Partners in UK offshore wind

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Preliminary Environmental Information Report

Volume 2, chapter 7: Benthic subtidal ecology

Image of an offshore wind farm

April 2023
FINAL

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Prepared by:	Prepared for:
RPS	**Morgan Offshore Wind Ltd.**

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Glossary

Term	Meaning
Annelida	A large phylum that comprises the segmented worms, which include earthworms, lugworms, ragworms, and leeches.
Arthropoda	Phylum with a wide diversity of animals with hard exoskeletons and jointed appendages.
Benthic Ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment.
Biotope	The combination of physical environment (habitat) and its distinctive assemblage of conspicuous species.
Cumulative Effects	Changes to the environment caused by a combination of present and future projects, plans or activities.
Drop-down Video	A survey method in which imagery of habitat is collected, used predominantly to survey marine environments.
Deposit Feeder	Organisms which move along the surface or burrow within soft sediments and ingest some part of the sediment, digesting and assimilating some of the non-living and living organic matter.
Echinoderm	A marine invertebrate of the phylum Echinodermata, such as a starfish, sea urchin, or sea cucumber.
Epifauna	Organisms living on the surface of the seabed.
Epibenthic	Benthic invertebrates living on the surface of the seabed.
Eulittoral	Applied to the habitat formed on the lower shore of an aquatic ecosystem, below the littoral zone.
Filter Feeder	A sub-group of suspension feeding animals that feed by straining suspended matter and food particles from water, typically by passing the water over a specialized filtering structure.
Habitat	The environment that a plant or animal lives in.
Infauna	The animals living in the sediments of the seabed.
Infralittoral	A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae.
Isle of Man Territorial Sea Committee	A cross-governmental committee which was set up to manage the Isle of Man's interests regarding its territorial sea and the resources within it including hydrocarbon, coal and mineral rights, up to the 12 mile limit.
Invasive Species	An introduced organism that becomes overpopulated and negatively alters its new environment.
Mollusca	Phylum of invertebrates which have a soft unsegmented body, commonly protected by a calcareous shell.
National Marine Biological Analytical Quality Control Scheme	This scheme provides a source of external quality assurance for laboratories engaged in the production of marine biological data.
Polychaete	A class of segmented worms often known as bristleworms.
SACFOR Classification	A measure of abundance which records species in terms of percentage cover or counts and categorises in to superabundant, abundant, common, frequent, occasional and rare.
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Sublittoral	Area extending seaward of low tide to the edge of the continental shelf.
Subtidal	Area extending from below low tide to the edge of the continental shelf.
Tidal Excursion	The horizontal distance over which a water particle may move during one cycle of flood and ebb.

Acronyms

Acronym	Description
AC	Alternating Current
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIEEM	Chartered Institute of Ecology and Environmental Management
CPT	Cone Penetration Test
CSQGs	Canadian Environmental Quality Guidelines
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DCO	Development Consent Order
DDV	Drop Down Video
DEFRA	Department for Environment, Food and Rural Affairs
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EWG	Expert Working Group
HDD	Horizontal Directional Drilling
HRA	Habitat Regulations Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IEF	Important Ecological Feature
IMO	International Maritime Organisation
INNS	Invasive Non-Native Species
IPC	Infrastructure Planning Commission
ISAA	Information to Support an Appropriate Assessment
JNCC	Joint Nature Conservation Committee

Acronym	Description
MarESA	Marine Evidence based Sensitivity Assessment
MARLIN	Marine Life Information Network
MARPOL	The International Convention for the Prevention of Pollution from Ships
MBA	Marine Biological Association
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MPCP	Marine Pollution Contingency Plan
NMBAQC	National Marine Biological Analytical Quality Control Scheme
NPS	National Policy Statement
NRW	Natural Resources Wales
NRW (A)	Natural Resources Wales Advisory
NSIPs	Nationally Significant Infrastructure Project
OESEA	Offshore Energy Strategic Environmental Assessment
OSP	Offshore Substation Platform
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PEIR	Preliminary Environmental Information Report
SAC	Special Area of Conservation
sp	Species
SSC	Suspended Sediment Concentration
SPM	Suspended Particulate Matter
TSC	Isle of Man Territorial Sea Committee
TWT	The Wildlife Trust
WFD	Water Framework Directive
ZOI	Zone Of Influence

Units

Unit	Description
%	Percentage
mm	Millimetres
cm	Centimetres
m	Metres
km	Kilometres
m^2	Square metres
km^2	Square kilometres
m^3	Cubed metres
m/s	Metres per second
m/h	Metres per hour
m^3/h	Cubed metres per hour
mg/l	Milligrams per litre
kv	Kilovolts
mG	Milligauss
mV/cm	Millivolt per centimetre
µT	Microtesla
^oC	Degrees centigrade

7 Chapter 7 – Benthic subtidal ecology

7.1 Introduction

7.1.1 Overview

7.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the assessment of the potential impact of the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets) on benthic subtidal ecology during the construction, operations and maintenance, and decommissioning phases.

7.1.1.2 The assessment presented is informed by the following technical chapters:

- Volume 2, chapter 6: Physical processes of the PEIR
- Volume 2, chapter 8: Fish and shellfish ecology of the PEIR.

7.1.1.3 This chapter also draws upon information contained within:

- Volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR
- Volume 4, annex 6.1: Physical processes technical report of the PEIR.

7.1.2 Purpose of chapter

7.1.2.1 The primary purpose of the PEIR is outlined in volume 1, chapter 1: Introduction of the PEIR. In summary, the primary purpose of an Environmental Statement is to support the Development Consent Order (DCO) application for the Morgan Generation Assets under the Planning Act 2008 (the 2008 Act). The PEIR constitutes the Preliminary Environmental Information for the Morgan Generation Assets and sets out the findings of the EIA to date to support the pre-application consultation activities required under the 2008 Act. The EIA will be finalised following completion of pre-application consultation and the Environmental Statement will accompany the application to the Secretary of State for Development Consent.

7.1.2.2 The PEIR forms the basis for statutory consultation which will last for 47 days and conclude on 4 June 2023. At this point, comments received on the PEIR will be reviewed and incorporated (where appropriate) into the Environmental Statement, which will be submitted in support of the application for Development Consent scheduled for quarter one of 2024.

7.1.2.3 In particular, this PEIR chapter:

- Presents the existing environmental baseline established from desk studies, site-specific surveys and consultation
- Identifies any assumptions and limitations encountered in compiling the environmental information
- Presents the potential environmental effects on benthic subtidal ecology arising from the Morgan Generation Assets, based on the information gathered and the analysis and assessments undertaken
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects of the Morgan Generation Assets on benthic subtidal ecology.

7.1.3 Study area

7.1.3.1 For the purposes of the benthic subtidal ecology assessment, three study areas have been defined:

- The Morgan benthic subtidal ecology study area has been defined as the area encompassing the Morgan Array Area. The Morgan benthic subtidal ecology study area also includes the area within one tidal excursion around the Morgan Array Area known as the Zone Of Influence (ZOI). These are the areas within which the site-specific benthic subtidal surveys have been undertaken (Figure 7.1). The site-specific survey within the Morgan Array Area has been completed and was available to inform this chapter for the purposes of the PEIR. Further site-specific surveys were undertaken in the summer of 2022 to include the ZOI (Figure 7.1). This chapter will therefore be updated with this additional data for the final Environmental Statement following the completion of the data analysis.
- The regional benthic subtidal ecology study area encompasses the wider east Irish Sea habitats and includes the neighbouring consented offshore wind farms and designated sites (Figure 7.1). It has been characterised by desktop data and provides a wider context to the site-specific data
- The Cumulative Effects Assessment (CEA) Morgan benthic subtidal ecology study area has been defined as a 50km buffer around the Morgan Array Area (Figure 7.6). This 50km buffer is designed to capture all the relevant projects/plans/activities which have the potential to interact with the impact of the Morgan Generation Assets. For interactive/synergistic impacts (i.e. increase in suspended sediment concentration and changes in physical processes) the study area was defined by the CEA physical processes study area which is defined as two tidal excursions.

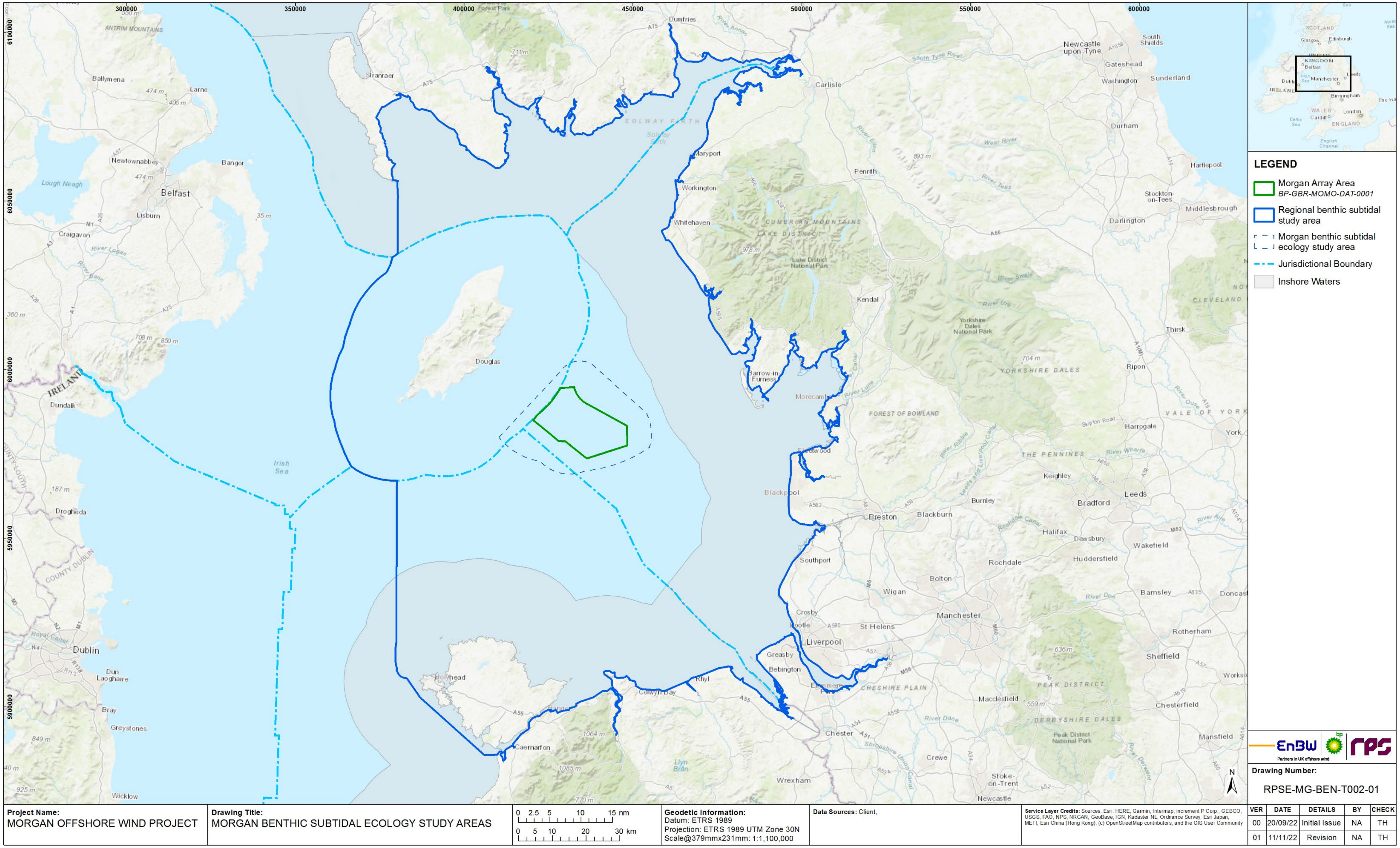


Figure 7.1: Morgan benthic subtidal ecology study areas.

7.2 Policy context

7.2.1 National Policy Statements

7.2.1.1 Planning policy on renewable energy infrastructure is presented in volume 1, chapter 2: Policy and legislation of the PEIR. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to benthic subtidal ecology, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (EN-3, DECC, 2011b).

7.2.1.2 NPS EN-1 and NPS EN-3 include guidance on what matters are to be considered in the assessment. These are summarised in Table 7.1 below. 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 7.2 below.

7.2.1.3 Table 7.1 refers to the current NPSs, specifically NPS EN-1 (DECC, 2011a) and NPS EN-3 (DECC, 2011b). If the NPSs are updated prior to the application for Development Consent, the revised NPSs will be fully considered in relation to benthic subtidal ecology within the Environmental Statement.

Table 7.1: Summary of the NPS EN-1 and NPS EN-3 provisions relevant to benthic subtidal ecology.

Summary of NPS EN-3 and EN-1 provision	How and where considered in the PEIR
NPS EN-1	
To help the Infrastructure Planning Commission (IPC) consider thoroughly the potential effects of a proposed project in cases where the EIA Directive does not apply and an Environmental Statement is not therefore required, the applicant should instead provide information proportionate to the scale of the project on the likely significant environmental, social and economic effects. (NPS EN-1 paragraph 4.2.10)	The scoping process enables the Morgan Generation Assets to deliver environmental information proportionate to the infrastructure. This is demonstrated in this chapter in regard to the justification of the topics scoped out (section 7.6.2 and Table 7.15) as this demonstrates a proportionate approach.
The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. (NPS EN-1 paragraph 5.3.4)	The Morgan Generation Assets will aim to conserve habitats through a number of measures adopted to reduce the impact of the Morgan Generation Assets (section 7.7).
Marine Conservation Zones (MCZs) introduced under the Marine and Coastal Access Act 2009, are areas that have been designated for the purpose of conserving marine flora or fauna, marine habitats or types of marine habitat or features of geological or geomorphological interest. As a public authority, the IPC is bound by the duties in relation to MCZs imposed by sections 125 and 126 of the Marine and Coastal Access Act 2009. (NPS EN-1 paragraph 5.3.12)	MCZs have been taken account of through the identification of designated sites within the Morgan benthic subtidal study area (sections 0). As a result of this process two MCZs have been considered in this assessment, and the relevant MCZs are identified in section 7.4.6 and assessed throughout section 7.8.
The applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • During construction and the operational and maintenance phase best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements • Habitats will, where practicable, be restored after construction works have finished • Opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals. (NPS EN-1 paragraph 5.3.18)	The Maximum Design Scenario (MDS) ensures that those assessing the Morgan Generation Assets are fully aware of the area which the Morgan Generation Assets will cover. It represents a realistic scenario without overcompensating for any one activity, in this sense it represents the minimum area required to work (section 7.6.1 and Table 7.25). Best practice during construction and maintenance will be set out in the Construction Method Statement and the Environmental Management Plan (Table 7.16). Following the completion of most activities sedimentary habitats will recover naturally (section 7.8.1 and 7.8.2) and measures have been adopted for the Morgan Generation Assets to avoid direct impacts on sensitive habitats where recovery would be limited (section 7.7). The Morgan Generation Assets will aim to conserve habitats through a number of measures adopted to reduce the impact of the Morgan Generation Assets (section 7.7).
NPS EN-3	
Where cumulative effects on intertidal and subtidal habitats are predicted as a result of the cumulative impact of multiple cable routes, applicants of various schemes are encouraged to work together to ensure that the number of cables crossing the intertidal zone are minimised and installation and decommissioning phases are coordinated to ensure that disturbance is also reasonably minimised. (NPS EN-3 paragraph 2.6.89)	The project alone assessment MDS includes the impact of cable crossings where relevant (Table 7.25). Cumulative effects have been quantified and their significance assessed in section 7.10, including the impact of cables from other projects within the benthic subtidal ecology CEA study area.
The applicant should follow The Crown Estate's cable route protocol. 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 • Environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour protection • 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 (NPS EN-3 paragraph 2.6.113)	The impact of suspended sediments, long term habitat loss and temporary habitat disturbance from cable installation and maintenance as well as anchors and vessel legs (i.e. jack-up legs) has been quantified in the MDS (Table 7.14). The effect of these impacts on the habitats within the Morgan Array Area has then been assessed throughout section 7.7. A stand-alone DCO application is being sought for the transmission assets required to enable the export of electricity from the Morgan Generation Assets, which will consider the impacts on benthic ecology associated with the construction, operations and maintenance, and decommissioning of the export cables. Therefore the offshore export cable corridor for the Morgan Transmission Assets to accompany the Morgan Generation Assets has not been included in this PEIR assessment. The predicted rates of recovery in the subtidal zone from temporary effects has been considered in the sensitivity of the subtidal biotopes and then used to determine the final significance of an impact (section 7.8.1).

Table 7.2: Summary of NPS EN-1 and NPS EN-3 policy on decision making relevant to benthic subtidal ecology.

Summary of NPS EN-1 and EN-3 provision	How and where considered in the PEIR
NPS EN-1	
The aim of the NPS is to ensure a halting, and if possible, a reversal, of declines in priority habitats and species, with wild species and habitats as part of healthy, functioning ecosystems. (NPS EN-1 paragraph 5.3.5)	The conservation status of habitats and species is considered throughout this assessment and measures have been adopted to ensure impacts are reduced (section 7.7).
In having regard to the aim of the Government's biodiversity strategy the IPC should take account of the context of the challenge of climate change: failure to address this challenge will result in significant adverse impacts to biodiversity. (NPS EN-1 paragraph 5.3.6)	The future impact of climate change on the habitats in the east Irish Sea has been considered in section 7.4.8.
Developments should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives; where significant harm cannot be avoided, then appropriate compensation measures should be sought. (NPS EN-1 paragraph 5.3.7)	Mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor. This assessment is undertaken for each impact.
In taking decisions, the IPC should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment. (NPS EN-1 paragraph 5.3.8)	As part of this chapter the process of identifying designated sites has been undertaken for the Morgan benthic subtidal study area (section 7.4.6). This was done to ensure all habitats, features and species of conservation importance were considered, where relevant, in this assessment.
NPS EN-3	
The conservation status of subtidal and intertidal habitat and species are of relevance to the Secretary of State. (NPS EN-3 paragraphs 2.6.84 and 2.6.115)	The conservation status of habitats and species has been considered in the designation of the importance of Important Ecological features (IEFs) which can be seen in section 7.4.7.
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. (NPS EN-3 paragraph 2.6.116)	The effect of impacts related to the design of the Morgan Generation Assets have been assessed in section 7.7. This included the consideration of the sensitivity of the relevant subtidal habitats and the consideration of mitigation where necessary. An expert working group (EWG) has been set up with the statutory nature conservation bodies (SNCBs) to discuss, amongst other things, sensitive subtidal environmental aspects.

7.2.2 North West Inshore and North West Offshore Coast Marine Plans

7.2.2.1 The assessment of potential changes to benthic subtidal ecology 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 7.3 along with details as to how these have been addressed within the assessment.

Table 7.3: North West Inshore and North West Offshore Coast Marine Plan policies of relevance to benthic subtidal ecology.

Policy	Key provisions	How and where considered in the PEIR
NW-SCP-1	Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty.	As part of this chapter (as well as volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR), designated sites within the Morgan benthic subtidal study area have been identified (section 7.4.6). This was done to ensure all habitats, features and species of conservation importance were considered, where relevant, in this assessment.
NW-MPA-1	Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported.	As part of this chapter, designated sites within the Morgan benthic subtidal study area have been identified (section 7.4.6). This was done to ensure all habitats, features and species of conservation importance were considered, where relevant, in this assessment.
NW-BIO-1	NW-BIO-1 encourages and supports proposals that enhance the distribution of priority habitats and priority species.	The Morgan Generation Assets will aim to conserve habitat through a number of measures adopted to reduce the impact of the Morgan Generation Assets (section 7.7).
NW-BIO-2	NW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the functioning of healthy, resilient and adaptable marine ecosystems.	Mitigation is considered where the significance of an impact is moderate or major to reduce the significance of the impact to negligible or minor. This assessment is undertaken for each impact.
NW-BIO-3	Proposals that conserve, restore or enhance coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, will be supported.	Section 7.7 considers the magnitude, sensitivity and significance of the impacts associated with the Morgan Generation Assets on the relevant subtidal IEFs. Additionally considering mitigation where impacts were found to be significant. As a result the Morgan Generation Assets seeks to conserve the function and services provided by coastal habitats
NW-INNS-1	NW-INNS-1 aims to avoid or minimise damage to the marine area from the introduction or transport of invasive non-native species.	The implementation of an Environmental Management Plan as part of the measures adopted by the Morgan Generation Assets (section 7.7 and Table 7.16) will manage and reduce the risk of introduction or spread of invasive species.
NW-CE-1	Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will avoid, minimise and mitigate.	Cumulative effects have been quantified and their significance assessed in section 7.10. This section includes the consideration of mitigation where the significance is found to be moderate or major.

