspended sediment concentrations may arise due to seabed preparation involving sandwave clearance, the installation of the wind turbines and OSP foundations, the installation and/or maintenance of cables and associated decommissioning activities. Should the other projects cited take place concurrently with the Morgan Generation Assets (construction or operations and maintenance), there is potential for cumulative increased turbidity levels. An assessment of these impacts can be seen in Table 1.17.

Table 1.17: Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Construction			
Magnitude of impact	The construction phase of the Morgan and Morecambe Offshore Wind Farms Transmission Assets includes activities which will give rise to increased SSC namely, site preparation/ sandwave clearance, export and interconnector cable trenching and potentially drilling of piles for OSPs. Noting that the OSPs and interconnector installation for Morgan Generation Assets have been included within the assessment presented in section 1.9.2. The site preparation and offshore export cable installation will be undertaken in close proximity to the Morgan Generation Assets using similar parameters and techniques to those	The Morecambe Offshore Windfarm Generation Assets includes activities which will give rise to increased SSC namely, site preparation/sandwave clearance, inter-array cable trenching and potential drilling of piles for wind turbine foundations. Due to the location of the Morecambe Generation Assets further south and also to the east of the Morgan Generation Assets, the tidal flows orientated in a north south direction therefore there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is	**Tier 1** The construction phase of Morgan Generation Assets and Transmission Assets would coincide with the construction phase of Mona Offshore Wind Project. The Mona Offshore Wind Project is located >10 km to the south of Morgan Generation Assets and Transmission Assets, where tidal flows are at an east to west orientation and therefore cumulative impact on SSC, particularly with respect to the receptors, would not occur. The Morgan Generation Assets and Transmission Assets construction phase

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	associated with the inter-array cable installation therefore a negligible amount of remobilised and redistributed material may reach the southern edges of the West of Copeland MCZ and the West of Walney MCZ. It is noted that given the relationship of these projects site preparation and installation of infrastructure would be phased and SSC increases would not occur concurrently from all activities. However, should multiple operations be undertaken plumes would be advected on the tide and not towards one another. In the case of export cables and inter-array cables these plumes may interact however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. In both cases the majority of sedimentation would occur within close proximity to each installation however, given the active sediment transport regime deposited material would be redistributed across the vicinity. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly.	predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	coincides with the maintenance phases of a number of offshore energy projects. In each case the activities which are associated with increased SSC relate to cable maintenance and reburial and, as such, would be of similar magnitude and extent as those associated with the Morgan Generation Assets operations and maintenance phase and be intermittent in nature. The route of the Isle of Man Interconnector cable is immediately adjacent to the north extent of the Morgan Generation Assets and intersects with the Transmission Assets, therefore if work is undertaken co-incidentally in these areas sediment plumes may coalesce and a negligible amount of material may reach the south edges of the West of Copeland MCZ and the West of Walney MCZ. The Walney Offshore Wind Farm (all areas) and the West of Duddon Sands Offshore Wind Farm are located approximately 10 km to the north of the Morgan Generation Assets and Transmission Assets. If reburial is undertaken to the south of these sites, the plume extent may reach Morgan Generation Assets. It is noted that sediment plumes would be carried in concert with the tide, and not towards one another and activities are

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	The magnitude is therefore, considered to be **negligible**.		associated with repair and reburial cables and would be characterised by short term intermittent mobilisation of sediment along relatively short sections of cable. In addition to these Offshore Wind Farms, Ormonde Offshore Wind Farm is located within the West of Copeland MCZ and the West of Walney MCZ designated receptors. So, although any potential contribution from Morgan Generation Assets and Transmission Assets would be negligible, the Offshore Wind Farm maintenance activities would directly impact the receptors. The Barrow Offshore Wind Farm is located on the east extent of the CEA physical processes study area and, due to distance and orientation, would not introduce cumulative impacts with Morgan Generation Assets and Transmission Assets with respect to the West of Copeland MCZ and the West of Walney MCZ designated receptors. Finally, the disposal site associated with the dredging operations at Douglas Harbour is located at the northwest extent of the CEA physical processes study area. Due to distance and the orientation of tidal currents it would not exhibit a cumulative effect with the Morgan Generation Assets and

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			Transmission Assets with respect to the West of Copeland MCZ and the West of Walney MCZ designated receptors. With suspended sediment plumes running in parallel instead of coalescing. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**. **Tier 2** The construction of the Morecambe Generation Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**. **Tier 3** The construction of a second interconnector cable between the Isle of Man and the UK may occur during the