7.2.3 Welsh National Marine Plan

7.2.3.1 The Morgan Generation Assets sits in English waters however the south of the Morgan benthic subtidal ecology study area overlaps with Welsh waters therefore the 2019 Welsh National Marine Plan (Welsh Government, 2019) has been considered. Key provisions are set out in Table 7.4 along with details as to how these have been addressed within the assessment.

Table 7.4: 2019 Welsh National Marine Plan policies of relevance to benthic subtidal ecology.

Policy	Key provisions	How and where considered in the PEIR
• ENV_01, 02, 03, 04, 05, 06, 07 • SOC_06, 09 • GOV_01	The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Commitments to supporting an ecologically coherent network of MPAs.	The extent of each potential impact on the benthic environment, therefore considering the abundance and distribution of species and habitats, is considered throughout the project alone assessment and the cumulative assessment (section 7.8 and 7.10). Consideration of the impact of the Morgan Generation Assets on designated sites is considered in section 7.4.6 and those which have the potential to be impacted have been considered throughout this assessment.
• ENV_01; 03 • GOV_01	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.	The potential impact of non-indigenous species in regard to the Morgan Generation Assets is assessed in section 7.8.6.
• ENV_01, 02, 03, 04, 05, 06, 07 • GOV_01	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.	The extent of each potential impact on the benthic environment, therefore considering the abundance and diversity of species and habitats, is considered throughout the project alone assessment and the cumulative assessment (section 7.8 and 7.10).
• ENV_01, 02, 03, 07 • GOV_01 • FIS_01	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	Sea floor integrity is considered within the temporary habitat disturbance/loss and long term habitat loss impacts (sections 7.8.1 and 7.8.4). These impacts consider pressures such as changes in substrate or seabed type and the sensitivity of the impacted habitats and species in relation to this pressure.
• SOC_09, 10 • ENV_01, 02 • GOV_01	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems. Plan policies recognise the importance of the physical parameters of seawater (temperature, salinity, depth, currents, waves, turbulence and turbidity) and the need to manage human activities which could impact the dynamics of the ecosystem.	The long term alteration of hydrographical conditions in relation to the placement of Morgan Generation Assets is considered as part of the changes in physical process impact (section 7.8.8). This section considers the changes in tidal, wave and sediment transport regime and identified no significant effects.
• ENV_06 • SOC_01 • GOV_01	Contaminants are at a level not giving rise to pollution effects.	The effects of contaminants is considered in the remobilisation of sediment-bound contaminants impacts (section 7.8.3). This section evaluated the impact of historical contaminant on habitats and identified no significant effects.

7.3 Consultation

7.3.1.0 A summary of the key issues raised during consultation activities undertaken to date specific to benthic subtidal ecology is presented in Table 7.5 below, together with how these issues have been considered in the production of this PEIR chapter.

7.3.1 Evidence plan

7.3.1.1 The purpose of the Evidence Plan process is to discuss, and where possible agree, the information the Morgan Generation Assets needs to supply to the Secretary of State, as part of a DCO application for Morgan Generation Assets, with Natural England, the Marine Management Organisation (MMO), the Joint Nature Conservation Committee (JNCC), Natural Resources Wales (NRW), the Centre for Environment, Fisheries and Aquaculture Science (Cefas), Environment Agency and The North West Wildlife Trust (TWT). The Evidence Plan seeks to ensure compliance with the Habitat Regulations Assessment (HRA) and EIA.

7.3.1.2 Discussion to date regarding benthic ecology with consultees via the benthic ecology, fish and shellfish and physical process EWG has focussed on providing consultees with information on the benthic subtidal surveys within the Morgan Array Area which were undertaken in 2021. It was stated that the results of these surveys would be used to characterise the seabed sediments and habitats. Key comments from stakeholders on the scope of the 2021 Morgan Array Area benthic survey included the absence of site-specific sampling with the ZOI, which was subsequently undertaken as part of the 2022 summer sampling campaign. A further update on the 2022 benthic surveys was provided including the methods and sampling locations within the ZOI.

7.3.1.3 Following the distribution of the 2022 survey scope the following responses were provided by the stakeholders:

- Natural England – welcomed that the survey scope was flexible based on data acquisition and adjustments can be made to ensure that all habitat types and sensitive habitats are appropriately sampled. They suggested sample stations should be located to allow ground truthing of the indicative habitats and sample stations should be increased should habitats differ from those expected. Transitional habitats should also be captured in this sampling plan. They welcomed that camera surveys will include both stills and video. They welcomed that eDNA procedure and physico-chemical sampling will be in line with appropriate guidance and that sensitive habitats will be avoided for grab sampling
- JNCC – requested clarification regarding the number of sample stations. They commended the applicant and surveyors on their intentions to return *Arctica*

islandica to the seabed and recommended this is done carefully. JNCC recognised that the initial station selection was based on available geophysical data and noted that necessary changes will be made on the receipt of new geophysical data

- NRW – agreed in general with the sampling strategy proposed and the broadscale habitats described by the geophysical data. They provided guidance on the number of samples per habitat and sought clarification regarding sampling in the south of the ZOI and sample spacing in the ZOI. NRW also welcomed the avoidance of sensitive features as part of the grab sampling strategy, and they made recommendations should a grab fail due to the presence of *Sabellaria spinulosa* reefs. They also welcomed the use of DNA metabarcoding analysis.

Table 7.5: Summary of key consultation issues raised during consultation activities undertaken for the Morgan Generation Assets relevant to benthic subtidal ecology.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
November 2021	NRW, Natural England, MMO, JNCC and Planning Inspectorate - consultation meeting	If the intention was to cover the wider designations in the evidence plan, it was advised that the applicant look at the MCZ Stage 2 assessment and Measures of Equivalent Environmental Benefit (MEEB) requirements.	An MCZ screening was undertaken prior to the start of the benthic subtidal ecology chapter and two MCZs were taken forward for a stage 2 assessment. MEEB have been considered where the SNCBs have requested.
February 2022	Natural England, MMO, JNCC Environment Agency, NRW, Cefas and TWT - 1st benthic ecology, fish and shellfish and physical process EWG	Natural England and JNCC have been working on best practice guidance which will be published on a Natural England SharePoint site next week to inform external stakeholders (Natural England, 2022). The Applicants should review this guidance.	The draft guidance has been reviewed and the evidence plan template has taken it into account.
March 2022	JNCC - 1st Benthic Ecology, Fish and Shellfish and Physical Processes EWG Meeting Response	JNCC noted the presence and initial analysis of sea-pen and burrowing megafauna communities within the array area and welcomed the opportunity to review the assessment of this feature. JNCC provided information which may prove useful in further analysis.	The presence of this feature was assessed Gardline following the 2021 site specific survey, a summary of these results is presented in volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR. The results concluded that the habitats within the Morgan Array Area had only a negligible resemblance to the sea-pens and burrowing megafauna habitat.
April 2022	NRW Advisory (A) - 2022 Survey Scope Response	In general, NRW (A) advised a minimum of one sample station per broadscale habitat (EUNIS L3/L4), and where the indicative habitat areas are extensive, the minimum number of sample stations per habitat type should be increased accordingly to provide sufficient coverage of that habitat type.	The sampling strategy ensured that a minimum of one sample station per broadscale habitat was undertaken with the most prevalent habitats having the most sample stations.
April 2022	Natural England - 2022 Survey Scope Response	Natural England welcomed: • The wider scope of the survey areas included in the 2022 primarily the ZOI for the array areas, which has been defined as the array area plus a buffer of one tidal excursion. • The survey scope remained flexible to ensure that there was appropriate coverage of all habitat types and sensitive features. • That camera survey consisted of both stills and video was undertaken and extended to map condition. • That the survey sampling methods remained the same as with those set out and agreed by Natural England for the previous surveys in 2021, allowing for data comparison. • The additional information on the analysis of the physio-chemical samples in accordance with MMO specifications and hydrocarbons analysis as set out in the report. • That eDNA procedures were in line with those set out to the UK Marine DNA Working Group. • The avoidance of sensitive habitats (i.e. *Sabellaria* sp.) and the detail for recording *Arctica islandica*. • That Golding *et al*. (2020) refinement of the criteria for defining areas with low resemblance to stony reef was taken into consideration in the analysis. • The consideration of species of conservation interest. • Commended bp, EnBW and Gardline on their intentions to return individual *A. islandica* to the sea and recommend that individuals be returned carefully to the seabed, in a suitable habitat.	Noted and this chapter will be updated with the 2022 data collected within the ZOI for the final Environmental Statement following the completion of the data analysis.
April 2022	JNCC - 2022 Survey Scope Response	JNCC noted that until further information from geophysical acquisition is complete the information gathered to date will be used as the basis for initial station selection. JNCC assumed and recommended that any necessary changes be made on receipt of new geophysical data.	The scope of works was kept flexible so that sample stations could be added based on data such as geophysical data.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
April 2022	MMO - 1st Benthic Ecology, Fish and Shellfish and Physical Processes EWG Meeting Response	The MMO noted that the sampling stations should be suitably located and representative to allow ground truthing of the indicative habitats. Should habitats encountered differ from those expected based on the geophysical data acquired then we would expect to see an increase in sample stations to ensure that all potential habitats are sampled and mapped. The stations should ensure sampling of all habitats and particularly transitions between habitats.	The sample stations were located to sample the full range of habitats expected to occur in the Morgan Array Area and ZOI. The survey scope was kept flexible to allow for the addition of sample stations if necessary.
		The MMO requested clarity on whether the 50 stations for co-located camera and sediment sampling across the Morgan and Mona Array Areas and ZOIs were the combined total for both projects or 50 stations per project. JNCC recommended that the number of sample sites not be capped at 50 and should instead be based on geophysical evidence.	As noted above, the scope of works was kept flexible so that sample stations could be added based on the geophysical data.
July 2022	Natural England – Scoping Opinion	Natural England advised 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.	Effects on benthic receptors resulting from changes in physical processes is assessed in section 7.8.8. The effects of scour protection in enabling the colonisation of hard substrates and the introduction and spread of INNS are assessed in sections 7.8.5 and 7.8.6.
		Natural England did not agree that there was sufficient evidence to scope out: • electromagnetic fields (EMF) • the release of sediment-bound contaminants. They were unclear whether impacts from temperature changes due to heating from cables on benthic communities has been considered and whether it is scoped into or out of the project assessment.	All impact pathways have been scoped into this assessment. Effects of EMF effects are assessed in section 7.8.9, the release of sediment bound contaminants is assessed in section 7.8.3, and heat effects is assessed in section 7.8.10.
		The following types of projects should be included in the cumulative assessment: 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 cumulative assessment has been undertaken and is presented in section 7.10. The methodology for determining which projects have been included is presented in section 7.9.
		Natural England advised that the potential impact of the proposal upon features of nature conservation interest and opportunities for habitat creation/enhancement should have been included within this assessment in accordance with appropriate guidance on such matters. The Environmental Statement should thoroughly assess the potential for the proposal to affect designated sites.	The impact of the Morgan Generation Assets on designated sites and their relevant protected features has been considered throughout this assessment. Section 7.4.6 explains which sites and features (i.e. species and habitats) were scoped into this assessment. Opportunities for habitat creation have been considered in the colonisation of hard substrate impact (section 7.8.5).
		Highlighted that mitigation for non-designated but important conservation assets should be further considered and set out in the Environmental Statement.	Mitigation had been considered throughout this assessment in regard to habitats of conservation importance not in designated sites. In the absence of significant effects, no mitigation is deemed to be necessary, and no mitigation has therefore been proposed.
		Natural England advised that seabed preparation activities and impacts to benthic ecology will need to be considered.	The MDS (Table 7.14) sets out the potential temporary habitat disturbance/loss which may result from the seabed preparation proposed for the Morgan Generation Assets. The effects have also been assessed in other relevant impacts such as increased suspended sediments and re-mobilisation of sediment bound contaminants (sections 7.8.2 and 7.8.3).
		Natural England requested detail on how impacts from increased suspended sediments concentration (SSC) and associated deposition during decommissioning was to be assessed.	Modelling was undertaken for the extent of this impact in the construction phase when the greatest levels of SSC were expected to occur. The assessment assumes that following decommissioning, increases in SSC and potential impacts would be of lesser magnitude than both the construction phase and the operations and maintenance phase with cables and scour and cable protection remaining *in situ*. For further information on modelling see volume 4, annex 6.1: Physical processes technical report of the PEIR.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
		Natural England noted that the report states 'permanent habitat loss may occur under any infrastructure that is not decommissioned'; however it does not go on to fully justify that all infrastructure will be removed in decommissioning phase as this level of detail is currently unknown. In the absence of this, we would consider there could be permeant habitat loss from Morgan OWF.	The magnitude of permanent habitat loss (the result of infrastructure which will not be removed during decommissioning) has been set out in the MDS (Table 7.14) and assessed in section 7.8.4.
		Further consideration of how the removal of foundations and potential loss of species/habitats will need to be assessed in order to determine the significance of effect.	The effect of the removal of hard substrates on the relevant habitats has been assessed in section 7.8.7.
		Natural England stated that it was not clear in the benthic section how any changes to hydrodynamics and impacts of these on benthic habitats will be assessed e.g. changes in water flow, wave and tide climate.	The effect of the changes in physical processes on the relevant habitats has been assessed in section 7.8.8. These processes were also modelled as part of the physical processes technical report (see volume 4, annex 6.1: Physical processes technical report of the PEIR).
		Natural England advised that the method of classification of habitats is clearly set out (e.g. EUNIS/JNCC habitat code).	The method for the classification of habitat is described in detail in volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR. The habitats were classified using the JNCC Marine Habitat Classification for Britain and Ireland system.
July 2022	MMO – Scoping Opinion	The MMO was content that the approach provided by the applicant is sufficient to fully identify and assess potential impacts. The approach includes an assessment of the current information available and a commitment to undertake site specific surveys to collect relevant information on the benthic environment within the scoping area (sampled in 2021) and ZOI (sampled in 2022).	Noted and this chapter will be updated with the 2022 data collected within the ZOI for the final Environmental Statement following the completion of the data analysis.
		The impacts considered within the document appear appropriate and include those relevant to benthic ecology.	Noted and the full list of impacts assessed is detailed in Table 7.14.
		The MMO advised that EMF is considered and discussed further in the EIA and is evidenced with the latest available literature.	The impact of EMF has been assessed in section 7.8.9 and has included consideration of the provided sources.
		The MMO recommended that impacts on the wider benthic assemblage within the Morgan Generation Assets are also considered, particularly when it comes to developing the monitoring plan for the site so that the impact of the Morgan Generation Assets on the benthic assemblage within the scoping area and ZOI can be suitably evidenced.	The wider benthic community within the Morgan ZOI has been characterised (see volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR for details on how) and important ecological features have been identified (Table 7.9). In the absence of significant effects, no monitoring has been proposed for the Morgan Generation Assets.
		The MMO highlighted that infrastructure should be positioned to avoid impacts on any features of conservation importance identified during baseline or pre-construction surveys.	Features of conservation importance were not recorded within the Morgan Array Area and so will not be directly affected by the infrastructure.
		The MMO was content that the following impacts can be scoped out of further assessment at EIA stage: • Accidental pollution during construction, operations and maintenance and decommissioning phases • Underwater noise from wind turbine operation during operations and maintenance phase • Underwater noise from vessels during all phases • Impacts from the release of sediment-bound contaminants.	Noted however the impact of sediment-bound contaminants was assessed based on feedback from other consultees.
		The MMO was content with the proposal for cumulative impacts and in-combination impacts.	Noted.
July 2022	The Planning Inspectorate – Scoping Opinion	The Scoping Report proposed to scope out accidental pollution at all phases of the project. The Inspectorate agreed that such effects can be scoped out of the assessment. The Environmental Statement should provide details of the proposed mitigation measures to be included in the Environmental Management Plan and its constituent Marine Pollution Contingency Plan (MPCP). The Environmental Statement should also explain how such measures will be secured.	Accidental pollution has been scoped out of this report. Details of the proposed mitigation measures to be included in the Environmental Management Plan and MPCP will be included in the final ES.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
		The Planning Inspectorate agreed that: • an assessment of the potential risk of INNS introduction and spread during the operations and maintenance phase • an assessment should consider the colonisation of hard structures in the construction and decommissioning phases • an assessment should consider that there is potential for physical processes to change during the construction phase • long term habitat loss during the decommissioning phase can be scoped out.	• An assessment of the potential risks if INNS introduction and spread has been completed in section 7.8.6 • An assessment considering the colonisation of hard structures has been completed in section 7.8.4.16 • An assessment of the effects associated with the potential for physical processes change has been completed in section 7.8.8 • An assessment of long term habitat loss in the decommissioning phase has been scoped out.
		The Environmental Statement should establish what impacts are temporary, medium and long term in relation to the receptor being impacted where it has influence on the assessment of significance.	The duration of an impact and the potential recovery time in relation to that impact has been assessed within each impact. This has been taken into account when assessing the magnitude of an impact and the sensitivity of the receptors, both of which have then been used to determine if an impact significantly affects the benthic environment.
		The Environmental Statement should assess impacts on the wider benthic assemblage where significant effects are likely to occur.	The wider benthic environment within the benthic subtidal ecology study area has been described within section 7.4 and characterised as important ecological features in Table 7.9. All of which have been assessed where relevant throughout this assessment (section 7.7.1.3).
		The Environmental Statement should determine if there would be any temperature changes as a result of cable presence and assess any impacts on benthic communities where they are likely to occur.	An assessment of the potential impact of the release of heat from subsea cables within the Morgan Array Area is presented in section 7.8.10.
		Drilling arisings disposal site. The Environmental Statement should have identified the likely site for disposal of drilling arisings and include an assessment of effects from these activities.	The disposal of drilling has been assumed to occur within the Morgan Array Area and the effects of drilling on SSC have been assessed in section 7.8.2.
		The Inspectorate considered that during construction, there will be activities with potential to cause changes in physical processes e.g. laying cable protection and piling. As construction is anticipated to last four years, during this time, changes in physical processes may occur. Therefore, the Inspectorate does not agree to scope this matter out. The ES should assess impacts to physical processes during construction and decommissioning where significant effects are likely to occur.	The infrastructure is not fully installed in the construction phase therefore the impact in relation to the effect of the infrastructure installed in the construction phase has been assessed following its completion in the operations and maintenance phase. Additionally no infrastructure is left in the water column following decommissioning therefore no assessment has been conducted for this phase of the project.

7.4 Baseline environment

7.4.1 Methodology to inform baseline

7.4.2 Desktop study

7.4.2.1 Information on benthic subtidal ecology within the benthic subtidal ecology study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 7.6 below.

Table 7.6: Summary of key desktop reports.

Title	Source	Year	Author
OneBenthic	Cefas	2021	Cefas
Marine recorder public UK snapshot	Joint Nature Conservation Committee (JNCC)	2020	JNCC
National Biodiversity Network (NBN) Atlas	NBN Atlas	2019	NBN Atlas
EMODnet broad scale seabed habitat map for Europe (EUSeaMap)	EMODnet – Seabed Habitats	2019	EMODnet – Seabed Habitats
JNCC Marine Protected Area (MPA) mapper	JNCC	2019	JNCC
Subtidal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).	The Government of the Isle of Man	2018	Lara Howe
Coastal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).	The Government of the Isle of Man	2018	Lara Howe
Marine Phase 1 Intertidal Habitat Survey	NRW	2016	Natural Resources Wales
Burbo Bank extension benthic and Annex I habitat pre-construction survey	Marine Data Exchange	2015	Centre for Marine and Coastal Studies Ltd (CMACS)
Rhiannon offshore wind project Preliminary Environmental Information Report - benthic Ecology	Marine Data Exchange	2014	Celtic Array Ltd
Walney Year 3 post consent benthic monitoring survey report	Marine Data Exchange	2014	CMACS
Burbo Bank extension environmental statement - benthic ecology	Marine Data Exchange	2013	Dong Energy Ltd.
Walney Extension environmental statement. chapter 10 benthic ecology	Marine Data Exchange	2013	Dong Energy
Walney Year 2 post-consent benthic monitoring survey report	Marine Data Exchange	2013	CMACS
Ormonde Year 1 post-construction benthic environmental monitoring survey	Marine Data Exchange	2012	CMACS
Burbo Bank Year 3 post construction benthic monitoring survey	Marine Data Exchange	2010	CMACS
Walney pre-construction monitoring report	Marine Data Exchange	2009	CMACS
Gwynt y Môr offshore wind farm baseline characterisation	Marine Data Exchange	2005	CMACS
Burbo Bank pre-construction contaminants investigation	Marine Data Exchange	2005	CMACS
Marine Nature Conservation Review (MNCR) areas summaries- Liverpool Bay and the Solway Firth	JNCC	1998	Covey. R.

7.4.3 Identification of designated sites

7.4.3.1 All designated sites within the benthic subtidal ecology 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 benthic subtidal ecology study area were identified using a number of sources. These sources included the Department for Environment, Food and Rural Affairs (DEFRA) magic map and the JNCC interactive map
- Step 2: Information was compiled on the relevant features qualifying interests 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
  - Sites and associated qualifying interests were located within the potential ZOI for impacts associated with the Morgan Generation Assets. The ZOI was determined through project specific outputs from the marine processes assessment (volume 2, chapter 6: Physical processes of the PEIR).

7.4.4 Site specific surveys

7.4.4.1 In order to inform the PEIR, site-specific surveys were undertaken, as agreed with the JNCC, Natural England and NRW (see Table 7.7 for further details). A summary of the surveys undertaken to inform the benthic subtidal ecology impact assessment is outlined in Table 7.7 below.

Table 7.7: Summary of site-specific survey data.

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.	XOcean Ltd	June 2021 - March 2022	XOCEAN (2022) and volume 4, annex 6.1: Physical processes technical report of the PEIR
Geophysical Survey	Morgan Array Area	High resolution side scan sonar and multibeam bathymetry.	Gardline Ltd.	June - September 2021	Volume 4, annex 6.1: Physical processes technical report of the PEIR
Benthic Subtidal Survey	Morgan Array Area	Combined grab and Drop Down Video (DDV) sampling was undertaken at 35 sites and DDV sampling alone was undertaken at two sample sites. A total of ten sediment samples from across the Morgan Array Areas within the benthic subtidal ecology study areas were analysed for sediment chemistry.	Gardline Ltd.	8 August 2021 - 20 September 2021	Volume 4, annex 7.1: Benthic subtidal ecology technical report of the PEIR

7.4.5 Baseline environment

Subtidal seabed sediments

7.4.5.1 Subtidal sediments recorded from infaunal grab samples collected across the Morgan Array Area during the site-specific benthic subtidal surveys ranged from gravelly sand to muddy sandy gravel with most samples classified as gravelly muddy sand (Figure 7.2). A single sample station was classified as muddy sandy gravel (ENV05) which was located in the west of the Morgan Array Area. According to the simplified Folk Classification (Long, 2006), most stations were classified as mixed or coarse sediments. This aligned with the desktop data which indicated coarse sediments, sand and coarse sediments across the Morgan benthic subtidal ecology study area (EMODnet, 2019).

7.4.5.2 The percentage sediment composition (i.e. mud ≤0.63mm; sand <2mm; gravel ≥2mm) at each grab sample station in the Morgan Array Area was also determined. Across all sample stations in the Morgan Array Area, the average percentage sediment composition was 14.90% gravel, 77.26% sand and 7.84% mud, with sand making up the highest proportion of the sediment composition. Sediments across the Morgan Array Area were typically very poorly sorted (49% of samples). Of the samples, 37% were classified as poorly sorted and 9% were classified as moderately well sorted.

Subtidal sediment contamination

7.4.5.3 As part of the subtidal sediment contamination analysis of samples within the Morgan Array Area, levels of heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) were identified and compared to Cefas Action Levels 1 and 2 (AL1 and AL2) as well as the Canadian Environmental Quality Guidelines (CSQGs) (i.e. probable effect level (PEL) and threshold effect level (TEL)). In summary, no contaminants were found to exceed Cefas AL2 or the Canadian PEL. Levels of arsenic, however, exceeded the Canadian TEL at eight out of the nine sample stations in the Morgan Array Area but were below the Cefas AL1, Cefas AL2 and Canadian PEL at all stations. Concentrations of PAHs and PCBs in all samples were found to be below Cefas AL1 and the CSQGs. As outlined in section 7.1.3, further site-specific surveys were undertaken in the summer of 2022 which included characterisation of sediment contamination in the Morgan Array Area ZOI. This chapter will therefore be updated with this additional data for the final Environmental Statement.

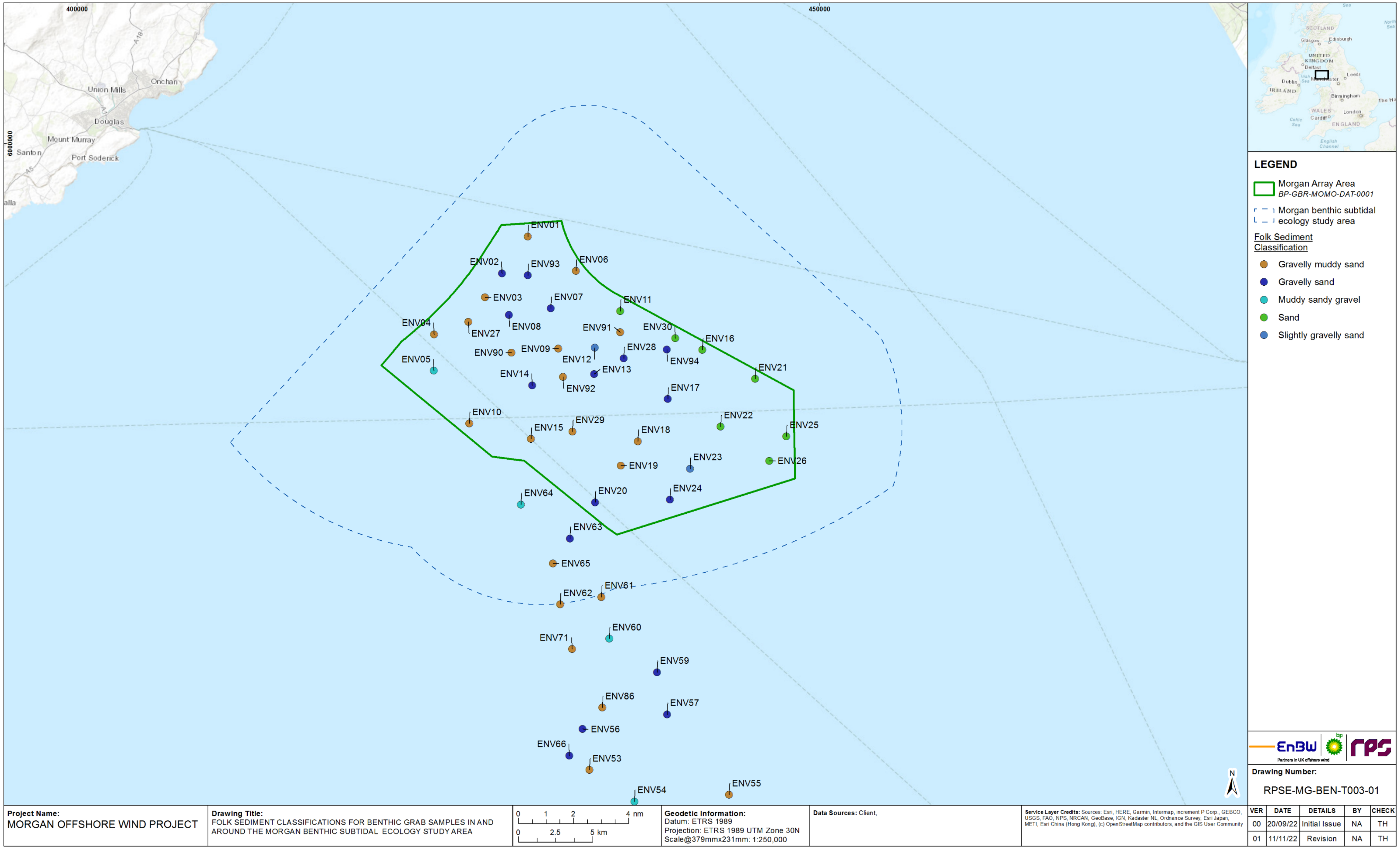


Figure 7.2: Folk sediment classifications for benthic grab samples in the Morgan Array Area within the Morgan benthic subtidal ecology study area (ENV codes refer to sample station numbers).

Subtidal biotopes and habitats

7.4.5.4 Across the Morgan Array Area, the infaunal communities were generally dominated by Annelids and Crustaceans. The most abundant individuals generally belonged to Annelida with the polychaete *Scalibregma inflatum* being overall the most abundant species with a total of 896 individuals recorded. The biomass data reflected the dominance of Annelida with respect to the number of individuals and number of taxa, in 37% of stations Annelida contributed the most to biomass. Mollusca and Echinoderms contributed the second and third most to biomass (36% and 17% respectively).

7.4.5.5 The epifaunal communities recorded by the seabed imagery varied according to the type of sediment. In general, high numbers of epifaunal species were recorded in association with the coarser sediments. Epifaunal species recorded were dominated by Annelida and Echinoderms with low numbers of Molluscs and Arthropods. Stations in areas of coarse and mixed sediments were associated with the presence of dead man's fingers *Alcyonium digitatum*, common starfish *Asterias rubens*, brittle stars *Ophiura* sp. and the common hermit crab *Pagurus bernhardus*.

7.4.5.6 A full description of the habitats and biotopes recorded in the site-specific benthic surveys in the Morgan benthic subtidal ecology study area, including full descriptions of the biotope codes discussed in this section and shown in Figure 7.3, are provided in volume 4, annex 7.1: Benthic ecology technical report of the PEIR. Figure 7.3 also includes biotopes which were determined as part of the PEIR for the Mona Offshore Wind Project, which partially overlap with the Morgan Generation Assets ZOI. The benthic communities in the Morgan Array Area were characterised by three main biotopes. In the west of the Morgan Array Area the polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope was dominant. Figure 7.3 shows that the SS.SMx.OMx.PoVen biotope was the most extensive biotope recorded within the Morgan Array Area, characterising the communities in the north and along the western boundary and extending into the south and east of the Morgan Array Area as well as further south into the Mona Offshore Wind Project. This biotope is characterised by a diverse community particularly rich in polychaetes potentially with a significant venerid bivalve component. Species present in this biotope included polychaetes such as *Glycera lapidum*, *Aonides paucibranchiata*, and *Mediomastus fragilis* as well as the echinoderm *Echinocyamus pusillus*.

7.4.5.7 A similar biotope, offshore circalittoral mixed sediment (SS.SMx.OMx) was recorded in a small area in the centre of the Morgan Array Area. The sediments and communities in areas of the SS.SMx.OMx biotope were characterised by polychaetes, bivalves and Nemertea. Species recorded in this biotope included *Kurtiella bidentata, E. pusillus, Pholoe baltica, Glycera lapidum, Syllis armillaris* and *Urothoe marina.*

7.4.5.8 The circalittoral coarse sediment biotope (SS.SCS.CCS) was recorded across the central sections of the Morgan Array Area, with smaller areas in the north and east of the Morgan Array Area. The SS.SCS.CCS biotope was characterised by a robust community of infaunal polychaetes, mobile crustacea and bivalves which included species such as *Scoloplos armiger*, *Owenia* sp., Nemertea and *Abra* sp.

7.4.5.9 In the east of the Morgan Array Area, the *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel) biotope was dominant extending along the northeast and east boundaries. The communities associated with this biotope were also characterised by polychaetes and bivalves with most species adapted to sandy habitats such as *L. koreni, Spiophanes bombyx* and *P. baltica*.

7.4.5.10 As outlined in section 7.1.3, further site-specific surveys were undertaken in the summer of 2022 to characterise the benthic habitat and communities present in the Morgan ZOI. This chapter will therefore be updated with this additional data for the final Environmental Statement.

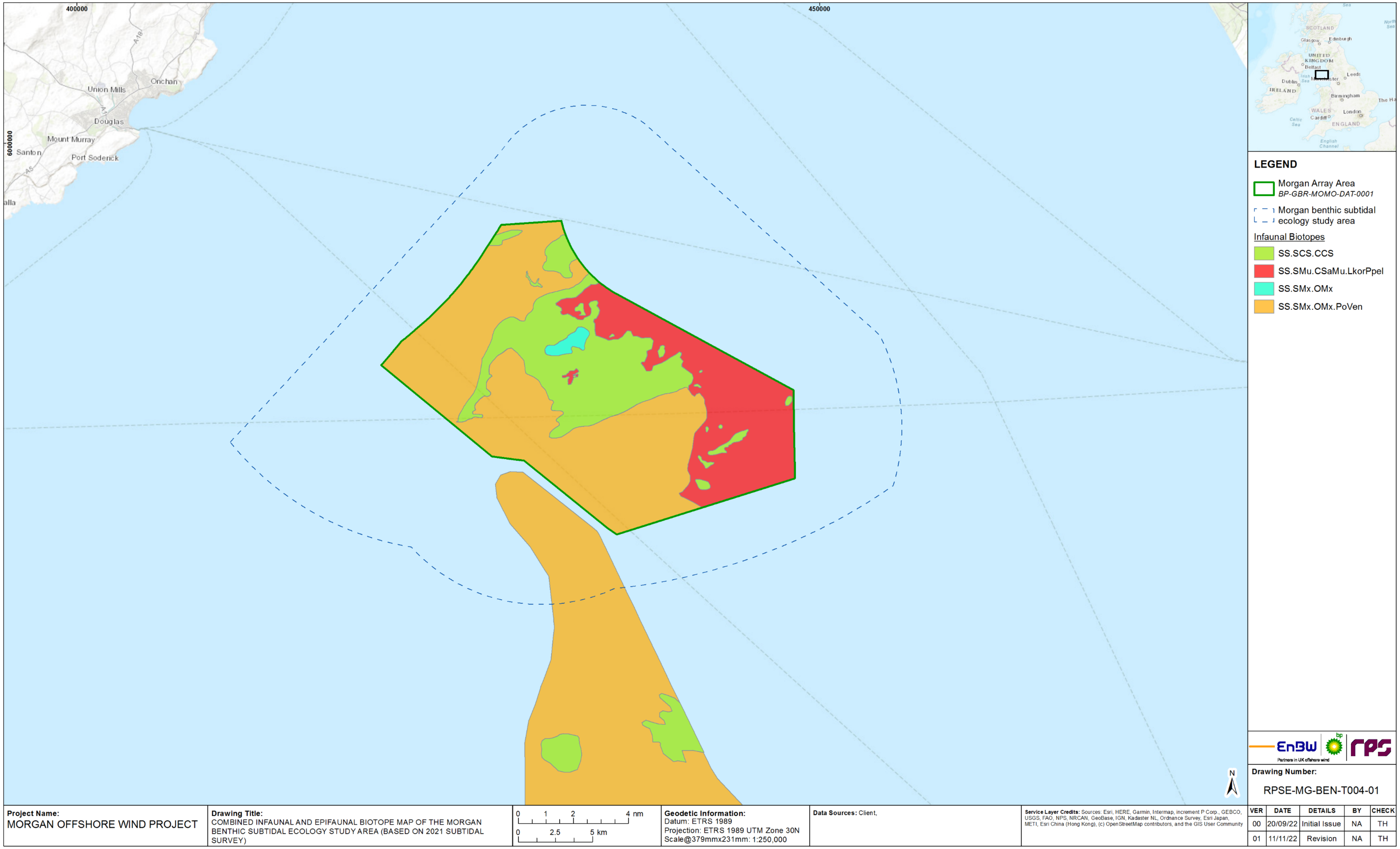


Figure 7.3: Combined infaunal and epifaunal biotope map of the Morgan Array Area within the Morgan benthic subtidal ecology study area (data for the Mona Offshore Wind Project is also displayed for wider context).

Habitat assessment

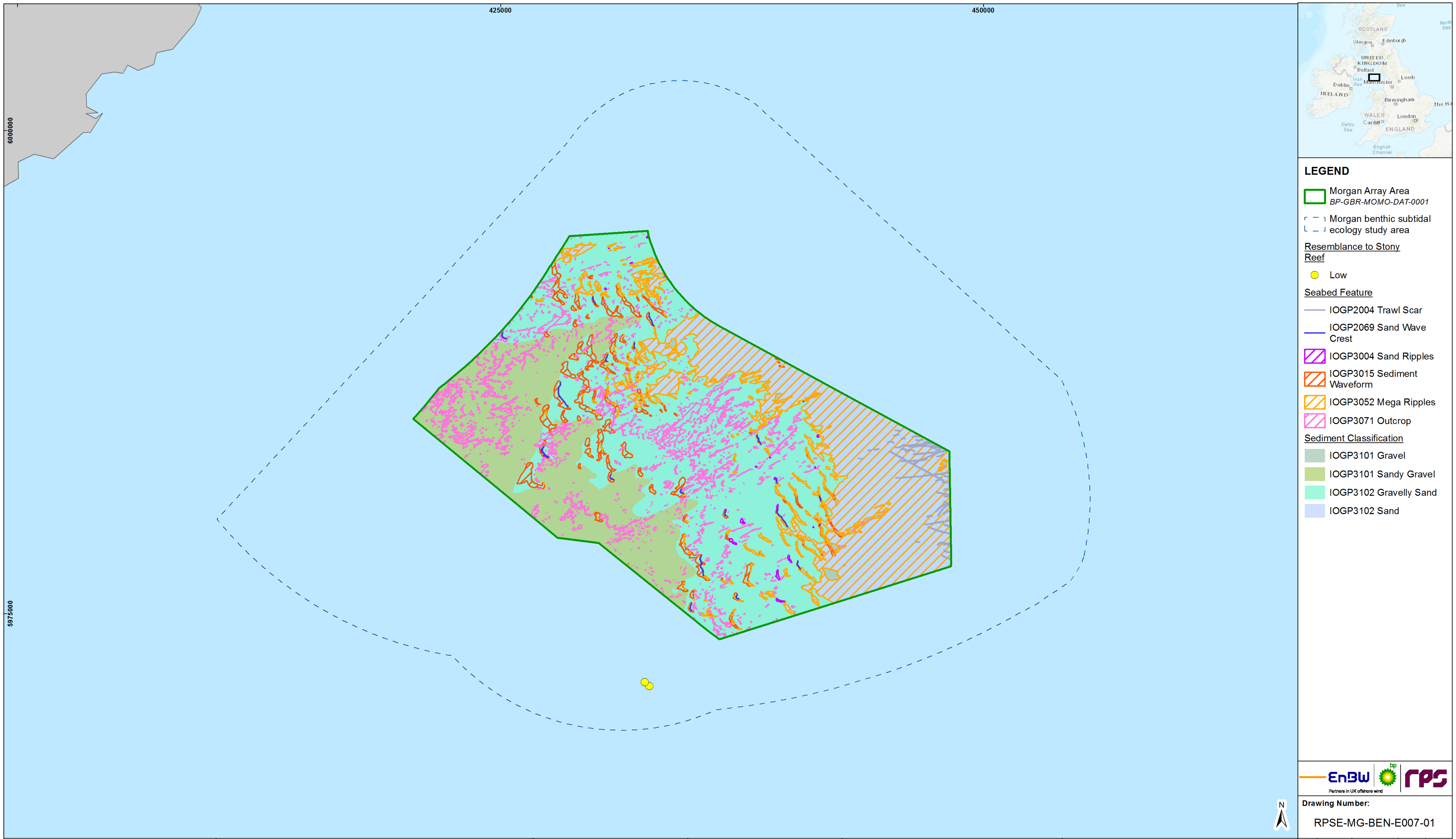
7.4.5.11 Several seabed habitats were taken forward for further assessment to determine their potential to align with features of conservation habitats.

7.4.5.12 Across the Morgan Array Area small pencil burrows were observed in the site-specific surveys. Although no sea-pens were observed the JNCC (2013) guidance stipulates that 'sea pen and burrowing megafauna communities' habitat can occur without sea pens. As a result an analysis of this habitat was undertaken by determining the density of burrows and their abundance which was then categorised using the SACFOR (Superabundant, Abundant, Common, Frequent, Occasional and Rare) abundance scale. The density of burrows varied from 0.39 burrows per m^2 at ENV94 (see Figure 7.2) to 6.62 burrows per m^2 at ENV73 (drop down video only station) within the Morgan Array Area. The majority of burrows were the 0-1 cm size range category with 43% of images from the Morgan Array Area falling within this range. Burrow abundance was not identified as greater than 'frequent' on the SACFOR scale at any station across the Morgan Array Area. Very few burrows were observed at stations where soft sediment was dominant. In combination with an absence of associated fauna and gravelly sediment, it was concluded that no stations had anything other than a negligible resemblance to the 'sea pen and burrowing megafauna communities' habitat.