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			construction phase of the Morgan Generation Assets and Transmission Assets as it is due to be operational in 2030. Interconnector cable installation activities would likely be of similar magnitude and extent as those associated with the Morgan Generation Assets cable installation operations. Dependent on the detailed design and cable routing associated with the interconnector cable a cumulative impact may arise with the Morgan Generation Assets and Transmission Assets with respect to the West of Copeland MCZ and the West of Walney MCZ designated receptors. As a Tier 3 project there is limited information available in this respect, however it is anticipated that this impact would be temporary in nature and of limited scale. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The West of Copeland MCZ is designated for protected features such as, subtidal coarse sediment, subtidal sand and subtidal mixed sediments. These subtidal sediments may provide habitats which support a wide range of associated biological		

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	communities. The sedimentation identified as part of the Morgan Generation Assets assessment is localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The protected features within the West of Walney MCZ are subtidal sand, subtidal mud and sea-pen and burrowing megafauna communities. The physical processes sediment features would recover from sedimentation as it is localised and composed of native material therefore the composition and function of the features is of low vulnerability and recoverable. These are active seabed features not sensitive to SSC and low sensitivity to deposition due to natural exposure to sediment redistribution and of high value due to the designated status. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1,Tier 2 and Tier 3** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Operations and maintenance			
Magnitude of impact	The operations and maintenance phase of the Morgan and Morecambe Offshore Wind Farms Transmission Assets includes cable burial activities which may result in increased SSC. Maintenance activities are both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative	It is noted that maintenance activities are both intermittent and a smaller scale than that of the construction phase. Additionally, due to the location of the Morecambe Generation Assets further south and to the east of the Morgan Generation Assets there are no additional cumulative effects from Scenario 1 in relation to the West of	**Tier 1** The Morgan Generation Assets and Transmission Assets operations and maintenance phase coincides with the operations and maintenance phases of the Mona Offshore Wind Project and the Morecambe Generation Assets. In all cases the magnitude is reduced from that of the construction phases

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	impacts are less likely to occur and be on a smaller scale than the construction phases of the Morgan Generation Assets and Transmission Assets. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	associate with each of the projects due to the limited temporal and spatial nature of repair activities. The operations and maintenance phase of the Morgan Generation Assets and Transmission Assets is associated with cable repair and reburial activities. These activities are both intermittent and on a smaller scale than that of the construction phase cable installation therefore the magnitude of the impact is reduced. The Morgan Generation Assets and Transmission Assets operations and maintenance phase also coincides with the maintenance phases of the same offshore energy projects identified for the construction phase. Any potential cumulative impacts would be of a lesser magnitude. Noting that Walney (all phases), West of Duddon Sands and Ormonde Offshore Wind Farms are located within the West of Copeland MCZ and the West of Walney MCZ and although any potential contribution from Morgan Generation Assets and Transmission Assets would be negligible, the Offshore Wind Farm maintenance activities associated with the other projects would directly impact the receptors.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**. **Tier 2** The Mooir Vannin Offshore Wind Farm would be under construction at the commencement of this period and going forward into the operations and maintenance phase following completion. The associated activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Morgan Generation Assets due to the orientation of the tidal flows and the intermittent nature of all activities. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase.		

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Decommissioning			
Magnitude of impact	Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline. In both cases it is proposed that cables will be removed using similar techniques to those applied in the construction phase, with scour protection remaining *in situ*. Decommissioning activity will therefore result in increased SSC however this would be localised and of a lesser magnitude than the construction phase with sandwave clearance and dredging activities being significantly reduced. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high	As outlined in the construction phase, the decommissioning of Morecambe generation Assets, should it occur concurrently with Scenario 1, would not results in any additional impacts on the West of Copeland MCZ or the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	**Tier 1** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of the Mona Offshore Wind Project. It is proposed that cables will be removed using similar techniques to those applied in the construction phase, with scour protection remaining *in situ*. Decommissioning activity will therefore result in increased SSC however this would be localised and of a lesser magnitude than the construction phase with sandwave clearance and dredging activities being significantly reduced.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.		**Tier 2** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of the Morecambe Generation Assets. It is proposed that cables will be removed using similar techniques to those applied in the construction phase, with scour protection remaining *in situ*. Decommissioning activity will therefore result in increased SSC however this would be localised and of a lesser magnitude than the construction phase with sandwave clearance and dredging activities being significantly reduced. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase. The West of Copeland MCZ and within the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	of negligible adverse significance, which is **not significant** in EIA terms.	considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		

1.11.3 Impacts to the tidal regime due to presence of infrastructure

1.11.3.1 The presence of infrastructure may lead to changes to the tidal regime principally during the operations and maintenance phase of the Morgan Generation Assets. This impact is also relevant to the construction phase and following decommissioning associated with residual infrastructure. An assessment of these impacts can be seen in Table 1.18.