7.4.5.13 Hard substrate Porifera were observed across the Morgan Array Area, with six stations showing evidence of Porifera. This evidence largely comprised images showing less than 1% of the image occupied by lone sponges such as cf. *Polymastia* sp., cf. *Suberites* sp. and cf. *Tethya* sp. Although several of the sponge species present, and non-sponge species (e.g. *Nemertesia* sp.), are listed within the description for the fragile sponge and anthozoan communities on rocky habitats which are Biodiversity Action Plan (BAP) Priority Habitats (JNCC, 2008; JNCC, 2014), they were only recorded at very low abundances and therefore, no stations, were considered to represent this habitat.

7.4.5.14 Seabed imagery indicated no areas of potential stony reef within the Morgan Array Area. The seabed imagery indicated potential stony reef at two stations within the Morgan ZOI, to the south of the Morgan Array Area. As a result, an Annex I stony reef assessment was undertaken to determine if there was a resemblance to the protected habitat based on criteria set out by Irving (2009) and Golding (2020) considering sediment composition, elevation, extent and ecological communities. Both stations within the Morgan ZOI were classified as low resemblance to stony reef, and this was often a reflection of a wider geophysical feature nearby as the quality observed was low (Figure 7.4).

7.4.5.15 As outlined in section 7.1.3, further site-specific surveys were undertaken in the summer of 2022 to characterise the benthic habitats present in the Morgan Array Area ZOI. This chapter will therefore be updated with this additional data for the final Environmental Statement.



Project Name: MORGAN OFFSHORE WIND PROJECT

Drawing Title: RESULTS OF THE STONY REEF ASSESSMENTS UNDERTAKEN WITHIN THE MORGAN SUBTIDAL ECOLOGY STUDY AREAS (BASED ON XOCEAN 2021 SURVEY)

0 1 2 nm
0 2.5 5 km

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N

Data Sources: Client.

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

VER	DATE	DETAILS	BY	CHECK
00	31/10/22	Initial Issue	NA	TH
01	11/11/22	Revision	NA	TH

Figure 7.4: Results of the Annex I reef assessment within the Morgan Generation Assets benthic subtidal ecology study area.

7.4.6 Designated sites

7.4.6.1 Designated sites identified for consideration in the benthic subtidal ecology chapter are described below in Table 7.8. All designated sites including Marine Nature Reserves (MNRs) and Marine Conservation Zones (MCZs) within the regional benthic subtidal ecology study area were identified within volume 4, annex 7.1: Benthic ecology technical report of the PEIR. The designated sites, and their relevant qualifying benthic features, that could be affected by the construction, operations and maintenance, and decommissioning of the Morgan Generation Assets (i.e. that fall within the potential ZOI of the Morgan Generation Assets), were identified using the process described below:

- Sites with relevant benthic ecology features which overlap with the Morgan Generation Assets and therefore have the potential to be directly affected (e.g. by temporary and/or long term habitat loss)
- Sites with relevant benthic ecology features with the potential to be indirectly affected by the Morgan Generation Assets (i.e. by changes in SSCs and/or sediment deposition as determined by the assessment presented in volume 2, chapter 6: Physical processes of the PEIR).

7.4.6.2 All other designated sites, including the MNRs around the Isle of Man, are outside the ZOI and so will not be affected by the Morgan Generation Assets. These sites have, therefore, not been considered further in this chapter.

Table 7.8: Designated sites and relevant qualifying interests for the Morgan benthic subtidal ecology chapter.

Designated site	Closest distance to the Morgan Array Area (km)	Relevant qualifying interest
West of Copeland MCZ	7.32	• Subtidal coarse sediment • Subtidal sand • Subtidal mixed sediment.
West of Walney MCZ	7.57	• Subtidal sand • Subtidal mud • Sea-pen and burrowing megafauna communities.

7.4.6.3 The consideration of the features of each MCZ is in line with relevant best practice guidance provided by Natural England and JNCC (2022).

Designated sites baseline

West of Copeland MCZ

7.4.6.4 The West of Copeland MCZ is characterised by its sedimentary protected features (subtidal sand, subtidal coarse sediment and subtidal mixed sediment) all of which are identified to be in an unfavourable condition with the general management approach to return these features to a favourable condition (JNCC, 2022a).

7.4.6.5 The subtidal mixed sediment designated feature occupies the smallest area within the MCZ, extending across the majority of the boundary in the north of the site. This feature is composed of a range of sediments including muddy gravelly sands and mosaics of cobbles and pebbles as well as physical features such as sand ribbons and lag deposits (JNCC, 2022b). The biological communities in this feature are equally varied with a wide range of infauna and epibionts, including polychaetes, bivalves, echinoderms, anemones, hydroids and bryozoans (Connor *et al*., 2004).

7.4.6.6 The subtidal sand designated feature covers a large area of the West of Copeland MCZ with the largest areas of this features found in the north and south of the site. This feature is composed of medium to fine sand or slightly muddy sand (JNCC, 2022b). This feature is subject to a degree of tidal current which restricts the silt and clay content (JNCC, 2022b). Biologically this feature is characterised by polychaetes, bivalve molluscs and amphipods (Connor *et al*., 2004).

7.4.6.7 The subtidal coarse sediment designated feature is largely found in the centre of the West of Copeland MCZ and is comprised of coarse sand, gravel, pebbles, shingle and cobbles. These sediments typically have a low silt content and are characterised by robust fauna, including venerid bivalves (Connor *et al*., 2004).

West of Walney MCZ

7.4.6.8 The West of Walney MCZ is characterised by its sedimentary protected features (subtidal sand and subtidal mud) as well as protected marine habitat (sea-pens and burrowing megafaunal communities), all of which are identified to be in an unfavourable condition with the general management approach to return these features to a favourable condition (DEFRA, 2016).

7.4.6.9 The subtidal mud designated feature is the most extensive feature within the MCZ and is part of the wider Irish Sea mud belt. The subtidal mud is an important habitat for a range of animals including worms, molluscs, sea urchins, crustaceans (MMO, 2018). Other larger animals, such as mud shrimps, live within this habitat and burrow into the mud (MMO, 2018). This creates networks of burrows which shelter smaller creatures like worms and brittlestars (MMO, 2018). The subtidal mud biotope *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud was considered to best describe the infaunal community within this broadscale habitat (European Environment Agency, 2016).

7.4.6.10 The subtidal muds also provide a habitat for sea-pens, which are tall, erect and luminous animals which live in groups (MMO, 2018). The representative communities of this feature are encompassed by the Sea pens and burrowing megafauna in circalittoral fine mud biotope (European Environment Agency, 2016). Many of the burrows observed in the MCZ will have been created by burrowing decapods such as *Upogebia deltaura*, *Callianassa subterranean*, *Jaxea nocturna*, *Goneplax rhomboides*, and *Nephrops norvegicus*, all of which have been recorded in surveys within the MCZ (NIRAS Consulting Ltd, 2015). Other organisms, characteristic of the sea pen and burrowing megafauna community that are found in the MCZ, include the spoon worm, *Maxmuelleria lankasteri*, the burrowing sea urchin, *Brissopsis lyrifera*, and the sea pen *Virgularia mirabilis* (Ocean Ecology, 2015).

7.4.6.11 The subtidal sand designated feature within this MCZ has only been identified within a small area in the northeast of the site. It is an important habitat as flatfish and sand eels camouflage themselves on the surface of it, and it supports burrowing megafauna communities, such as the Norway lobster (*Nephrops norvegicus*) (MMO, 2018). The subtidal sands within the MCZ also support high densities of burrowing brittlestars (MMO, 2018). Samples from this area have been described as a reasonable match to the biotope *Mysella bidentata* and *Thyasira* spp. In circalittoral muddy mixed sediment (Centre for Marine and Coastal Studies Ltd, 2009) and *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud (Centre for Marine and Coastal Studies Ltd, 2014).

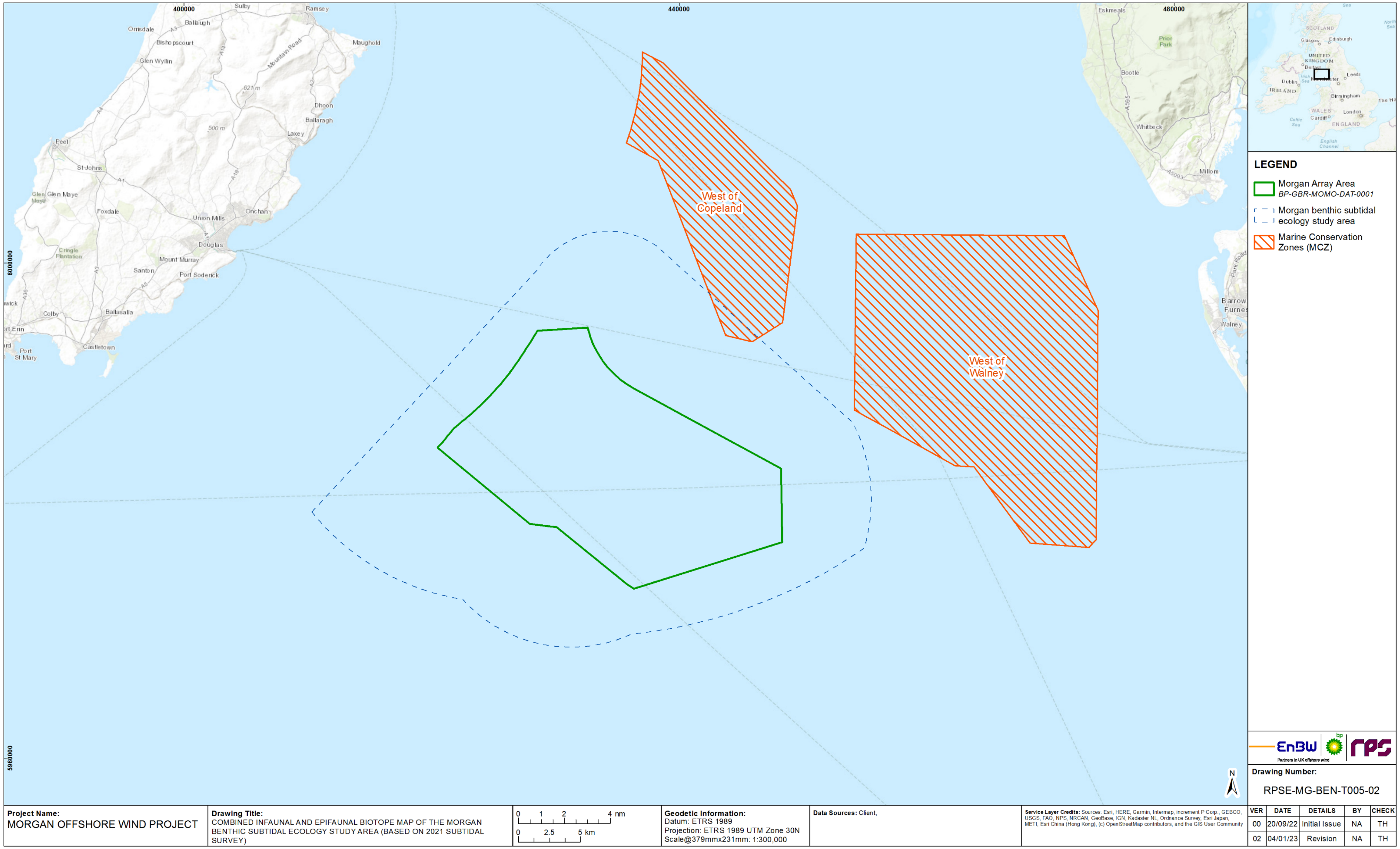


Figure 7.5: Designated sites with benthic habitat features screened into the Morgan benthic subtidal ecology assessment.

7.4.7 Important ecological features

7.4.7.1 In accordance with the best practice guidelines for ecological impact assessment in the UK and Ireland (CIEEM, 2019), for the purposes of the benthic subtidal ecology EIA, IEFs have been identified. The potential impacts of the Morgan Generation Assets which have been scoped into the assessment have been assessed against the IEFs to determine whether or not they are significant. The IEFs assessed are those that are considered to be important and potentially affected by the Morgan Generation Assets. Importance may be assigned due to quality or extent of habitats, habitat or species rarity or the extent to which they are threatened (CIEEM, 2019). Species and habitats are considered IEFs if they have a specific biodiversity importance recognised through international or national legislation or through local, regional, or national conservation plans (e.g. Annex I habitats under the Habitats Directive, The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), National Biodiversity Plan or the Marine Strategy Framework Directive).

7.4.7.2 All of the IEFs within the Morgan benthic subtidal ecology study area are listed in Table 7.9. The main habitats identified throughout the Morgan benthic subtidal ecology study area comprise three broad subtidal IEFs.

Table 7.9: IEFs within the Morgan benthic subtidal ecology study area.

IEF	Description and representative biotopes	Conservation interest/Protected Status	Importance within the Morgan benthic subtidal ecology study area
Subtidal habitats			
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes.	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. Identified within the Morgan Array Area. • SS.SMu.CSaMu.LkorPpel.	UK Biodiversity Action Plan (BAP) priority habitat, Environment (Wales) Act 2016: Section 7	National
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. Identified within the Morgan Array Area. • SS.SCS.CCS[1] • SS.SMx.OMx • SS.SMx.OMx.PoVen.	UK BAP priority habitat, Environment (Wales) Act 2016: Section 7	National
Low resemblance stony reef	Cobbles and boulders with indicator species such as *A. digitatum*, *Nemertesia* sp. and *Tubularia* sp. Identified within the ZOI to the south of the Morgan Array Area. • CR.HCR.XFa.SpNemAdia.	Annex I habitat outside an SAC	National
West of Walney MCZ			
Subtidal mud	Muds and sandy muds in extremely sheltered areas with very weak tidal currents. High numbers of polychaetes, bivalve and echinoderms such as urchins and brittle stars. • SS.SMu.CSaMu.AfilKurAnit	UK BAP priority habitat Designated feature of the MCZ	National
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit • SS.SMx.CMx.KurThyMx	UK BAP priority habitat Designated feature of the MCZ	National
Sea-pens and burrowing megafauna communities	Fine mud heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature with conspicuous populations of sea pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. • SS.SMu.CFiMu.SpnMeg	OSPAR habitat, UK BAP priority habitat Designated feature of the MCZ	National
West of Copeland MCZ			
Subtidal coarse sediment[2]	Coarse sand and gravel or shell fragments. Largely characterised by infaunal communities include bristleworms, sand mason worms, burrowing anemones and bivalves. • SS.SCS.CCS	UK BAP priority habitat Designated feature of the MCZ	National
Subtidal mixed sediment[3]	A range of different types of sediments. Animals found here include worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. • SS.SMx.OMx • SS.SMx.OMx.PoVen	Designated feature of the MCZ	National

[1] This biotope which was recorded within the Morgan benthic subtidal ecology study area was not present in the MarESA therefore SS.SCS.CCS.MedLumVen biotope has been used as a proxy for sensitivity.

[2] No known biotopes have been allocated for this IEF in the literature therefore biotopes have been assigned based on descriptions of the physical environment and the biological communities.

[3] No known biotopes have been allocated for this IEF in the literature therefore biotopes have been assigned based on descriptions of the physical environment and the biological communities.

IEF	Description and representative biotopes	Conservation interest/Protected Status	Importance within the Morgan benthic subtidal ecology study area
Subtidal sand[4]	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit	UK BAP priority habitat Designated feature of the MCZ	National

7.4.8 Future baseline scenario

7.4.8.1 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 the Morgan Generation Assets do not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

7.4.8.2 Further to potential change associated with existing cycles and processes, it is necessary to take account of potential effects of climate change on the marine environment. Variability and long-term changes on physical influences may bring direct and indirect changes to benthic habitats and communities in the mid to long term future (UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3)) (Department of Energy and Climate Change, 2016). A strong base of evidence indicates that long term changes in the benthic ecology may be related to long term changes in the climate or in nutrients (Department of Energy and Climate Change, 2016), with climatic process driving shifts in abundances and species composition of benthic. Benthic communities are also currently being influenced by anthropogenic activities including, contamination or seabed disturbing activities such as trawling, dredging and development. Studies of benthic ecology over the last three decades have shown that biomass has increased by at least 250% to 400%; opportunistic and short-lived species have increased; and long-living sessile animals have decreased (Krönke, 1995; Krönke, 2011). The Marine Climate Change Impacts Partnership Annual Report Card 2007-2008 Scientific Review -Seabed Ecology (MCCIP, 2008) concluded that the available data show that climatic processes, both directly, e.g. winter mortality, and indirectly, via hydrographic conditions, influence the abundance and species composition of sea bed communities. The alteration in the seafloor communities could alter rates and timing of processes such as nutrient cycling, larval supply to the plankton and organic waste assimilation. DEFRA's recent focus on the risk of climate change to ecosystem services (HM Government, 2022) focuses on invasive non-native species and their likely detriment to native communities and ecosystems, the increased risk to species as their distributions shift of disease from new pathogens, and the impacts on areas of high biodiversity value in the coastal zone from increased storms and erosion. DEFRA also highlight the risks associated with ocean acidification and higher water temperatures which are linked to climatic changes (HM Government, 2022).

7.4.9 Data limitations

7.4.9.1 The data sources used in this chapter are detailed in Table 7.6. The desktop data used are the most up to date, publicly available information which can be obtained from the applicable data sources as cited. To ensure an up-to-date baseline characterisation, the site-specific benthic subtidal ecology survey data have been validated with site-specific geophysical surveys undertaken in 2021 and 2022.

7.4.9.2 Although the sampling design and collection process for the site-specific benthic subtidal ecology survey data provided robust data on the benthic communities, interpreting these data has limitations. It can be difficult to interpolate data collected from discrete sample locations to cover a wider area and define the precise extents of each biotope. Benthic communities generally show a gradual transition from one biotope to another and therefore boundaries of where one biotope ends and the next begins is an approximation; these boundaries indicate where communities grade into one another. The classification of the community data into biotopes is a best fit allocation, as some communities do not readily fit the available descriptions in the biotope classification system. The biotope map should be used to describe the main habitats which characterised the Morgan Array Area. Due to the limitations described previously, the biotope map shown in Figure 7.3 should not be interpreted as definitive areas. However, this does provide a suitable baseline characterisation which describes the main habitats and communities within the Morgan Array Area for the purposes of the assessment.

7.5 Impact assessment methodology

7.5.1 Overview

7.5.1.1 The benthic subtidal ecology impact assessment has followed the methodology set out in volume 1, chapter 5: EIA methodology of the PEIR. Specific to the benthic subtidal ecology impact assessment, the following guidance documents have also been considered:

- Guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland. Terrestrial, Freshwater and Coastal (CIEEM, 2019)
- Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008)
- Identification of the Main Characteristics of Stony Reef Habitats under the Habitats Directive (Irving, 2009; Golding, 2020)
- Marine Evidence-based Sensitivity Assessment – A Guide (Tyler-Walters *et al.*, 2018)

[4] No known biotopes have been allocated for this IEF in the literature therefore biotopes have been assigned based on descriptions of the physical environment and the biological communities.

- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Judd, 2012)
- Nature Conservation Considerations and Environmental Best Practice for Subsea Cables for English Inshore and UK Offshore Waters (Natural England and JNCC, 2022).

7.5.1.2 In addition, the benthic subtidal ecology impact assessment has considered the legislative framework as defined by:

- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (relevant to the application for development consent)
- The Planning Act 2008 (as amended) (relevant to the application for development consent)
- Marine and Coastal Access Act 2009.

7.5.2 Impact assessment criteria

7.5.2.1 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 PEIR.

7.5.2.2 The criteria for defining magnitude in this chapter are outlined in Table 7.10 below.

Table 7.10: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse)
	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial)
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (Adverse)
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial)
Low	Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements (Adverse)
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial)
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse)
	Very minor benefit to, or positive addition of one or more characteristics, features or elements (Beneficial)
No change	No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial.

7.5.2.3 The Marine Evidence based Sensitivity Assessment (MarESA) has been drawn upon to support the assessment of sensitivity of the benthic subtidal ecology IEFs within the Morgan benthic subtidal ecology study area.

7.5.2.4 The MarESA is a database which has been developed through the Marine Life Information Network (MarLIN) of Britain and Ireland and is maintained by the Marine Biological Association (MBA), supported by statutory organisations in the UK (e.g. Department of Agriculture, Environment and Rural Affairs (DAERA), JNCC, Natural England and NatureScot). This database comprises a detailed review of available evidence on the effects of pressures on marine species or habitats, and a subsequent scoring of sensitivity against a standard list of pressures, and their benchmark levels of effect. The evidence base presented in the MarESA is peer reviewed and represents the largest review undertaken to date on the effects of human activities and natural events on marine species and habitats. It is considered to be one of the best available sources of evidence relating to recovery of seabed species and habitats. The benchmarks for the relevant MarESA pressures which have been used to inform each impact assessment have also been referenced under each impact assessment in section 7.7. The process for defining sensitivity in this chapter follows that defined by the MarESA sensitivity assessment, which correlates resistance and recoverability/resilience to categorise sensitivity, as set out in Table 7.11.

7.5.2.5 The sensitivities of benthic subtidal IEFs presented within this benthic subtidal ecology PEIR chapter have therefore been defined by an assessment of the combined vulnerability (i.e. resistance, following MarESA) of the receptor to a given impact and the likely rate of recoverability to pre-impact conditions (i.e. resilience). Here, vulnerability is defined as the susceptibility of a species to disturbance, damage or death, from a specific external factor. Recoverability/resilience is the ability of the same species to return to a state close to that which existed before the activity or event which caused change. Recoverability is dependent on a receptor's ability to recover or recruit subject to the extent of disturbance/damage incurred. Information on these aspects of sensitivity of the benthic subtidal IEFs to given impacts has been informed by the best available evidence following environmental impact or experimental manipulation in the field and evidence from the offshore wind industry and analogous activities such as those associated with aggregate extraction, electrical cabling, and oil and gas industries.

Table 7.11: Definition of terms relating to the sensitivity of the receptor (applicable to MarESA sensitivity assessment).

Recoverability/ Resilience	Resistance			
	None	**Low**	**Medium**	**High**
Very Low	High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Low	High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Medium	Medium sensitivity	Medium sensitivity	Medium sensitivity	Low sensitivity
High	Medium sensitivity	Low sensitivity	Low sensitivity	Not sensitive (Negligible)

7.5.2.6 The conclusions of the MarESA assessment have been combined with the importance of the relevant IEFs as presented in Table 7.9 for the benthic subtidal IEFs considered in this assessment. The criteria for defining sensitivity in this chapter are outlined in Table 7.12 below.

Table 7.12: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Nationally and internationally important receptors with high vulnerability and no ability to recover.
High	Regionally important receptors with high vulnerability and no ability to recover. Nationally and internationally important receptors with high vulnerability and low recoverability.
Medium	Nationally and internationally important receptors with medium vulnerability and medium recoverability. Regionally important receptors with medium to high vulnerability and low recoverability. Locally important receptors with high vulnerability and no ability to recover.
Low	Nationally and internationally important receptors with low to medium vulnerability and high recoverability. Regionally important receptors with low vulnerability and medium to high recoverability. Locally important receptors with medium to high vulnerability and low recoverability.
Negligible	Locally important receptors with low vulnerability and medium to high recoverability. Receptor is not vulnerable to impacts regardless of value/importance.

7.5.2.7 The significance of the effect upon benthic subtidal ecology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 7.13. Where a range of significance of effect is presented in Table 7.13, the final assessment for each effect is based upon expert judgement.

7.5.2.8 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 EIA Regulations.

Table 7.13: Matrix used for the assessment of the significance of the effect.

Sensitivity of Receptor	Magnitude of Impact				
	No Change	**Negligible**	**Low**	**Medium**	**High**
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

7.5.3 Designated sites

7.5.3.1 Where National Site Network sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the interest features of internationally designated sites as described within section 7.4.6 of this chapter (with the assessment on the site itself deferred to the Draft Information to Support an Appropriate Assessment (ISAA) Report. With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site (e.g. SSSIs which have not been assessed within the Draft ISAA Report), only the international site has been taken forward for assessment. This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken).

7.5.3.2 The Information to Support Appropriate Assessment (ISAA) has been prepared in accordance with Advice Note Ten: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (Planning Inspectorate, 2022).

7.6 Key parameters for assessment

7.6.1 Maximum design scenario

7.6.1.1 The MDS for each impact pathway identified in Table 7.14 has 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 Design Envelope provided in volume 1, chapter 3: Project description of the PEIR. 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 infrastructure layout), to that assessed here be taken forward in the final design scheme.

Table 7.14: Maximum design scenario considered for the assessment of potential impacts on benthic subtidal ecology.

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

<table>
<tr><th rowspan="2">Potential impact</th><th colspan="3">Phase[a]</th><th rowspan="2">Maximum Design Scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td>Temporary habitat loss/disturbance</td><td>✓</td><td>✓</td><td>✓</td><td>

Construction phase
Up to 87,360,220m² of habitat loss/disturbance due to:

Jack-up events: up to 908,400m² of disturbance from the use of jack-up vessels during foundation installation, with up to four jack-up events at each of 107 wind turbines (two jack-up events for wind turbines and two jack-up events for the foundations) and two jack-up events at each of four Offshore Substation Platform (OSP)
Cable installation: up to 35,224,000m² of disturbance comprising:

Inter-array cables: up to 31,000,000m² disturbance from installation of up to 500km of inter-array cables
Interconnector cables: up to 4,224,000m² disturbance from installation of up to 60km of interconnector cables
seabed disturbance width of up to 104m for sandwave clearance, up to 20m for boulder clearance along inter-array and interconnector, and up to 3m for cable burial
Sandwave clearance: required for up to 50% of inter-array and 60% of interconnector
Pre-lay preparation (boulder and debris clearance): is likely to be required across all inter-array and interconnector cables. Although, for the purposes of the MDS boulder clearance only has been assumed across, up to 50% of inter-array and 40% of interconnector (see justification)

Sandwave clearance deposition: Up to 50,107,820m² of habitat disturbance associated with the deposition of:

25,053,910m³ of sandwave clearance material within the Morgan Array Area affecting up to 50,107,820m²

Anchor placement: Up to 200,000m² of habitat disturbance from two 100m² anchor placements per inter-array cable link
Cable removal: Up to 920,000m² from the removal of 46,000m of disused cables
Maximum duration of the offshore construction phase is up to four years.

Operations and maintenance phase
Up to 11,566,500m² of temporary habitat loss/disturbance due to:

Up to 2,026,500m² of temporary habitat loss/disturbance due to jack-ups at wind turbines and OSPs, over the lifetime of the Morgan Generation Assets for the following:

up to 937 major component replacements (one every four years for each location) for wind turbines
12 major component replacements (three over the lifetime per OSP) for OSPs
four access ladder replacements and four modifications to/replacement of J-tubes for wind turbines
four access ladder replacements and four modifications to/replacement of J-tubes for OSPs

Up to 9,540,000m² of temporary habitat loss/disturbance due to inter-array and interconnector cables:

Inter-array cables: up to 20,000m for reburial events every five years and up to 8,000m for cable repair events every three years (assuming 20m width seabed disturbance for repair and remedial burial)
Interconnector cables: up to 3,000m for reburial events with one event every five years and up to 20,000m of cable in each of three events every 10 years for repair events (assuming 20m width seabed disturbance for repair and remedial burial).

Operations and maintenance phase up to 35 years.

Decommissioning phase
Temporary subtidal habitat loss/disturbance due to:

Cable removal: disturbance from the removal of 500km of inter-array cables and 60km of interconnector cables.
Jack-up events: disturbance from the use of jack-up vessels during foundation removal, with up to four jack-up events at each of 107 wind turbines (two jack-up events for wind turbines and two jack-up events for the foundations) and two jack-up events at each of four OSPs.
Anchor placements: habitat disturbance from two 100m² anchor placements per inter-array cable link.

</td><td>

<u>Site preparation:</u>
Maximum footprint which would be affected during the construction, operations and maintenance and decommissioning phases.
The MDS assumes that the width of disturbance for sandwave and pre-lay preparation (boulder and debris clearance) also includes subsequent burial.
Pre-lay preparation (boulder and debris clearance) is likely to be required across all inter-array and interconnector cables. For the purposes of the MDS, and to avoid double counting of the total footprint with sandwave clearance activities, the MDS assumes up to 50% of inter-array and 40% of interconnector will be subject to pre-lay preparation (boulder and debris clearance) only.
It is anticipated that the sandwaves requiring clearance in the Morgan Array Area are likely to be in the range 15m in height. The area of seabed affected by the placement of sandwave clearance material has been calculated based on the maximum volume of sediment to be placed on the seabed, assuming all this sediment is coarse material (i.e. is not dispersed through tidal currents; see "Increased suspended sediment concentrations" impact assessment below). The total footprint of seabed affected has been calculated, for the purposes of the MDS, assuming a mound of uniform thickness of 0.5m height. The MDS assumes temporary loss of benthic habitat is beneath this.
The disturbance width is driven by the need to survey for UXO over the cable route. The actual disturbance width for cable installation is likely to be considerably less.
<u>Decommissioning phase:</u>
Parameters for decommissioning will be significantly lower than for the construction phase as sandwave clearance and pre-lay preparations will not be required in advance of cable removal and cable protection and scour protection are assumed to be left in situ.
MDS assumes the complete removal of all wind turbine and OSP foundations and cables.
</td></tr>
</table>

Potential impact	Phase[a] C	O	D	Maximum Design Scenario	Justification
Increased suspended sediment concentrations (SSC) and associated deposition	✓	✓	✓	**Construction phase** Site preparation: Sandwave clearance: Sandwave clearance activities undertaken over a 12 month duration within the wider four year construction programme. • Wind turbines and Offshore Substation Platform (OSP) foundations: the MDS assumes that sandwave clearance for wind turbine foundations and that clearance is required 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 clearance diameter of 205m to an average depth of 7.5m. This equates to a total spoil volume of 10,149,455m^3 and a volume of 247,548m^3 per location • Inter-array cables: sandwave clearance along 500km of cable length, with a width of 104m, to an average depth of 5.1m. Total spoil volume of 11,843,641m^3 • Interconnector cables: sandwave clearance along 60km of cable length, with a width of 104m, to an average depth of 5.1m. Total spoil volume of 3,060,814m^3 • Removal of up to 46km of disused cables. Foundation installation: • Undertaken over an approximate 12 month duration • Wind turbines: installation of up to 68 monopiles of 16m diameter, drilled to a depth of 60m at a rate of up to 0.73m/h. Two monopiles installed concurrently. Spoil volume of 13,460m^3 per pile. • OSPs: installation of one OSP with foundations consisting of two 16m monopiles, drilled to a depth of 60m at a rate of up to 0.73m/h. Two monopiles installed concurrently. Spoil volume of 13,460m^3 per pile. Cable installation: • Inter-array cables: Installation via trenching of up to 500km of cable, with a trench width of up to 3m and a depth of up to 3m. Total spoil volume of 2,250,000m^3. Installed over a period of approximately 12 months • Interconnector cables: installation via jetting of up to 60km of cable, with a trench width of up to 3m and a depth of up to 3m. Total spoil volume of 270,000m^3. Installed over a period of approximately four-months **Operations and maintenance phase** • Project lifetime of 35 years • Inter-array cables: repair of up 8km of cable in one event every three years. Reburial of up to 20km of cable in one event every five years • Interconnector cables: repair of up to 20km of cable in each of three events every 10 years. Reburial of up to 3km of cable in one event every five years **Decommissioning phase** • Cables and scour and cable protection will remain *in situ.* If suction caissons are removed using the overpressure to release them then SSC will be temporarily increased. • Inter-array and interconnector cables will be removed and disposed of onshore	Site preparation: • 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 15m in height. • 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 disposal of material. • Boulder clearance activities will result in minimal increases in SSC s and have therefore not been considered in the assessment. Foundation installation: • Installation of foundations via augured (drilled) operations results in the release of the largest volume of sediment. The greatest volume of sediment disturbance by drilling at individual foundation locations and across the site as a whole is associated with the largest diameter monopile for wind turbines. The selected OSP scenario represents the greatest volume of sediment to be released for a drilling event. • The greatest drilling rate represents the maximum level of increase in SSC. Cable installation: • Cable routes inevitably include a variety of seabed material and in some areas 3m 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 jetting mobilising the greatest volume of material to increase SSCs. 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.
Disturbance/remobilisation of sediment-bound contaminants	✓	×	✓	**Construction phase** Maximum design scenario as described above for increased SSC and associated deposition during the construction phase. **Decommissioning phase** Maximum design scenario as described above for increased SSC and associated deposition during the decommissioning phase.	The justification for the disturbance/remobilisation of sediment-bound contaminants MDS is the same as for the increased SSC and associated deposition impact above, as this MDS results in the release of the largest volume of sediment and associated contaminants.

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Long term habitat loss	✓	✓	✓	**Construction and operations and maintenance phase** Up to 1,519,092m² of long term habitat loss over the lifetime of the Morgan Generation Assets associated with the following: • Presence of foundations and scour protection: up to 760,452m² of habitat loss comprising: – Wind turbines: up to 735,488m² from the presence of up to 68 wind turbine foundations on suction bucket 4-legged jacket foundations with associated scour protection – OSPs: up to 24,964m² from four OSPs on suction bucket 4-legged jacket foundations with associated scour protection • Presence of cable protection: up to 620,000m² of habitat loss comprising: – Inter-array cable protection: 500,000m² associated with up to 10% of 500km of inter-array cables (10m width of cable protection). – Interconnector cable protection: 120,000m² for up to 20% of 60km of interconnector cables (10m width of cable protection). • Presence of cable crossing protection: up to 138,640m² of habitat loss comprising: – Cable protection for cable crossings for inter-array cables: 128,640m² from 67 cable crossings (each up to 60m in length and 32m in width) – Cable protection for cable crossings for interconnector cables: 10,000m² from 10 cable crossings (each up to 50m in length and 20m in width) • Operations and maintenance phase up to 35 years. **Decommissioning phase** Up to 1,461,956m² of permanent subtidal habitat loss due to scour and cable protection left *in situ* post decommissioning.	Largest wind turbine and OSP foundation type and associated scour protection, maximum length of cables and cable protection resulting in greatest extent of habitat loss. MDS for decommissioning (and permanent habitat loss following decommissioning) assumes removal of the foundations, if any additional infrastructure is decommissioned, this will result in a reduced area of permanent habitat loss. Greatest amount of cable and scour protection resulting in the largest area of infrastructure to be left *in situ* after decommissioning.
Colonisation of hard structures	×	✓	×	**Operations and maintenance phase** Long term habitat creation of up to 1,995,525m² due to: • Wind turbines and OSPs: Presence of up to 68 wind turbines and four OSPs on suction bucket jacket foundations • Scour protection: Presence of scour protection for wind turbine foundations and OSP foundations • Cable protection: Presence of cable protection associated with up to 10% of the 500km of inter-array cables and up to 20% of the 60km of interconnector cables • Cable crossing protection: Presence of cable protection for cable crossings, 67 cable crossings for inter-array cables (each up to 60m in length and 32m in width) and 10 cable crossings for interconnector cables (each up to 50m in length and 20m in width) Operations and maintenance phase up to 35 years.	Maximum number of wind turbine and OSP foundations and associated scour protection, maximum length of cables and cable protection resulting in greatest surface area for colonisation. The estimate of habitat creation from the presence of foundations has been calculated as if the foundations were a solid structure. This is, therefore, likely to be a conservative estimate of habitat creation on the basis that the jacket foundations will have a lattice design rather than a solid surface.

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Increased risk of introduction and spread of invasive non-native species (INNS)	✓	✓	✓	**Construction phase** Increased risk of INNS due to: • Long term habitat creation: up to 1,995,525m^2 as set out in the colonisation of hard structures impact above • Vessel movement: vessels associated with site preparation, wind turbine installation, OSP installation and inter-array cables with up to 1,878 vessel round trips in total over the construction phase • Maximum duration of the offshore construction phase is up to four years. **Operations and maintenance phase** Increased risk of INNS due to: • Vessel return trips: Up to 1,970 vessel return trips per year during the operations and maintenance phase • Operations and maintenance phase up to 35 years. **Decommissioning phase** Increased risk of INNS due to: • Permanent habitat creation: up to 1,461,956m^2 due to cable protection and protection for crossings left *in situ*. Vessel return trips: Up to 1,878 decommissioning vessel return trips during the decommissioning phase. Maximum duration of the offshore decommissioning phase is up to four years.	Maximum surface area created by offshore infrastructure and maximum number of vessel movements during construction, operations and maintenance and decommissioning phases.
Removal of hard substrates	×	×	✓	**Decommissioning phase** Removal of hard substrate of up to 533,569m^2 due to: • Wind turbine and OSPs: Removal of up to 68 suction bucket 4-legged jacket foundations for wind turbines and up to four suction bucket 4-legged jacket foundations for OSPs.	MDS is based on the removal of foundations and cables but assumes that all cable protection and scour protection will be left *in situ*.
Changes in physical processes	×	✓	×	**Operations and maintenance phase** • Wind turbines: 68 installations with four-legged suction bucket foundations, each jacket leg with a diameter of 5m, spaced 48m apart, and each bucket with a diameter of 16m. Scour protection to a height of 2.5m. Total footprint of 10,816 m^2 per wind turbine • OSPs: four installations with gravity base foundations, each with a 14m diameter at the surface, a slab base diameter of 52.5m and with scour protection to a height of 2.6m. Total footprint of 6,236m^2 per OSP • Inter-array cables: cable protection along 50km of the cable, with a height of up to 3m and up to 10m width. Up to 67 cable crossings, each crossing has a height of up to 4m, a width of up to 32m and a length of up to 60m. • Interconnector cables: cable protection along 6km of the cable, with a height of up to 3m and up to 10m width. Up to ten cable crossings, each crossing has a height of up to 3m, a width of up to 20m and a length of up to 50m.	This provides the largest obstruction to flow in the water column. See volume 2, chapter 6: Physical processes of the PEIR.
EMF from subsea electrical cabling	×	✓	×	**Operations and maintenance phase** Presence of inter-array and offshore export cables: • Inter-array cables: between 450km and 500km of inter-array cables of 66kV to 132kV • Interconnector cables: up to 60km of 275kV HVAC cables • Minimum burial depth 0.5m • The MDS assumes up to 10% of inter-array cables and 20% of interconnector cables • Cable protection: cables will also require cable protection at asset crossings (up to 67 crossings for inter-array cables and 10 crossings for interconnector cables) • Operations and maintenance phase of up to 35 years.	Maximum length of cables across the array area and offshore export cable route and minimum burial depth (the greater the burial depth, the more the EMF is attenuated).

Potential impact	Phase[a]			Maximum Design Scenario	Justification
	C	O	D		
Heat from subsea electrical cables	×	✓	×	**Operations and maintenance phase** Presence of inter-array and offshore export cables: • Inter-array cables: between 450km and 500km of inter-array cables of 66kV to 132kV • Interconnector cables: up to 50km of 275kV HVAC cables • Minimum burial depth 0.5m • The MDS assumes up to 10% of inter-array cables and 20% of interconnector cables may require additional cable protection • Cable protection: cables will also require cable protection at asset crossings (up to 67 crossings for inter-array cables and 10 crossings for interconnector cables) • Operations and maintenance phase of up to 35 years.	Maximum length of cables across the array area and offshore export cable route and minimum burial depth.

7.6.2 Impacts scoped out of the assessment

7.6.2.1 On the basis of the baseline environment and the description of development outlined in volume 1, chapter 3: Project description of the PEIR, a number of impacts are proposed to be scoped out of the assessment for benthic subtidal ecology. These impacts are outlined, together with a justification for scoping them out, in Table 7.15.

Table 7.15: Impacts scoped out of the assessment for benthic subtidal ecology.

Potential impact	Justification
Accidental pollution during construction, operations and maintenance and decommissioning.	There is a risk of pollution being accidentally released during the construction, operations and maintenance and decommissioning phases from sources including vessels/vehicles and equipment/machinery. However, the risk of such events is managed by the implementation of measures set out in standard post-consent plans (e.g. Environmental Management Plan, including Marine Pollution Contingency Plan (MPCP)). These plans include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. It will also set out industry good practice and OSPAR (Oslo-Paris), International Maritime Organisation (IMO) and MARPOL (International Convention for the Prevention of Pollution from Ships) guidelines for preventing pollution at sea. Therefore, the likelihood of an accidental spill occurring is very low and in the unlikely event that such events did occur, the magnitude of these will be minimised through measures such as a MPCP. As such, this impact was scoped out of further consideration within the PEIR. NRW and the Planning Inspectorate agreed through their Scoping responses that the impact of accidental pollution could be scoped out of the assessment.