Table 1.18: Impacts to the tidal regime due to presence of infrastructure.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Construction			
Magnitude of impact	During the construction phase there will be gradual changes to tidal regime for Morgan Generation Assets and Transmission Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	During the construction phase there will be gradual changes to tidal regime for Scenario 1 and Morecambe Generation Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	**Tier 1** The construction phase of Morgan Generation Assets and Transmission Assets coincides with the construction phase of Mona Offshore Wind Project. During this period there will be gradual changes to tidal regime from the baseline environment (no presence of infrastructure) to the combined operations and maintenance phases of all offshore wind projects, as assessed in the following operations and maintenance phase section. The construction phase of Morgan Generation Assets and Transmission Assets also overlaps with the decommissioning phase of the Millom West offshore platform. When this platform is removed from the water column there a potential for cumulative effects with infrastructure associated with the Morgan Generation Assets and Transmission Assets. Given the Millom West offshore platform ultised suction bucket foundations of

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			a similar scale to those suction bucket foundations assessed for the Morgan Generation Assets, a similar spatial impact and magnitude is expected. This change will take the form of a restoration of the natural tidal regime. The presence of the suction bucket foundations associated with the Morgan Generation Assets and Transmission Assets may alter tidal currents in the lee of the structure up to a distance of *c*. 500 m, beyond which point changes to the tidal regime are indescernible from natural variability. Therefore the 3.1 km distance seperating the projects, no cumulative effect is expected to arise. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**. **Tier 2** The construction of the Morecambe Generation Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The West of Walney MCZ and the West of Copeland MCZ are designated for several protected features such as subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. Due to the localised and limited changes in tidal regime and the inherent natural variability of baseline conditions, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability to variations in tidal currents. These are active seabed features of low sensitivity due to ability to adapt to small changes in tidal flow, wave climate and sediment transport and of high value due to the designated status. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Operations and maintenance			
Magnitude of impact	The Transmission Assets infrastructure which effects the tidal regime is comprised of OSPs and cable/scour protection. The influence of these structures is typically limited to 500 m for Morecambe Generation Assets OSPs and cable protection in shallow water. This distance is significantly less at the Morgan Generations Assets offshore location, noting that Morgan Generation Assets OSP	The Morecambe Generation Assets infrastructure which effects the tidal regime is comprised of wind turbine foundations and cable/scour protection. The impact is predicted to be restricted to the immediate vicinity if the infrastructure, (i.e. immediately upstream and downstream of the structure in the form of a water wake). The wake signature will dissipate and recover with	**Tier 1** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance phases of Mona Offshore Wind Project. The infrastructure proposed for the Mona Offshore Wind Project is of a similar type and

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	structures are included within the assessment presented in section 1.9.3. The Morgan Generation Assets and Transmission Assets are in close proximity to each other, therefore whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	distance downstream, becoming indistinguishable to ambient conditions within tens to a few hundreds of metres. These impacts do not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors and there would therefore be no additional cumulative impacts from Scenario 1. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	scale to that of the Morgan Generation Assets and, as outlined for Morecambe Generation Assets under Scenario 1, the influence of these structures is typically limited to 500 m and focused in the lee of the infrastructure in the form of a water wake. So, whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure with regards to Morecambe Generation Assets and Transmission Assets, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. **Tier 2** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance phases of Morecambe Generation Assets and Mooir Vannin Offshore Wind Farm. The scoping report for Mooir Vannin Offshore Wind Farm indicates that the maximum size of infrastructure is similar to that proposed for Morgan Transmission Assets, (Ørsted, 2023). Therefore, for typical infrastructure, the distance of influence of tidal regime is *circa* 500 m. It is noted that Mooir Vannin Offshore Wind Farm is adjacent to the West of Copeland MCZ so it may be indirectly affected by presence of infrastructure however it would