7.7 Measures adopted as part of the Morgan Generation Assets

7.7.1.1 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 licence (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 licence (referred to as tertiary mitigation in IEMA, 2016).

7.7.1.2 A number of measures adopted as part of the Morgan Generation Assets have been proposed to reduce the potential for impacts on benthic subtidal ecology (see Table 7.16). 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 7.8 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 7.16: 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: Measures included as part of the project design		
Commitment to cable burial where possible.	This commitment will help to reduce the amount of EMF which benthic organisms are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables.	Proposed to be secured through a condition of the marine licence requiring the development of, and adherence to, a Cable Specification and Installation Plan (CSIP) and Construction Method Statement (CMS).
Tertiary measures: Measures required to meet legislative requirements, or adopted standard industry practice		
Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary.	The CSIP will aim to facilitate greater clarity with specific regard to sandwave clearance, cable burial and cable protection. The CSIP would be developed in line with standard industry approach to the CSIP documentation.	Proposed to be secured as a requirement of the marine licence.
Development of and adherence to a CMS.	The purpose of this measure is to confirm the actual methodology that will be employed to construct the windfarm, provide details on aspects of the methodology not known at the application stage and confirm that the methodology falls within the parameters assessment in the EIA.	Proposed to be secured as a requirement of the marine licence.
Development of, and adherence to, an Environmental Management Plan, including actions to minimise INNS, and a MPCP which will include planning for accidental spills, address all potential contaminant releases and include key emergency details.	The plan will outline measures to ensure vessels comply with the IMO ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as specific measures to be adopted in the event that a high alert species is recorded (e.g. carpet sea squirt *Didemnum vexillum*). Measures will also be adopted to ensure that the potential for release of pollutants from construction, operations and maintenance and decommissioning plant is reduced. These will likely include: designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds.	Proposed to be secured as a requirement of the marine licence.

7.7.1.3 Where significant effects have been identified, further mitigation measures (referred to as secondary mitigation in IEMA, 2016) have been identified to reduce the significance of effect to acceptable levels following the initial assessment. These are measures that could further prevent, reduce and, where possible, offset any adverse effects on the environment. These measures are set out, where relevant, in section 7.8 below.

7.8 Assessment of significant effects

7.8.1.1 The impacts of the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets have been assessed on benthic subtidal ecology. The potential impacts are listed in Table 7.14, along with the MDS against which each impact has been assessed.

7.8.1.2 A description of the potential effect on benthic subtidal ecology receptors caused by each identified impact is given below.

7.8.1 Temporary subtidal habitat disturbance

7.8.1.1 Temporary habitat loss/disturbance of subtidal habitats within the Morgan benthic ecology subtidal study area will occur during the construction, operations and maintenance and decommissioning phases. Temporary habitat loss/disturbance may result from activities including the use of jack-up vessels during the installation of foundations for wind turbines and OSPs, sandwave clearance, pre-lay preparation (e.g. boulder and debris clearance), cable installation and repair as well as anchor placements associated with these activities. Temporary habitat disturbance may also arise as a result of the removal of disused/out of service cables. The MDS for temporary habitat loss/disturbance is summarised in Table 7.14.

7.8.1.2 The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here:

- Habitat structure changes - removal of substratum (extraction): the benchmark for which is the extraction of substratum to 30cm. This pressure is considered to be analogous to the impacts associated with sandwave clearance and pre-lay preparation (e.g. boulder and debris clearance), and the construction of exit pits associated with trenchless techniques such as HDD
- Abrasion/disturbance at the surface of the substratum or seabed: the benchmark for which is damage to surface features (e.g. species and physical structures within the habitat). This pressure corresponds to the impacts associated with jack-up vessel operations and anchor placements
- Penetration and/or disturbance of the substratum subsurface: the benchmark for which is damage to sub-surface features (e.g. species and physical structures within the habitat). This pressure corresponds to the impacts associated with cable installation and jack-up vessel operations
- Smothering and siltation rate changes (heavy): the benchmark for which is heavy deposition of up to 30cm of fine material added to the habitat in a single discrete event. This pressure corresponds to impacts associated with the deposition of sandwave material dredged prior to foundation installation and cable installation.

Construction phase

Magnitude of impact

7.8.1.3 The installation of the Morgan Generation Assets infrastructure within the Morgan benthic subtidal ecology study area may lead to up to 87,360,220m^2 of temporary habitat loss/disturbance during the construction phase (Table 7.14). This equates to approximately 9.14% of the Morgan benthic subtidal ecology study area.

7.8.1.4 Temporary habitat disturbance in the construction phase is likely to result from pre-lay preparations (sandwave and boulder and debris clearance and associated deposition), jack-up events, cable installation (subtidal) and cable removal. Long term habitat loss associated with the footprint of the wind turbine foundations and associated scour protection is considered in section 7.8.4.

7.8.1.5 Any mounds of cleared material will erode over time and displaced material will re-join the natural sedimentary environment, gradually reducing the size of the mounds. As the sediment type deposited on the seabed will be similar to that of the surrounding areas, benthic assemblages would be expected to recolonise these areas (see paragraphs 7.8.1.11 and 7.8.1.12 below).

7.8.1.6 A recent study reviewed the effects of cable installation on subtidal sediments and habitats, drawing on monitoring reports from over 20 UK offshore wind farms (RPS, 2019). This review showed that sandy sediments recover quickly following cable installation (e.g. months to one to two years; Newell *et al*., 2004), with little or no evidence of disturbance in the years following cable installation. It also presented evidence that remnant cable trenches in coarse and mixed sediments were conspicuous for several years after installation. However, these shallow depressions were of limited depth (i.e. tens of centimetres) relative to the surrounding seabed, over a horizontal distance of several metres and therefore did not represent a large shift from the baseline environment (RPS, 2019). Remnant trenches (and anchor drag marks) were observed years following cable installation within areas of muddy sand sediments, although these were relatively shallow features (i.e. a few tens of centimetres).

7.8.1.7 The subtidal IEFs mostly likely to be affected by this impact are those which are sedimentary based. The majority of sandwave clearance and cable installation will take place within the subtidal coarse and mixed sediments with diverse benthic communities IEF. As detailed in paragraphs 7.8.1.11 and 7.8.1.12 this IEF is likely to recover from activities of this nature.

7.8.1.8 The maximum duration of the offshore construction phase for the Morgan Generation Assets is up to four years. Within the four year construction period, construction activities are anticipated to occur intermittently.

7.8.1.9 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

7.8.1.10 Subtidal IEFs which are expected to be affected by temporary subtidal habitat loss/disturbance, and the sensitivity of these IEFs is presented in Table 7.17. These sensitivities are based on assessments made by the MarESA.

7.8.1.11 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF has an overall medium sensitivity to temporary habitat loss/disturbance. The biotope which characterises this IEF will likely be detrimentally affected by the movement of sediment during sandwave clearance. Newell *et al*. (1998) state that removal of 0.5m depth of sediment is likely to eliminate benthos from the affected area. One of the key characterising species, *Lagis koreni,* inhabits the top 10cm of the sediment (Mayhew, 2007) and would be incapable of reconstructing their delicate sand-tubes once removed from them, resulting in mortality (Schäfer, 1972). However, the recovery of the habitat is likely to occur through infilling or before infilling if the sediment exposed is the same as that removed (De-Bastos, 2016). Furthermore, *Lagis koreni* is short lived and quick to mature as well as capable of rapid recolonization through larval recruitment following disturbance events, reaching former densities within a year (Arntz and Rumohr, 1986). The majority of the important characteristic species of the biotope can maintain the character of the biotope and recruit within the first two years after disturbance (De-Bastos, 2016). The majority of the characterising species in the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are infaunal and will therefore be somewhat protected from surface level abrasion (e.g. such as that arising from jack-ups, anchor placements and cable installation). Based on their sedimentary habitat, the species associated with this IEF are capable of surviving light smothering events (De-Bastos, 2016). Furthermore, penetration such as that which might be experienced from jack-up vessels may cause some damage and mortality in the short term however based on the limited scale of this impact recovery is highly likely (De-Bastos, 2016).

7.8.1.12 The subtidal coarse and mixed sediments with diverse benthic communities IEF, which dominates the Morgan Array Area, has an overall medium sensitivity to temporary habitat loss/disturbance. The biotopes within this IEF generally have a low sensitivity to abrasion and penetration related disturbance because these habitats are largely characterised by infauna and although abrasion or penetration may result in damage or mortality to some epifaunal organisms' resilience is considered to be high (Tillin, 2016a; Tillin, 2016b). Sensitivity to habitat structure change is generally considered to be medium. Sedimentary communities are likely to be intolerant of substratum removal, which will lead to partial or complete defaunation (Dernie *et al*., 2003). Recovery of the sedimentary habitat would occur via infilling, although some recovery of the biological assemblage may take place before the original topography is restored, if the exposed, underlying sediments are similar to those that were removed. Recovery of sediments will be site-specific following activities such as sandwave clearance and will be influenced by currents, wave action and sediment availability (Desprez, 2000). The sensitivity of this IEF to heavy smothering, such as that which might result from the deposition of sandwave clearance material, is considered to be low to medium as many of the bivalves and polychaete species in this IEF are able to migrate through depositions of sediment greater than the benchmark (30cm of fine material added to the seabed in a single discrete event) (Bijkerk, 1988; Powilleit *et al*., 2009).

7.8.1.13 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.8.1.14 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Table 7.17: Sensitivity of the benthic subtidal IEFs to temporary subtidal habitat loss/disturbance

IEF	Description and representative biotopes	Sensitivity to defined MarESA pressure				Overall sensitivity (based on Table 7.12)
		Habitat structure changes – removal of substratum	Abrasion/disturbance of the surface of the substratum or seabed	Penetration or disturbance of the substratum subsurface	Smothering and siltation rate changes (heavy)	
Subtidal habitats						
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	Medium	Medium	Medium	Not sensitive	Medium
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Medium	Low	Low	Medium	Low

Significance of the effect

7.8.1.15 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.8.1.16 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

7.8.1.17 Operations and maintenance activities within the Morgan benthic subtidal study area (i.e. jack-ups associated with maintenance and cable repair/reburial events) will result in temporary habitat loss/disturbance. The MDS accounts for up to 11,566,500m^2 of temporary habitat disturbance within this phase (Table 7.14). This equates to a small proportion (1.21%) of the Morgan benthic subtidal ecology study area. It should also be noted that only a small proportion of the total temporary habitat loss/disturbance is likely to occur at any one time over the 35 year operational lifetime.

7.8.1.18 The activities which contribute to temporary habitat loss/disturbance in this phase may include jack-up events at wind turbines and OSPs and inter-array and interconnector cable repairs and remedial burial over the 35 year lifetime of the Morgan Generation Assets.

7.8.1.19 The impacts of jack-up vessel activities will be similar to those identified for the construction phase and will be spatially restricted to the immediate area around the foundations, where the spud cans are placed on the seabed, with recovery occurring following removal of spud cans. The spatial extent of this impact is small in relation to the total Morgan benthic subtidal ecology study area, although there is the potential for repeat disturbance to the habitats in the immediate vicinity of the foundations because of these activities. The repair and reburial of inter-array and OSP interconnector cables will also affect benthic habitats in the immediate vicinity of these operations, with effects on seabed habitats and associated benthic communities expected to be similar to the construction phase.

7.8.1.20 The impact is predicted to be of local spatial extent, short term duration (i.e. individual maintenance activities would likely occur over a period of days to weeks, over the lifetime of the Morgan Generation Assets), 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

7.8.1.21 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.1.10 to 7.8.1.14 and above in Table 7.17.

7.8.1.22 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.8.1.23 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

7.8.1.24 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the localised and intermittent nature of this impact in this phase of the Morgan Generation Assets as well as the small scale of the disturbance expected from operations and maintenance activities.

7.8.1.25 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the localised and intermittent nature of this impact in this phase of the Morgan Generation Assets as well as the small scale of the disturbance expected from operations and maintenance activities.

Decommissioning phase

Magnitude of impact

7.8.1.26 The MDS for the decommissioning phase assumes that all foundations and cables will be removed and that the decommissioning sequence will generally be a reverse of the construction sequence.

7.8.1.27 The extent of temporary habitat disturbance to subtidal habitat IEFs that may occur as a result of decommissioning activities is predicted to be in line with that described for the construction phase in paragraph 7.8.1.3 to 7.8.1.9. On the basis that there will be no requirement for sandwave clearance or pre-lay preparation during decommissioning, the magnitude of the impact is likely to be lower than during construction. The MDS for decommissioning therefore assumes that temporary habitat disturbance may arise as a result of the removal of 500km of inter-array cables and 60km of interconnector cables as well as the use of jack-up vessels during the removal of foundations. This includes up to four jack-up events for each of the 107 wind turbines and two jack-up events at each of four OSPs.

7.8.1.28 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

7.8.1.29 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.1.10 to 7.8.1.14 and above in Table 7.17.

7.8.1.30 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.8.1.31 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

7.8.1.32 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the temporary habitat disturbance/loss impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.8.1.33 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the temporary habitat disturbance/loss impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the small area impacted in this phase and the high likelihood of recovery given there would be no potential for any further disturbance to sediments resulting from the Morgan Generation Assets.

7.8.2 Increase in suspended sediment concentrations and associated deposition

7.8.2.1 Increases of SSCs and associated deposition are predicted to occur during the construction and decommissioning phases as a result of the installation/removal of foundations, sandwave clearance activities and the installation of inter-array and interconnector cables. Increases in suspended sediments and associated sediment deposition are also predicted to occur during the operations and maintenance phase due to inter-array and OSP interconnector cable repair and reburial events. Volume 4, appendix 6.1: Physical processes technical report of the PEIR provides a full description of the physical assessment, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent deposition.

7.8.2.2 The benchmarks for the relevant MarESA pressures which have been used to inform this impact assessment are described here.

- Changes in suspended solids (water clarity): the benchmark for which is a change in one rank on the WFD scale (e.g. from clear to intermediate for one year, caused by activities disturbing sediment or organic particulate material and mobilising it into the water column such as dredging, disposal at sea, cable and pipeline burial).
- Smothering and siltation rate changes (light): the benchmark for light deposition is up to 5cm of fine material added to the habitat in a single discrete event.

7.8.2.3 These pressures correspond to the impacts associated with sandwave clearance, the installation of foundations for wind turbines and OSPs via drilling and the installation of cables (inter-array and interconnector) by trenching.

7.8.2.4 With regards to background SSCs, the Cefas Climatology Report 2016 (Cefas, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the UK Continental Shelf. Between 1998 and 2005, the greatest plumes are associated with large rivers such as those that discharge into the Thames Estuary, The Wash and Liverpool Bay, which show mean values of SPM above 30mg/l. Based on the data provided within this study, the SPM associated with the Morgan Generation Assets has been estimated as approximately 0.9mg/l to 3mg/l over 1998 to 2005.

7.8.2.5 Seabed preparation activities (e.g. sandwave and boulder, debris clearance) and out of service cable removal will occur in advance of installation of the offshore cables. Pre-lay ploughed material will be disposed of within the Morgan Array Area, whilst any debris will be taken ashore for disposal.

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.8.2.6 Full details of the modelling undertaken to inform this assessment including relevant figures are presented in volume 4, appendix 6.1: Physical processes technical report of the PEIR, including the individual scenarios considered and assumptions within these and full modelling outputs for suspended sediments and associated sediment deposition. For the purposes of this assessment, the following activities have been considered (see Table 7.14):

- Seabed preparation (sandwave, boulder and debris clearance)
- Drilling for foundation installation
- Installation of inter-array and interconnector cables.

7.8.2.7 As outlined in Table 7.14, seabed preparation activities may be undertaken using a range of techniques, but 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 disposal of material. 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, resulting in higher quantification of sedimentation compared to the plough dredging.

7.8.2.8 The dredging phase plumes, during sandwave clearance, are predicted to be smaller than the plumes generated during the dumping phase (<50mg/l). The deposition plume is expected to be most extensive when the deposited material is redistributed on the successive tides, with average SSC levels of <500mg/l above background levels, extending a tidal excursion circa 20km from the site. During the dumping phase the plume is slightly larger with concentrations reaching 3,000mg/l above background levels at the release site for the inter-array and interconnector cables, with the plume extending 5km northeast of the dump site.

7.8.2.9 Average sedimentation associated with the sandwave clearance for inter-array and interconnector cables is expected to be up to 0.5mm, with sedimentation extending the furthest west and east of the site approximately 10km. One day following cessation of activities deposited material at the site of release is modelled to be 0.3mm deep reducing to <0/01mm at distances of 100m from the release site. The dispersion of the released material is predicted to continue on successive tides.

7.8.2.10 As outlined in Table 7.14, the MDS for foundation installation assumes all wind turbine and OSP foundations will be installed by drilling a 16m diameter monopile to a depth of 60m at a rate of 0.73m/h. A sample of three representative pile installation scenarios were simulated to cover the range of conditions in terms of water depth, tidal currents and sediment grading. At each location modelling assessed two piles being installed simultaneously. Modelling of suspended sediments (showed in volume 2, chapter 6: Physical processes of the PEIR) associated with drilling for foundation installation in the northwest of the Morgan Array Area predicted average concentrations of <30mg/l at the modelled site with the concentration reducing rapidly with distance from the two discharge locations. During drilling for foundation installation the sediment plume envelope in the northwest of the site are predicted to extend to a distance of approximately 6km (i.e. 6km to the southwest and 6km to the northeast of the foundation installation site). Where the plumes converge concentrations of suspended sediment are <1mg/l above background levels. In the northeast of the site the stronger currents and finer material means that a greater proportion of the material will be suspended. The peak concentrations for the installation and up to three days following installation in the northeast of the Morgan Array Area are approximately 50mg/l and average values are typically less than one fifth of this magnitude. In the northeast, the maximum extent of the plume envelope is approximately 22km (12km to the southwest to 10km to the northeast). In the southeast of the site average sediment concentrations are 50mg/l where the plumes coalesce. The total maximum extent of this plume envelope is approximately 13km (southwest to northeast). This is similar to the unmerged values as the plumes are travelling in concert with the tide (and not towards one another) and at the point that the plume reaches the adjacent discharge it is highly dispersed.

7.8.2.11 Within the Morgan Array Area, following foundation installation, sediment was expected to be deposited on the slack tide and then subsequently re-suspended in to the water column. The plume concentration associated with this resuspension was <50mg/l and reduces with the distance from the site as the sediment is dispersed. In the northeast of the Morgan Array Area material is also predicted to settle out on the slack tide and be re-suspended with increasing current speed. In the southeast of the Morgan Array Area at the centre of the plume envelope peak values are circa 50mg/l. Three days after the cessation of foundation installation, sediment concentrations are reduced with decreased current speeds on slack tides and mobilise settled material as speed increase through the tidal cycle. Under these circumstances peak concentrations are 50mg/l and average values are typically one tenth of this value, with the peaks centred on areas of remobilised material.

7.8.2.12 Following drilling in the northwest of the Morgan Array Area sedimentation depths are particularly low with sedimentation values of <0.1mm during all phases of drilling at all the modelled sites. This corresponds with the immediate settlement of coarser material fractions, the lower neap current speed and also for the portion of work undertaken on slack tide. This settlement would be imperceptible from the background sediment transport activity.

7.8.2.13 For the inter-array cable installation, peak plume concentrations are 300 - 500mg/l (at the release site) with the sediment settling during slack water becoming resuspended in the form of an amalgamated plume. Sedimentation of up to 50mm is predicted at the trench site, with sediment depths reducing with increasing distance from the trench to <0.5mm with the maximum extent of the plume from the cable installation site being 13Km. Plume envelopes of increased SSCs of between 0.13-300mg/l are predicted to extend over a plume envelope of 33km width in total, extending from the southwest to the northeast of the modelled installation pathway, and are associated with remobilisation of the deposited material on subsequent tides. Following the completion of the inter-array cable installation the turbidity levels will return to baseline within a couple of tidal cycles. Sedimentation depths of <30mm arise beyond the immediate vicinity of the trench one day following the cessation of drilling and therefore would be indiscernible from the existing seabed.

7.8.2.14 The result of the modelling for the interconnector cables were similar to those for the inter-array cable. The plume is predicted to extend east and west on the tide as the release progresses along the route perpendicular to the tidal flow. This gives rise to average SSCs of <50mg/l offshore. SSCs along the modelled installation route however range between 50 and 1,000mg/l where the greatest levels are located at the source of the sediment release. The sedimentation level is small typically <0.5mm and the greatest levels of deposition occur along the trenching route as coarser material settles. The re-mobilisation of deposited material on subsequent tides is predicted to result in plumes of increased sediment concentration extending 11km northwest to southeast along the corridor of installation and 3.5km on either side of the installation corridor.