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			not be in the region potentially affected by Morgan Generation Assets and Transmission Assets. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Decommissioning			
Magnitude of impact	Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline. In both cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on tidal regime. Residual structures left on the seabed from	Decommissioning of Morgan Generation Assets, Morecambe Generation Assets and Transmission Assets are on the same projected timeline. In all cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on tidal regime. Residual	**Tier 1** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of Mona Offshore Wind Project. In all cases the only residual infrastructure is scour and

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.	structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.	cable protection and would have a negligible magnitude of impact on tidal regime. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. **Tier 2** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of Morecambe Generation Assets. The decommissioning of the Morecambe Generation Assets and Morecambe Offshore Windfarm Transmission Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase.		

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		

1.11.4 Impacts to the wave climate due to presence of infrastructure

1.11.4.1 Introducing infrastructure may lead to changes to the wave regime principally during the operations and maintenance phase of the Morgan Generation Assets. Also, relevant to a lesser degree is the construction phase and following decommissioning associated with residual infrastructure. An assessment of these impacts can be seen in Table 1.19.

Table 1.19: Impacts to the wave climate due to presence of infrastructure.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Construction			
Magnitude of impact	During the construction phase there will be gradual changes to wave climate for Morgan Generation Assets and Transmission Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	During the construction phase there will be gradual changes to wave climate for Scenario 1 and Morecambe Generation Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	**Tier 1** The construction phase of Morgan Generation Assets and Transmission Assets coincides with the construction phase of Mona Offshore Wind Project. During this period there will be gradual changes to wave climate from the baseline environment (no presence of infrastructure) to the combined operations and maintenance phases of all offshore wind projects, as assessed in the following operations and maintenance phase section. The construction phase of Morgan Generation Assets and Transmission Assets also overlaps with the decommissioning phase of the Millom West offshore platform. When this platform is removed from the water column there a potential for cumulative effects with infrastructure associated with the Morgan Generation Assets and Transmission

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			Assets. Given the Millom West offshore platform ultised suction bucket foundations of a similar scale to the suction bucket foundations assessed for the Morgan Generation Assets, a similar spatial impact and magnitude is expected. This change will take the form of a restoration of the natural wave climate. The change associated with the removal of the Millow West offshore platform would be limited to *c.* 200 m from its original location. The presence of infrastructure associated with the Morgan Generation Assets and Transmission Assets may alter the wave climate in an overlapping area with the Millow West offshore platform when storm waves approach from the west/southwest, however given the scale of effect associated with the removal of the Millom West offshore platform alone, the cumulative change would behighly localised and of low order. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**. **Tier 2** The construction of the Morecambe Generation Assets was assessed under Scenario 2 and concluded there are no

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The West of Walney MCZ and the West of Copeland MCZ are designated for several protected features such as subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. Due to the localised and limited changes in wave climate and the inherent natural variability of baseline conditions, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability to variations in wave climate. These are active seabed features of low sensitivity due to ability to adapt to small changes in tidal flow, wave climate and sediment transport and of high value due to the designated status. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Operations and maintenance			

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Magnitude of impact	The Transmission Assets infrastructure which may affect wave climate is comprised of OSPs and cable/scour protection. The influence of these structures is typically limited to 1 km for Morecambe Generation Assets OSPs and cable protection in shallow water. This distance is significantly less at the Morgan Generation Assets offshore location, noting that Morgan Generation Assets OSP structures are included within the assessment presented in section 1.9.4. The Morgan Generation Assets and Transmission Assets are in close proximity to each other, therefore whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	The Morecambe Generation Assets infrastructure which effects the wave climate is comprised of wind turbine foundations and cable/scour protection. The impact is predicted to occur principally in the immediate lee of the infrastructure in the form of a water wake, with alterations to the wave climate diminishing rapidly with increased distance and being indistinguishable from background levels at 10 km. Therefore these impacts may interact locally with the Transmission Assets, however these impacts would not extend to Morgan Generation Assets situated at a distance of >11 km. Additionally, these impacts do not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors and there would therefore be no additional cumulative impacts from Scenario 1. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	**Tier 1** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance phases of Mona Offshore Wind Project. The infrastructure proposed for the Mona Offshore Wind Project is of a similar type and scale to that of the Morgan Generation Assets and, as outlined for Morecambe Generation Assets under Scenario 1, the influence of these structures is typically limited to 10 km and focused in the lee of the infrastructure in the form of a water wake. So, whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure with regards to Morecambe Generation Assets and Transmission Assets, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. **Tier 2** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance phases of Mooir Vannin Offshore Wind Farm and Morecambe Generation Assets. The maximum size of infrastructure proposed for the Mooir Vannin Offshore Wind Farm is a similar scale to that proposed for the Morgan

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			Generation Assets, therefore the distance of influence of wave climate is *circa* 10 km (Ørsted, 2023). There is the potential for the alteration in the wave field from Morgan Generation Assets to extend to the Mooir Vannin Offshore Wind Farm and *vice versa*. However, it should be recognised that the changes in wave climate from each project arise from the same incident wave field and would not converge (i.e. waves approaching from the southwest would give rise to changes in wave fields to the northeast of both sites). It is also noted that the Mooir Vannin Offshore Wind Farm is adjacent to the West of Copeland MCZ so it may be indirectly affected by presence of infrastructure however it would not be in the region potentially affected by Morgan Generation Assets and Transmission Assets. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Decommissioning			
Magnitude of impact	Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline. In both cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on wave climate. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the	Decommissioning of Morgan Generation Assets, Morecambe Generation Assets and Transmission Assets are on the same projected timeline. In all cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on wave climate. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the	**Tier 1** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of Mona Offshore Wind Project. In each case the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on wave climate. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. **Tier 2**

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	receptors. The magnitude is therefore, considered to be **negligible**.	receptors. The magnitude is therefore, considered to be **negligible**.	Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of Morecambe Generation Assets. The decommissioning of the Morecambe Generation Assets and Morecambe Offshore Windfarm Transmission Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		

1.11.5 Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry

1.11.5.1 During the operations and maintenance phase the presence of infrastructure may alter the sediment transport and sediment transport pathways leading to changes in the Morgan Generation Assets area. The construction phase and following decommissioning associated with residual infrastructure is relevant, but changes are gradual and to a lesser extent in these phases as shown in Table 1.20.

Table 1.20: Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Construction			
Magnitude of impact	During the construction phase there will be gradual changes to sediment transport and sediment transport pathways for Morgan Generation Assets and Transmission Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	During the construction phase there will be gradual changes to sediment transport and sediment transport pathways for Scenario 1 and Morecambe Generation Assets with changes occurring from the baseline environment (no presence of infrastructure) to the operations and maintenance phase as assessed in the following operations and maintenance phase section. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	**Tier 1** The construction phase of Morgan Generation Assets and Transmission Assets coincides with the construction phase of Mona Offshore Wind Project. During this period there will be gradual changes to sediment transport and sediment transport pathways from the baseline environment (no presence of infrastructure) to the combined operations and maintenance phases of all offshore wind projects, as assessed in the following operations and maintenance phase section. The construction phase of Morgan Generation Assets and Transmission Assets also overlaps with the decommissioning phase of the Millom West offshore platform. When this platform is removed from the water

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			column there a potential for cumulative effects with infrastructure associated with the Morgan Generation Assets and Transmission Assets. Given the Millom West offshore platform ultised suction bucket foundations of a similar scale to those suction bucket foundations assessed for the Morgan Generation Assets, a similar spatial impact and magnitude is expected. This change will take the form of a restoration of the natural sediment trnasport regime. The presence of the suction bucket foundations associated with the Morgan Generation Assets and Transmission Assets may alter residual currents in the lee of the however significant changes are limited to the direct vicinity of the structures, beyond which point changes to the residual currents are +/- 0.003 m/s and thus indescernible from natural variability. Therefore the 3.1 km distance seperating the projects, no cumulative effect is expected to arise with respect to sediment transport rates. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**. **Tier 2** The construction of the Morecambe Generation Assets and Morecambe Offshore

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
			Windfarm Transmission Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The West of Walney MCZ and the West of Copeland MCZ are designated for several protected features such as, subtidal coarse sediment, subtidal sand and subtidal mixed sediments supporting burrowing species and megafauna. Due to the localised and limited changes in the littoral currents which drives sediment transport and natural exposure to sediment redistribution, the West of Walney MCZ and the West of Copeland MCZ features are of low vulnerability and recoverable. These are active seabed features of low sensitivity due to ability to adapt to small changes in tidal flow, wave climate and sediment transport and of high value due to the designated status. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Operations and maintenance			