7.8.2.15 The impact is predicted to be of local spatial extent, medium term duration (i.e. construction phase of up to four years, although at any one time only a small proportion of activities resulting in this impact will occur), intermittent and medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

West of Walney MCZ

7.8.2.16 Construction activities will not occur within the West of Walney MCZ and so the designated features will not be directly affected. 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 western edge of the West of Walney MCZ. However, prior to reaching these locations, significant dispersion will have occurred with concentrations predicted to be well below 1mg/l. The deposition arising from these very low SSCs is predicted to be *de minimis*. The effects of increased SSC and associated deposition on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

7.8.2.17 The impact is predicted to be of local spatial extent, medium term duration (i.e. construction phase of up to four years, although at any one time only a small proportion of activities resulting in this impact will occur), intermittent and medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

West of Copeland MCZ

7.8.2.18 Construction activities will not occur within the West of Copeland MCZ and so the designated features will not be directly affected. 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 western edge of the southern tip of the West of Copeland MCZ. However, prior to reaching these locations, significant dispersion will have occurred with concentrations predicted to be well below 1mg/l. the deposition arising from these very low SSCs is predicted to be *de minimis*. The effects of increased SSC and associated deposition on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

7.8.2.19 The impact is predicted to be of local spatial extent, medium term duration (i.e. construction phase of up to four years, although at any one time only a small proportion of activities resulting in this impact will occur), intermittent and medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible.**

Sensitivity of receptor

Subtidal Habitat IEFs

7.8.2.20 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is not sensitive to the pressures associated with this impact due to the infaunal nature of these communities and their natural sedimentary environment which enables them to adapt. Changes in SSC and deposition can occur naturally in these habitats as a result of changes in hydrodynamics (De-Bastos, 2016). Increases in suspended sediment may lead to reduced feeding or respiration for filter feeders as their feeding apparatus or gills can get clogged (De-Bastos, 2016). An increase in suspended particulates and subsequent increased deposition of organic matter will increase food resources to deposit feeders which can result in changes in community composition (De-Bastos, 2016). Furthermore, the characterising species *Lagis koreni* and *Phaxas pellucidus* are likely to be able to burrow through light smothering events, although sudden smothering would temporarily halt feeding and respiration. However, the increase in suspended sediments associated with the construction phase is likely to be intermittent and will dissipate quickly and the biotope is likely to resist smothering at the benchmark level.

7.8.2.21 The subtidal coarse and mixed sediments with diverse benthic communities IEF is representative of biotopes which are characterised by their sedimentary substrate. The characteristic communities associated with the sedimentary habitats are largely adapted for burrowing, for example Powilleit *et al*., (2009) studied the response of the polychaete *Nephtys hombergii* to smothering. This species successfully migrated to the surface of 32-41cm deposited sediment layer of till or sand/till mixture and restored contact with the overlying water.). In general bivalves and polychaetes in these habitats are likely to be able to survive short periods under sediments and to reposition (Tillin, 2016b), especially with the aid of strong currents to rapidly re-distribute sediment. An increase in suspended sediment may have a deleterious effect on the suspension feeding community. An increase in suspended solids may have a negative effect on growth and fecundity by reducing filter feeding efficiency but the characterising species of these biotopes are likely to be tolerant to short-term increases in turbidity following sediment mobilization by storms and other events (Tillin, 2016b).

7.8.2.22 The low resemblance stony reefs IEF are assessed by the MarESA as having no sensitivity to this pressure (see Table 7.18). Whilst increases in SSCs may result in extra energetic expenditure in cleaning, it is unlikely to increase mortality for the characteristic species (Readman, 2016). Deposition of 5cm may bury some of the characterising species, however the biotope experiences moderate water flow and sediment is likely to be removed rapidly. Additionally, this biotope is sand scoured and occasional disposition events are likely to occur which the biotic community is likely to be adapted for.

7.8.2.23 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

7.8.2.24 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.8.2.25 The sensitivities of the subtidal mud IEF, subtidal sand IEF and sea-pens and burrowing megafauna IEF are summarised in Table 7.18.

7.8.2.26 The subtidal mud IEF and subtidal sand IEF can both be represented by the SS.SMu.CsaMu.AfilKurAnit biotope which has been mapped across the West of Walney MCZ (Clements and Service, 2016). This biotope has a similar sensitivity to the pressures from increases in suspended sediments and deposition as the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF described in paragraph 7.8.2.20 (see also Table 7.18). Clogging of feeding apparatus by suspended sediment is likely to be the main consideration for the characterising species of the biotopes, which include a number of suspension feeders, such as brittlestar *Amphiura filiformis*, and bivalves *Kurtiella bidentata* (De-Bastos and Hill, 2016). The biotopes are characterized by burrowing species that are likely to be able to burrow upwards and therefore unlikely to be adversely affected by smothering of up to 5cm sediment (De-Bastos and Hill, 2016). Polychaetes such as *Nephtys* and *Nereis* have been reported as tolerate of up to 50cm of mud and up to 80cm of sand (Essink, 1999). The subtidal sand biotope is also represented by the SS.SMx.CMx.KurThyMx biotope which has been assessed by the MarESA as being insensitive to the pressures associated with increases in SSC and the associated deposition. This conclusion has been reached based on *Kurtiella bidentata* being regularly found in high turbidity environments and *Thyasira flexuosa* are buried within the sediment and are fed by symbiotic bacteria they are considered insensitive to a change in suspended solids (De-Bastos and Marshall, 2016).

7.8.2.27 The sea-pens and burrowing megafauna IEF is also well adapted to its sedimentary habitat and is often subject to high suspended sediment loads although feeding apparatus may be clogged (Hill, Tyler-Walter and Garrard, 2020). Once siltation levels return to normal, feeding will be resumed therefore recovery is likely to be immediate. Furthermore, both *Pennatula phosphorea* and *Virgularia mirabilis* can burrow and move into and out of their own burrows. It is probable therefore that deposition of up to 5cm of fine sediment will have little effect on these communities.

7.8.2.28 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

West of Copeland MCZ

7.8.2.29 The sensitivities of the subtidal coarse sediment IEF and subtidal mixed sediment IEF are as described in paragraph 7.8.2.21 for the subtidal coarse and mixed sediment IEF (Table 7.18). The sensitivity of the subtidal sand IEF is as described in paragraph 7.8.2.25.

7.8.2.30 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

7.8.2.31 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

Table 7.18: Sensitivity of all of the relevant IEFs to increased SSC and associated sediment deposition.

IEF	Description and representative biotopes	Sensitivity to defined MarESA pressure		Overall sensitivity (based on Table 7.12)
		Changes in suspended solids (water clarity)	Smothering and siltation rate changes (light)	
Subtidal habitats				
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	Not sensitive	Not sensitive	Negligible
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Not sensitive - Low	Low	Low
Low resemblance stony reef	Cobbles and boulders with indicator species such as *A. digitatum*, *Nemertesia* sp. and *Tubularia* sp. • CR.HCR.XFa.SpNemAdia.	Not sensitive	Not sensitive	Negligible
West of Walney MCZ				
Subtidal mud	Muds and sandy muds in extremely sheltered areas with very weak tidal currents. High numbers of polychaetes, bivalve and echinoderms such as urchins and brittle stars. • SS.SMu.CSaMu.AfilKurAnit	Not sensitive	Not sensitive	Negligible
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit • SS.SMx.CMx.KurThyMx	Not sensitive	Not sensitive	Negligible
Sea-pen and burrowing megafauna communities	Fine mud heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature with conspicuous populations of sea pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. • SS.SMu.CFiMu.SpnMeg	Not sensitive	Not sensitive	Negligible
West of Copeland MCZ				
Subtidal coarse sediment	Coarse sand and gravel or shell fragments. Largely characterised by infaunal communities include bristleworms, sand mason worms, burrowing anemones and bivalves. • SS.SCS.CCS	Low	Low	Low
Subtidal mixed sediment	A range of different types of sediments. Animals found here include worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. • SS.SMx.OMx • SS.SMx.OMx.PoVen	Not sensitive - Low	Low	Low

Significance of effect

Subtidal Habitat IEFs

7.8.2.32 Overall, for the sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the increase in suspended sediments and associated deposition impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the intermittent and low magnitude of the impact together with the ability of these habitats to recover from the relevant pressures.

7.8.2.33 Overall, for the subtidal coarse and mixed sediment with diverse benthic communities IEF the magnitude of the increase in suspended sediments and associated deposition impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the intermittent and low magnitude of the impact together with the ability of these habitats to recover from the relevant pressures.

West of Walney MCZ

7.8.2.34 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the increase in suspended sediments and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

West of Copeland MCZ

7.8.2.35 Overall, for the subtidal coarse sediment IEF and subtidal mixed sediment IEF the magnitude of the increase in suspended sediments and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and the very low levels of suspended sediment and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

7.8.2.36 Overall, for the subtidal sand IEF the magnitude of the increase in suspended sediments and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.8.2.37 Maintenance activities within the Morgan Array Area may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Morgan Generation Assets. The MDS, as outlined in Table 7.14, includes the repair of 8km of inter-array cable in one event every three years, the reburial of 20km of inter-array cable in one event every five years, the repair of 20km of interconnector cable in three events every 10 years and the reburial of 3km of interconnector cable with one event every three years.

7.8.2.38 In each case the length of the repair or reburial activity may be up to 20km; therefore, the magnitude of the impacts would be a fraction of those predicted to occur during the construction phase (volume 2, chapter 6: Physical processes of the PEIR). 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 (Table 7.14).

7.8.2.39 The removal of encrusted growth from offshore structures may also occur during the operations and maintenance phase however no quantitative assessment can be made as the volume of encrusting material that may be removed is not known. An investigation conducted at the research platform Forschungsplattformen in Nord- und Ostsee 1 FINO 1 in the southwestern German Bight in the North Sea reported that yearly, 878,000 single shell halves from *M. edulis* sink onto the seabed from the FINO 1 platform, thereby greatly extending the reef effects created by the construction of the offshore platform structure (Krone *et al*., 2013). Although recent monitoring from Beatrice offshore wind farm found no *M. edulis* colonised its structures reducing the amount of debris reaching the seabed (APEM, 2021).

7.8.2.40 Removal of marine growth from the wind turbine foundations may cause debris to fall within the vicinity of the wind turbine foundation and smother benthic communities within the impact zone. It is likely that seaweed/algal material would disperse into the water column, with heavier material (e.g. mussels) being deposited within 10m to 15m of the foundation (Vattenfall Wind Power Ltd, 2018). The discharge of the fine material generated as a result of the use of high- pressure jet washing to remove the encrusting fauna into the marine environment may result in a short-term increase in suspended organic material in the water column. This material would be expected to be rapidly dispersed on the following tides and under the prevailing hydrodynamic conditions. The study by Mavraki *et al*. (2020) of gravity-based foundations in the Belgian part of the North Sea found that higher food web complexity was associated with zones where high accumulation of organic material such as soft substrate or scour protection which begins to describe the potential reef effect that can be found at these hard structures and is considered further in section 7.8.4.16.

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

West of Walney MCZ

7.8.2.42 The magnitude of the increase in suspended sediment and associated deposition within the West of Walney MCZ is likely to be a fraction of that described for the subtidal habitat IEFs in paragraphs 7.8.2.37 and 7.8.2.40. The West of Walney MCZ is located 7.57km from the Morgan Array Area and whilst there may be some impact from SSCs in the operations and maintenance phase is predicted to be *de minimis*, the magnitude would be considerably smaller than that predicted during the construction phase. The effects of increased SSC and associated deposition on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

West of Copeland MCZ

7.8.2.44 The magnitude of the increase in SSC and associated deposition within the West of Copeland MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.2.37 and 7.8.2.40. The West of Copeland MCZ is located 7.32km from the Morgan Array Area and whilst there may be some impact from SSCs in the operations and maintenance phase is predicted to be *de minimis*, the magnitude would be considerably smaller than that predicted during the construction phase. The effects of increased SSC and associated deposition on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

Sensitivity of receptor

Subtidal Habitat IEFs

7.8.2.46 The sensitivity of the subtidal habitat IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.20 to 7.8.2.24 and above in Table 7.17.

7.8.2.47 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore considered to be **negligible**

7.8.2.48 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore considered to be **low**.

West of Walney MCZ

7.8.2.49 The sensitivity of the West of Walney MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.25 to 7.8.2.28 and above in Table 7.17.

7.8.2.50 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore considered to be **negligible.**

West of Copeland MCZ

7.8.2.51 The sensitivity of the West of Copeland MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.29 to 7.8.2.30 and above in Table 7.17.

7.8.2.52 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore considered to be **low**.

7.8.2.53 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of effect

Subtidal Habitat IEFs

7.8.2.54 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

7.8.2.55 Overall, for the subtidal coarse and mixed sediment with diverse benthic communities IEF the magnitude of the increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets and the ability of the communities to recover.

West of Walney MCZ

7.8.2.56 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and the very low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

West of Copeland MCZ

7.8.2.57 Overall, for the subtidal coarse sediment IEF and the subtidal mixed sediment IEF the magnitude of the increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and the very low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

7.8.2.58 Overall, for the subtidal sand IEF the magnitude of the increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

Subtidal habitat IEFs

7.8.2.59 Decommissioning of the Morgan Generation Assets infrastructure may lead to increases in SSCs and associated sediment deposition. The MDS assumes that suction caisson foundations would be removed as well as cables, and this would result in an increase is SSCs.

7.8.2.60 Following decommissioning, increases in SSC and potential impacts 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. Increases in SSC due to the removal of inter-array, interconnector and offshore export cables would be similar to those experienced during the construction phase, as retrieval would be undertaken using similar techniques to installation. As per the MDS (Table 7.14), SSC would increase temporarily if suction caissons were removed using overpressure to release. The increase in SSC and the potential impact on physical features may persist during decommissioning, however they would be localised in nature.

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

West of Walney MCZ

7.8.2.62 The magnitude of the increase in SSC and associated deposition within the West of Walney MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.2.59 and 7.8.2.60. The West of Walney MCZ is located 7.57km from the Morgan Array Area and whilst there may be some impact from SSCs in the decommissioning phase is predicted to be *de minimis*, the magnitude would be considerably smaller than that predicted during the construction phase. The effects of increased SSC and associated deposition on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

West of Copeland MCZ

7.8.2.64 The magnitude of the increase in SSC and associated deposition within the West of Copeland MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.2.59 and 7.8.2.60. The West of Copeland MCZ is located 7.32km from the Morgan Array Area and whilst there may be some impact from SSCs in the decommissioning phase is predicted to be *de minimis*, the magnitude would be considerably smaller than that predicted during the construction phase. The effects of increased SSC and associated deposition on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

Sensitivity of receptor

Subtidal Habitat IEFs

7.8.2.66 The sensitivity of the subtidal habitat IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.20 to 7.8.2.24 and above in Table 7.17.

7.8.2.67 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible**

7.8.2.68 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.8.2.69 The sensitivity of the West of Walney MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.25 to 7.8.2.28 and above in Table 7.17.

7.8.2.70 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

West of Copeland MCZ

7.8.2.71 The sensitivity of the West of Copeland MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.29 to 7.8.2.30 and above in Table 7.17.

7.8.2.72 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

7.8.2.73 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible**.

Significance of effect

Subtidal Habitat IEFs

7.8.2.74 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover.

7.8.2.75 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover.

West of Walney MCZ

7.8.2.76 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the increase in SSC and associated deposition impact decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the distance of this MCZ from these activities.

West of Copeland MCZ

7.8.2.77 Overall, for the subtidal coarse sediment IEF and the subtidal mixed sediment IEF the magnitude of the increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the distance of this MCZ from these activities.

7.8.2.78 Overall, for the subtidal sand IEF the magnitude of the increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

7.8.3 Disturbance/remobilisation of sediment-bound contaminants

7.8.3.1 During activities such as sandwave clearance and cable and foundation installation/removal there is potential for sediment-bound contaminants such as metals, hydrocarbons and organic pollutants, to be remobilised into the water column and lead to adverse effects on benthic receptors.

7.8.3.2 The relevant MarESA pressures and benchmarks used to inform this impact assessment are described here.

- Transitional elements and organometal contamination: Exposure of marine species or habitat to one or more relevant contaminants via uncontrolled releases or incidental spills. The increase in transition elements levels compared with background concentrations due to their input from land/riverine sources, by air or directly at sea
- Hydrocarbon and PAH contamination: Exposure of marine species or habitat to one or more relevant contaminants via uncontrolled releases or incidental spills. Increases in the levels of these compounds compared with background concentrations
- Synthetic compound contamination: Exposure of marine species or habitat to one or more relevant contaminants via uncontrolled releases or incidental spills. Increases in the levels of these compounds compared with background concentrations.

7.8.3.3 These pressures are relevant to the installation of foundations via drilling, cable installation and seabed preparation activities.

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.8.3.4 The results of the sediment chemistry analysis for the Morgan Array Area is presented in section 7.4.5.3. The full results of this sediment chemistry analysis are detailed in volume 4, annex 7.1: Benthic ecology technical report of the PEIR. In summary, levels of transitional elements, PCBs and PAHs were below Cefas AL1, AL2 and the Canadian TEL and PEL and so generally at levels that would not be of concern to the marine environment. The only exception was arsenic which exceeded the Canadian TEL at eight sites in the southwest of the Morgan Array Area but did not exceed the Cefas AL1 or AL2 or the Canadian PEL at any location.

7.8.3.5 The total area that is likely to be disturbed by construction activities, and therefore the potential volume of material disturbed, resulting in the potential release of sediment bound contaminants is small and localised in extent to the Morgan Array Area as well as occurring intermittently over the construction phase. The MDS is for 25,053,910m^3 of spoil from sandwave clearance, up to 13,460m^3 spoil volume per pile for wind turbine foundations, 13,460m^3 spoil volume per pile for OSP foundations and spoil from cable installation (Table 7.14).

7.8.3.6 Following disturbance during construction activities, the majority of re-suspended sediments are expected to be deposited in the immediate vicinity of the works (as described in detail in section 7.8.2). The release of contaminants from the small proportion of fine sediments is likely to be rapidly dispersed with the tide and/or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects are not expected.

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

West of Walney MCZ

7.8.3.8 As discussed in paragraph 7.8.3.4, levels of contaminants in sediments were very low. The magnitude of the remobilisation of sediment-bound contaminants impact within the West of Walney MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.3.4 and 7.8.3.7. The West of Walney MCZ is located 7.57km from the Morgan Array Area and, as discussed in paragraph 7.8.2.16, whilst sediment plumes may extend to the western edge of the southern tip of the West of Walney MCZ, prior to reaching these locations, significant dispersion will have occurred. Concentrations at the West of Walney MCZ are predicted to be well below 1mg/l. Any remobilised sediment-bound contaminants are predicted to have also been subject to significant dispersion and dilution. The effects of increased SSC and associated deposition on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

West of Copeland MCZ

7.8.3.10 As discussed in paragraph 7.8.3.4, levels of contaminants in sediments were very low. The magnitude of the remobilisation of sediment-bound contaminants impact within the West of Copeland MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.3.4 and 7.8.3.7. The West of Copeland MCZ is located 7.32km from the Morgan Array Area, as discussed in paragraph 7.8.2.18, whilst sediment plumes may extend to the western edge of the southern tip of the West of Copeland MCZ, prior to reaching these locations, significant dispersion will have occurred. Concentrations at the West of Copeland MCZ are predicted to be well below 1mg/l. Any remobilised sediment-bound contaminants are predicted to have also been subject to significant dispersion and dilution. The effects of increased SSC and associated deposition on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

Sensitivity of receptor

Subtidal habitat IEFs

7.8.3.12 The disturbance/remobilisation of sediment-bound contaminants has the potential to affect all the subtidal IEFs. Whilst the representative biotopes for the subtidal habitat IEFs are not assessed by the MarESA, in general, tolerance to heavy metals varies depending on species and tolerance tends to be low for most groups of benthic species in these IEFs. For example, the capacity of bivalves to accumulate heavy metals in their tissues, far in excess of environmental levels, is well known, resulting in sub-lethal effects (Aberkali and Trueman, 1985). Echinoderms are also regarded as being intolerant of heavy metals (e.g. Bryan, 1984; Kinne, 1984) while polychaetes are generally tolerant (Bryan, 1984). The only heavy metal of concern within the subtidal area of the Morgan Generation Assets is arsenic, which is present in levels lower than those typical of deep-sea sediments (typically 40 µg/g) (Bostrom and Valdes, 1969). As such, the benthic communities have developed in an environment of existing contamination, so any release of contaminants from construction activities is not likely to significantly increase bioavailability.