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
Magnitude of impact	The Transmission Assets infrastructure which effects sediment transport and sediment transport pathways are comprised of OSPs and cable/scour protection. The influence of these structures is typically limited to 2 km for Morecambe Generation Assets OSPs and cable protection in shallow water. This distance is significantly less at the Morgan Generation Assets offshore location, noting that Morgan Generation Assets OSP structures are included within the assessment presented in section 1.9.5. The Morgan Generation Assets and Transmission Assets are in close proximity to each other, therefore whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	The Morecambe Generation Assets infrastructure which effects sediment transport and sediment transport pathways are comprised of wind turbine foundations and cable/scour protection. Sediment transport may be influenced directly by infrastructure located on the seabed, which would be of a similar area of influence of tidal flow, or by changes to littoral currents, with a similar scale of influence as wave climate alterations. The impact is therefore predicted to occur principally in the immediate lee of the infrastructure and diminishing rapidly with increased distance and being indistinguishable from background levels at 10 km. These impacts would not extend to Morgan Generation Assets or to the West of Copeland MCZ and the West of Walney MCZ designated receptors and there would be no additional cumulative impacts from Scenario 1. The sediment transport pathway in the east Irish Sea occurs in an easterly direction, with sediment carried into the region from the Irish Sea between Anglesey and the Isle of Man. The sediment which enters the Morgan Array Area derives from the northern section of this corridor whilst the Morecambe Generation Assets sediment transport is supplied from the central section of this pathway, also from	**Tier 1** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance phases of Mona Offshore Wind Project. The infrastructure proposed for the Mona Offshore Wind Project is of a similar type and scale to that of the Morgan Generation Assets and, as outlined for Morecambe Generation Assets under Scenario 1, the influence of these structures is typically 2 km and no more than 10 km and focused in the lee of the infrastructure in the form of a water wake. So, whilst there is some limited potential for cumulative impacts in the immediate vicinity of the infrastructure with regards to Morecambe Generation Assets and Transmission Assets, this does not extend to the West of Copeland MCZ and the West of Walney MCZ designated receptors. As outlined for Scenario 2, the sediment which enters the Morgan Array Area derives from the northern section of the corridor between Anglesey and the Isle of Man whilst the sediment which enters the Mona Array Area originates from the southern section of this corridor, also from an easterly direction, as it is located directly to the south of the Morgan Array Area, (ABPmer, 2023). As such, any potential changes to sediment

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
		an easterly direction, as it is located south east of the Morgan Array Area, (ABPmer, 2023). As such, any potential changes to sediment budgets or sediment transport regimes as a result of the Morgan Generation Assets will not cumulatively impact with Morecambe Generation Assets. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.	budgets or sediment transport regimes as a result of the Morgan Generation Assets will not cumulatively impact with the Mona Offshore Wind Project as they do not share a common sediment transport pathway. **Tier 2** The operations and maintenance phase of Morgan Generation Assets and Transmission Assets coincides with the operations and maintenance of the Mooir Vannin Offshore Wind Farm. For the maximum type and scale of infrastructure proposed within scoping report, (Ørsted, 2023), the distance of influence on sediment transport is anticipated to be *circa* 2 km. It is noted that the Mooir Vannin Offshore Wind Farm is adjacent to the West of Copeland MCZ so it may be indirectly affected by presence of infrastructure however it would not be in the region potentially affected by Morgan Generation Assets and Transmission Assets. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase.		

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		
Decommissioning			
Magnitude of impact	Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline. In both cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on sediment transport and sediment transport pathways. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors.	Decommissioning of Morgan Generation Assets, Morecambe Generation Assets and Transmission Assets are on the same projected timeline. In all cases the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on sediment transport and sediment transport pathways. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase. It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors.	**Tier 1** Decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as decommissioning of Mona Offshore Wind Project. In each case the only residual infrastructure is scour and cable protection and would have a negligible magnitude of impact on sediment transport and sediment transport pathways. Residual structures left on the seabed from decommissioning will not cause a cumulative impact on changes to the tidal regime and will result in a lesser magnitude of impact than that described in the operations and maintenance phase.

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.	The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.	It is predicted that the impact will not affect West of Walney MCZ and the West of Copeland MCZ receptors. **Tier 2** The decommissioning of Morgan Generation Assets and Transmission Assets are on the same projected timeline as the decommissioning of Morecambe Generation Assets. The decommissioning of the Morecambe Generation Assets and Morecambe Offshore Windfarm Transmission Assets was assessed under Scenario 2 and concluded there are no additional cumulative effects from Scenario 1 in relation to the West of Copeland MCZ and the West of Walney MCZ. The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will not affect the receptors. The magnitude is therefore, considered to be **negligible**.
Sensitivity of receptor	The sensitivity of the receptors remains the same as the construction phase. The West of Copeland MCZ and the West of Walney MCZ are deemed to be of low vulnerability, high recoverability and high value. The sensitivity of the receptor is therefore, considered to be **low**.		
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be	Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be	**Tier 1 and Tier 2** Overall, the magnitude of the cumulative impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be

	Scenario 1 Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 2: Morgan Generation Assets + Morecambe Offshore Windfarm Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets	Scenario 3: Morgan Generation Assets + Morgan and Morecambe Offshore Wind Farms: Transmission Assets + Tier 1, Tier 2, Tier 3 projects
	of negligible adverse significance, which is **not significant** in EIA terms.	of negligible adverse significance, which is **not significant** in EIA terms.	of negligible adverse significance, which is **not significant** in EIA terms.
Further mitigation and residual significance	No effects which are significant in EIA terms have been identified therefore no further mitigation measures are proposed.		

1.11.6 Future monitoring

1.11.6.1 Overall, no cumulative effects which are significant in EIA terms have been identified therefore, in terms of physical processes, no specific monitoring is recommended. However, as outlined in section 1.9.7, asset integrity monitoring surveys together with the relevant data gathered, will be considered in the context of seabed mobility, seabed recovery and sandwave recovery, for information purposes. This will highlight any morphological changes to the seabed in areas directly impacted by construction activities..

1.12 Transboundary effects

2.1.1.1 A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to physical processes from the Morgan Generation Assets upon the interests of other states. The Morgan Generation Assets are located entirely within the UK Exclusive Economic Zone (EEZ). Any potential impacts on physical processes are likely to be confined to within one tidal excursion of the Morgan Generation Assets (i.e. potential changes to the wave regime, tidal regime and sediment transport due to the presence of infrastructure, and potential changes in SSC related to construction and maintenance activities). Any potential impacts on physical processes will not extend beyond the UK Exclusive Economic Zone (EEZ).

1.13 Inter-related effects

1.13.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Morgan Generation Assets (construction, operations and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases (e.g. subsea noise effects from piling, operational turbines, vessels and decommissioning)
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on physical processes, such as sediment plumes, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

1.13.1.2 A description of the likely interactive effects arising from the Morgan Generation Assets on physical processes is provided in Volume 2, Chapter 15: Inter-related effects of the Environmental Statement.

1.13.1.3 Table 1.21 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets, and also the inter-related effects (receptor-led effects that are predicted to arise for physical processes receptors.

Table 1.21: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects).

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Significance
	C	O	D		
Increase in suspended sediments due to construction, operation and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	Increases in SSC during construction phase would not extend into the operations and maintenance phase. Similarly, those increases which occur in the operations and maintenance phase due to maintenance activities would not extend to decommissioning.	Negligible
Impacts to the tidal regime due to presence of infrastructure. Impacts to the wave regime due to presence of infrastructure. Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	Changes to tidal regime, wave climate and sediment transport due to infrastructure relate to the same structures within the construction, operations and maintenance and decommissioning phases. The decommissioning phase structures are those remaining bed structures such as scour protection when wind turbine structures have been removed, thus resulting in a lesser magnitude of the same impact.	Negligible
Receptor-led effects					
West of Walney MCZ and West of Copeland MCZ: During principally the operational phase increased suspended sediment concentrations and associated deposition on physical features may occur due to maintenance activities; this would coincide with changes to tidal currents, wave climate, littoral currents and sediment transport due to the presence of the structures. Maintenance activities are sporadic, with the impacts predicted to be of local spatial extent, short term duration and intermittent. Within the West of Walney MCZ and the West of Copeland MCZ these impacts would be indistinguishable from background variations and would therefore not be significant in EIA terms.					

1.14 Summary of impacts, mitigation measures and monitoring

1.14.1.1 Information on physical processes within the physical processes study area was collected through detailed desktop review of existing studies and datasets and supported by numerical modelling.

- Table 1.22 presents a summary of the potential impacts, measures proposed to be adopted as part of the project and residual effects in respect to physical processes. The impacts assessed include:
  - Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features
  - Changes to tidal regime, wave climate and sediment transport due to presence of infrastructure

- Overall, it is concluded that there will be **no significant effects** arising from the Morgan Generation Assets during the construction, operations and maintenance or decommissioning phases
- Table 1.23 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include:
  - Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features
  - Changes to tidal currents, wave climate, littoral currents and sediment transport
- Overall, it is concluded that there will be **no significant cumulative effects** from the Morgan Generation Assets alongside other projects/plans
- No potential transboundary impacts have been identified in relation to effects of the Morgan Generation Assets.

Table 1.22: Summary of potential environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to the tidal regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of impact	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
Impacts to the wave regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of impact	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				which is of such a nature that it may be more readily removable at decommissioning. • Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works and within the licenced disposal area applied for, which is the Morgan Array Area. • Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. The decommissioning of gravity bases and the removal of ballast material will not be released back into the local system. • Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: – Avoid UXO – Clear UXO with low order techniques						

Description of impact	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				– Clear UXO with high order techniques.						

Table 1.23: Summary of potential cumulative environmental effects, mitigation and monitoring.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of effect	Phase[a] C	Phase[a] O	Phase[a] D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
Scenario 1										
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to the tidal regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				removable at decommissioning.						
Impacts to the wave regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning. • Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works and within the licenced disposal area applied for, which is the Morgan Array Area. • Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. The decommissioning of gravity bases and the removal of ballast material will not be released back into the local system. • Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with						

Description of effect	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
	C	O	D							
				regard to UXO clearance that follows: – Avoid UXO – Clear UXO with low order techniques – Clear UXO with high order techniques.						
Scenario 2										
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to the tidal regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.						
Impacts to the wave regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to sediment transport and sediment transport pathways due to presence of	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
infrastructure and associated potential impacts to physical features and bathymetry.				used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning. • Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works and within the licenced disposal area applied for, which is the Morgan Array Area. • Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. The			D: Negligible - adverse			

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				decommissioning of gravity bases and the removal of ballast material will not be released back into the local system. • Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: – Avoid UXO – Clear UXO with low order techniques – Clear UXO with high order techniques.						
Tier 1										
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to the tidal regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.			D: Negligible - adverse			
Impacts to the wave regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.						
Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning. • Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				and within the licenced disposal area applied for, which is the Morgan Array Area. • Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. The decommissioning of gravity bases and the removal of ballast material will not be released back into the local system. • Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: – Avoid UXO – Clear UXO with low order techniques – Clear UXO with high order techniques.						
Tier 2										
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
related activities, and the potential impact to physical features.							D: Negligible - adverse			
Impacts to the tidal regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A
Impacts to the wave regime due to presence of infrastructure.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that it may be more readily removable at decommissioning.						
Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry.	✓	✓	✓	• Development and adherence to an Offshore CMS, which will include details of scour protection management, to be used around offshore structures and foundations to reduce scour. The scour protection measures will be subject to engineering design to ensure they minimise as much as practical the occurrence of scour. • Development and adherence to an Offshore CMS including a CSIP which will include cable burial where possible and cable protection. Consideration will be given for the use of scour protection which is of such a nature that	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				it may be more readily removable at decommissioning. • Development and adherence to an Offshore CMS which includes a CSIP which requires material arising from drilling and/or sandwave clearance to be deposited in close proximity to the works and within the licenced disposal area applied for, which is the Morgan Array Area. • Development of, and adherence to, a Decommissioning Programme in accordance with the Energy Act 2004. The decommissioning of gravity bases and the removal of ballast material will not be released back into the local system. • Development and adherence to a Marine Mammal Mitigation Protocol (MMMP) that requires implementation of a mitigation hierarchy with regard to UXO clearance that follows: – Avoid UXO – Clear UXO with low order techniques						

Description of effect	Phase[a] C	O	D	Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual significant effect	Proposed monitoring
				– Clear UXO with high order techniques.						
Tier 3										
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features.	✓	×	×	• Development and adherence to an Offshore CMS, which will include details to minimise sandwave clearance volumes and will be included within the CSIP.	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Negligible - adverse O: Negligible - adverse D: Negligible - adverse	N/A	Negligible	N/A

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