7.8.3.13 The subtidal coarse and mixed sediments with diverse benthic communities IEF, subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.8.3.14 The impacts on the subtidal sand IEF and subtidal mud IEF are likely to be negligible due to the nature of the contamination. Arsenic has been pervasive in this region for decades therefore benthic communities in this area are likely to be acclimated to these conditions. These IEFs are predominantly characterised by infaunal communities composed of polychaetes, Experimental studies with various species suggest that polychaete worms are quite tolerant of heavy metals (Bryan, 1984). Bryan (1984) also reports that early work has shown that echinoderm larvae are intolerant of heavy metals whereas adults are more resistant. The low levels of contamination however in this area as well as the short term nature of this disturbance are unlikely to result in pervasive negative impacts.

7.8.3.15 The sea-pens and burrowing megafauna communities IEF has not been specifically assessed in regard to exposure to transition elements such as arsenic as part of the MarESA. Research has however shown that arsenic can accumulate in the tissue of benthic organisms such as the filter-feeding bivalves *Cerastoderma edule* and *Mytilus edulis* accumulate arsenic from ingested living and dead particles which can at high concentrations lead to lethal effects (Neff, 2009). The concentrations of arsenic likely to be resuspended as a result of Morgan Generation Assets however are unlikely to result in this level of bioaccumulation due to the short time period over which exposure may occur and the generally low levels of contamination present.

7.8.3.16 The sea-pens and burrowing megafauna communities IEF, subtidal sand IEF and subtidal mud IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Copeland MCZ

7.8.3.17 Within the West of Copeland MCZ the potential impact to the subtidal coarse sediment IEF and mixed sediment IEF will be the same as described in paragraph 7.8.3.12 for the subtidal habitat IEFs.

7.8.3.18 The impact on the subtidal sand IEF will be the same as described in paragraph 7.8.3.14, for the same biotope in the West of Walney MCZ.

7.8.3.19 The subtidal mixed sediment IEF, subtidal sand IEF and subtidal coarse sediment IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.8.3.20 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF, the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during the construction phase of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

West of Walney MCZ

7.8.3.21 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during the construction phase of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

West of Copeland MCZ

7.8.3.22 Overall, for the subtidal coarse sediment IEF, subtidal mixed sediment IEF and the subtidal sand IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during all phases of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

Decommissioning phase

Magnitude of impact

Subtidal habitat IEFs

7.8.3.23 In the decommissioning phase of the Morgan Generation Assets there is potential for the remobilisation of sediment bound contaminants due to sediment disturbance arising from the removal of cables and suction caissons foundations for wind turbine and OSPs, if they are removed using the overpressure to release. During these activities, SSCs may be temporarily increased.

7.8.3.24 It is reasonable to assume that the metals, PCBs and PAHs identified in the baseline characterisation survey would continue to be present in the sediments of the Morgan Array Area at the same concentrations in the decommissioning phase. Therefore the magnitude of this impact will be similar to the construction phase as presented in paragraphs 7.8.3.4 and 7.8.3.5.

7.8.3.25 As in the construction phase the majority of sediments resuspended during decommissioning activities are expected to be deposited in the immediate vicinity of the works (for further detail on deposition see section 7.8.2). The release of contaminants from the small proportion of fine sediments is likely to be rapidly dispersed with the tide and/or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects are not expected.

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

West of Walney MCZ

7.8.3.27 As discussed in paragraph 7.8.3.4, levels of contaminants in sediments were very low. The magnitude of the remobilisation of sediment-bound contaminants impact within the West of Walney MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.2.27 and 7.8.2.30. The West of Walney MCZ is located 7.57km from the Morgan Array Area and, as discussed in paragraph 7.8.2.60, SSC in the decommissioning phase will be similar to the construction phase where whilst sediment plumes may extend to the western edge of the southern tip of the West of Walney MCZ. Prior to reaching these locations, significant dispersion will have occurred. Concentrations at the West of Walney MCZ are predicted to be well below 1mg/l. Any remobilised sediment-bound contaminants are predicted to have also been subject to significant dispersion and dilution. The effects of increased SSC and associated deposition on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

West of Copeland MCZ

7.8.3.29 As discussed in paragraph 7.8.3.4, levels of contaminants in sediments were very low. The magnitude of the remobilisation of sediment-bound contaminants impact within the West of Copeland MCZ is likely to be a fraction of what is described for the subtidal habitat IEFs in paragraphs 7.8.2.27 and 7.8.2.30. The West of Copeland MCZ is located 7.32km from the Morgan Array Area and , as discussed in paragraph 7.8.2.60, SSC in the decommissioning phase will be similar to the construction phase where whilst sediment plumes may extend to the western edge of the southern tip of the West of Copeland MCZ. Prior to reaching these locations, significant dispersion will have occurred. Concentrations at the West of Copeland MCZ are predicted to be well below 1mg/l. Any remobilised sediment-bound contaminants are predicted to have also been subject to significant dispersion and dilution. The effects of increased SSC and associated deposition on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

Sensitivity of receptor

Subtidal habitat IEFs

7.8.3.31 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.3.12 to 7.8.3.13.

7.8.3.32 The subtidal coarse and mixed sediments with diverse benthic communities IEF, subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.8.3.33 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.3.14 to 7.8.3.15.

7.8.3.34 The sea-pens and burrowing megafauna communities IEF, subtidal sand IEF and subtidal mud IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Copeland MCZ

7.8.3.35 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.3.17 to 7.8.3.19.

7.8.3.36 The subtidal mixed sediment IEF, subtidal sand IEF and subtidal coarse sediment IEF are deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.8.3.37 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF, the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during the decommissioning phase of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

West of Walney MCZ

7.8.3.38 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during the decommissioning phase of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

West of Copeland MCZ

7.8.3.39 Overall, for the subtidal coarse sediment IEF, subtidal mixed sediment IEF and the subtidal sand IEF the magnitude of the disturbance/remobilisation of sediment-bound contaminants impact during all phases of the Morgan Generation Assets is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the very low levels of contamination in the Morgan Array Area.

7.8.4 Long term habitat loss

7.8.4.1 Long term subtidal habitat loss within the Morgan benthic subtidal ecology study area will begin during the construction phase as infrastructure is gradually installed and will continue during the operations and maintenance phase when infrastructure is operational (Table 7.14). Long term habitat loss will occur directly under all wind turbine and OSP foundation structures (suction bucket jacket foundations for all structures). The installation of scour protection and cable protection (including at cable crossings), where this is required, will also lead to habitat alteration and a physical change to another seabed type under the scour/cable protection material. Magnitude has been considered for both phases combined as the structures will be placed during construction and remain throughout the operations and maintenance phase. The potential impact of habitat loss persisting after the decommissioning phase has also been considered as the MDS assumes that scour and cable protection will be left *in situ* following decommissioning.

7.8.4.2 The relevant MarESA pressures and their benchmarks which have used to inform this impact assessment are described here.

- Physical change (to another seabed type): the benchmark for which is change in sediment type by one Folk class (based on UK SeaMap simplified classification (Long, 2006)) and change from sedimentary or soft rock substrata to hard rock or artificial substrata or vice-versa.

7.8.4.3 These pressures are relevant to the installation of wind turbine and OSP foundations, the associated scour protection and the cable protection which will replace the sedimentary seabed with hard structures for the duration of the operations and maintenance phase (35 years).

Construction and operations and maintenance phases

Magnitude of impact

Subtidal habitat IEFs

7.8.4.4 The presence of the Morgan Generation Assets infrastructure within the Morgan benthic subtidal ecology study area will result in long term habitat loss. The MDS is for up to 1,519,092m^2 of long term habitat loss due to the installation of suction bucket jacket foundations and associated scour protection and cable protection associated with wind turbines and all types of cable (Table 7.14). This represents 0.16% of the Morgan benthic subtidal ecology study area.

7.8.4.5 Foundations and associated scour protection may account for up to 760,452m^2 of the total long term habitat loss in the Morgan Array Area. Cable protection may account for up to 620,000m^2 of long term habitat loss. The MDS accounts for 10% of the inter-array cables and 20% of the interconnector cables having cable protection with a width of 10m. Additionally cable crossing protection may result in 138,640m^2 of long term habitat loss. Cable protection may be required for 67 crossings for the inter-array cable and 10 crossings for the interconnector cable.

7.8.4.6 Long term subtidal habitat loss potential impacts will occur during the construction phase and will be continuous throughout the 35-year operations and maintenance phase.

7.8.4.7 The impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.4.8 Long term habitat loss will affect all subtidal IEFs within the Morgan Array Area (i.e. subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF).

7.8.4.9 All subtidal IEFs have high sensitivity to long term habitat loss where a change in seabed type would cause a fundamental change in habitat type (Table 7.19). As outlined previously, this habitat alteration represents a small proportion of the Morgan benthic subtidal ecology study area.

7.8.4.10 The subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are characterised by their sedimentary composition. To change the seabed to rock or artificial substratum would lead to a loss of the abiotic and biotic features of the biotopes in this IEF and would result in a reclassification (Tillin, 2016a; De-Bastos and Marshall, 2016; Tillin, 2016b). It is likely that infrastructure such as cable protection will largely occur on sedimentary habitats, and this introduced hard substrate could be colonised by similar communities which have been identified in areas of cobbles/stony sediment (further detail on the colonisation of hard structures is presented in section 7.8.4.16).

7.8.4.11 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptor is therefore considered to be **high**.

Table 7.19: Sensitivity of the benthic IEFs to long term subtidal habitat loss.

IEF	Representative biotope	Sensitivity to defined MarESA Physical change (to another seabed type)	Overall sensitivity (based on Table 7.12)
Subtidal biotopes			
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	High	High
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	High	High

Significance of effect

Subtidal habitat IEFs

7.8.4.12 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the long term subtidal habitat loss impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The long term habitat loss will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

Decommissioning phase

Magnitude of impact

7.8.4.13 The presence of the Morgan Generation Assets infrastructure within the Morgan benthic subtidal ecology study area post-decommissioning will result in permanent habitat alteration. The MDS is for up to 1,461,956m^2 of permanent habitat alteration due to scour protection and cable protection associated with cables and cable crossings being left *in situ* after decommissioning. This equates to a very small proportion (0.15%) of the Morgan benthic subtidal ecology study area. In areas of previously soft sediments where the cables and scour protection are left *in situ* on the seabed, the substrate will not return to soft sediments and therefore there is no potential for recovery of sedimentary communities. Throughout the operations and maintenance phase however it is likely that the Morgan Generation Assets infrastructure will be colonised by hard structure adapted communities similar to those which occur on the natural hard substrates (further detail on the colonisation of hard structures is presented in in section 7.8.4.16). As a result of this it may be more accurate to refer to the permanent placement of Morgan Generation Assets infrastructure as habitat alteration rather than loss, as used for the other phases, as these artificial habitats will provide a basis for benthic communities although they are likely to be different from those originally found at these sites.

7.8.4.14 The impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.4.15 The sensitivity of the IEFs is as described previously for the construction and operations and maintenance phase assessment in paragraph 7.8.4.8 to 7.8.4.11 and above in Table 7.19.

Significance of effect

Subtidal habitat IEFs

7.8.4.16 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the long term subtidal habitat loss potential impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The long term habitat loss will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

7.8.5 Colonisation of hard structures

7.8.5.1 The introduction of infrastructure within the Morgan benthic subtidal ecology study area may result in the colonisation of foundations, scour protection and cable protection.

7.8.5.2 The environmental pressures associated with this potential impact are the same as those associated with long term subtidal habitat loss because the physical change (to another substratum type) pressure involves the permanent loss of one marine habitat type but has an equal creation of a different marine habitat type component such as the installation of wind turbine foundations and cable protection. The pressure is described for the MarESA in paragraph 7.8.4.2.

Construction and operations and maintenance phases

Magnitude of impact

Subtidal habitat IEF

7.8.5.3 The MDS is for up to 1,995,525m^2 of habitat creation due to the installation of suction bucket jacket foundations, associated scour protection and cable protection associated with inter-array cables and interconnector cables as well as their associated crossings (Table 7.14). This equates to 0.21% of the Morgan benthic subtidal ecology study area. This value however is likely an over estimation of habitat creation as it has been calculated assuming the foundations were a solid structure. In reality the suction caisson jacket foundations will have a lattice design rather than a solid surface, which would result in a smaller surface area than has been assumed for the MDS. It is expected that the foundations and scour and cable protection will be colonised by epifaunal species already occurring in the Morgan benthic subtidal ecology study area (e.g. tunicates, bryozoans, mussels and barnacles which are typical of temperate seas).

7.8.5.4 The introduction of new hard substrate will represent a shift in the baseline conditions from soft substrate areas (i.e. muds, sands and gravels) to hard substrate in the areas where infrastructure is present. This may produce some potentially beneficial effects, for example the likely increase in biodiversity and individual abundance of reef species and total number of species over time, as has been observed at the monopile foundations installed at Lysekil research site (a test site for offshore wind-based research, north of Gothenburg, Sweden) (Bender *et al*., 2020). Additionally, the structural complexity of the substrate may provide refuge as well as increasing feeding opportunities for larger and more mobile species. The presence of mobile benthic organisms is considered to be dependent on sufficient food sources, cover of epibenthic communities and appropriate habitat with shelter opportunities to hide from predators (Langhamer, and Wilhelmsson, 2009). This effect can also be applied to jacket foundations, a study by Lefaible *et al*. (2019) identified that jacket foundations had higher densities and diversity (species richness) of species in closer vicinity of the wind turbines compared to a control and a monopile foundation. Mavraki *et al.* (2020), study of gravity-based foundations in the Belgian part of the North Sea found that higher food web complexity was associated with zones where high accumulation of organic material such as soft substrate or scour protection, suggesting potential reef effect benefits from the presence of the hard structures.

7.8.5.5 The reef effect may be enhanced by the deposition of fouling material on the seabed. An investigation conducted at the research platform Forschungsplattformen in Nord- und Ostsee 1 FINO 1 in the south-western German Bight in the North Sea reported that yearly, 878,000 single shell halves from Mytilus edulis sink onto the seabed from the FINO 1 platform, thereby greatly extending the reef effects created by the construction of the offshore platform structure (Krone *et al*., 2013). Removal of marine growth from the wind turbine foundations may also cause debris to fall within the vicinity of the wind turbine foundation. It is likely that seaweed/algal material would disperse into the water column, with heavier material (e.g. mussels) being deposited within 10m to 15m of the foundation. This material has the potential to change the prevailing sediment type in the immediate vicinity of the wind turbines, and therefore extending the reef effect.

7.8.5.6 The increased biodiversity, species richness and species abundance which has been noted as a feature of colonised infrastructures, such as the jacket foundations of wind turbines, will also provide greater foraging opportunities for some fish species (this has been assessed in volume 2, chapter 8: Fish and shellfish ecology of the PEIR). This is supported by monitoring from Beatrice offshore wind farm (APEM, 2021) which noted fish and shellfish at the base of foundations although no biological material was recorded on the seabed. Material may be rapidly consumed by organisms or relocated due to tidal currents and further monitoring will be required to clarify if biological material builds up over time (APEM, 2021). Any additionally effects up the food chain are considered in relation to marine mammals (volume 2, chapter 9: Marine mammals of the PEIR) and ornithology (volume 2, chapter 10: Offshore ornithology of the PEIR) in their individual chapters.

7.8.5.7 A review by Degraer *et al* (2020) explained the process by which wind turbine foundations are colonised and the vertical zonation of species that can occur. In general biofouling communities on offshore installations are dominated by mussels, macroalgae, and barnacles near the water surface, essentially creating a new intertidal zone; filter feeding arthropods at intermediate depths; and anemones in deeper locations (De Mesel *et al*., 2015). Colonisation by these species will likely represent an increase in biodiversity and a change compared to the situation if no hard substrates were present (Lindeboom *et al*., 2011).

7.8.5.8 Furthermore, there is the potential for the presence of the infrastructure to result in reduced fishing pressure within the Morgan Array Area. During the construction phase, it is proposed that temporary 500m safety zones will be present around wind turbine generators and OSPs where works are underway. Existing UK legislation does not prohibit commercial fishing within operational offshore wind farms and the Mona Offshore Wind Project is committed to co-existence with commercial fishing. It is therefore assumed that commercial fishing will continue within the Mona Array Area. However, as assessed in volume 2, chapter 11: Commercial Fisheries chapter of the PEIR, during the operations and maintenance phase safety requirements and different attitudes to risk, as well as different operating requirements associated with gear width when actively fishing, may potentially result in a reduction in fishing activity within the Morgan Array Area such as scallop fishing. A recent study by Dunkley and Solandt (2022) used publicly available fishing effort data and found fishing rate from vessels using bottom-towed gear was reduced by 77 % following offshore wind farm construction in 11 of the 12 sites studied within the UK exclusive economic zone. A decline in bottom-towed fishing activity was recorded in OWFs where wind turbines were constructed in a densely aggregated patch (Dunkley and Solandt, 2022). Based on these findings Dunkley and Soldandt (2022) concluded that offshore wind farms afforded the marine ecosystem within their array areas some protection from bottom trawling.

7.8.5.9 The impact is predicted to be of local spatial extent, long term duration, continuous and irreversible during the lifetime of the Morgan Generation Assets. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.5.10 The sensitivity of the IEFs to physical change (to another substratum) is as described previously for the long term subtidal habitat loss assessment and above in 7.8.4.10.

7.8.5.11 Within the Morgan benthic subtidal ecology study area sediments are dominated by gravelly sand and gravelly muddy sand. As such, the introduction of hard substrates due to installation of foundation structures, associated scour protection, and any cable protection, will represent a shift in community type and will have a direct effect on benthic ecology IEFs through the colonisation of these hard substrates.

7.8.5.12 The colonisation of hard structures will affect subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF). Scour protection and cable protection may have indirect adverse effects on the baseline communities and habitats due to increased predation on and competition with the existing soft sediment species. These effects are difficult to predict, especially as monitoring to date has focused on the colonisation and aggregation of species close to the foundations rather than broad scale studies.

7.8.5.13 Placing the hard structures on the seabed not only creates new habitat but also modifies or removes existing habitat. Often it replaces an essentially two-dimensional sedimentary seabed, such as subtidal sandbanks, with a complex 3-D structure, thereby increasing surface area, surface complexity and number of niches (e.g. Dannheim *et al*., 2019). The development of such surfaces and their role in connectivity of populations depends on the right type of surface being created but also in the right location and distances from source populations (Marine Pollution Bulletin, 2022). The surface may only be suitable for colonisation after being suitably weathered, through the loss of any surface contaminants, the production of biofilms and the sequence of development of the community after settlement (Marine Pollution Bulletin, 2022).

7.8.5.14 Some studies have also shown that the installation and operation of offshore wind farms have no significant impact on the soft sediment environments. De Backer *et al*. (2020) found that eight to nine years after the installation of C-power and Belwind offshore wind farms (offshore Belgium) the soft sediment epibenthos underwent no drastic changes; and the species originally inhabiting the sandy bottom were still present and remained dominant in both wind farms. Additionally, a review of monitoring from Block Island wind farm in the United States showed no strong gradients of change in sediment grain size, enrichment, or benthic macrofauna within 30m to 90m distance bands of the wind turbines (Hutchison *et al*., 2020).

7.8.5.15 The deployment of scour and cable protection may facilitate the colonisation of rock protection by epifaunal species typical of coarse sediment which are found within the Morgan Array Area. Previous studies have shown that for artificial hard substrate to be colonised by a benthic community similar to that of the baseline, its structure should resemble that of the baseline habitat as far as possible (Coolen, 2017). The addition of smaller grained material to scour/cable protection may therefore be of some benefit to the native epifaunal communities (Van Duren *et al*., 2017; Lengkeek *et al*., 2017).

7.8.5.16 The most recent monitoring data at the time of writing this chapter to come from an operational wind farm has come from Beatrice Offshore Wind farm Post-Construction Monitoring (APEM, 2021). This monitoring was undertaken in October 2020 and used DDV, remotely operated vehicles and grab samples to gather qualitative data on the biofouling community composition on wind turbines (four wind turbines with jacketed foundations in four different locations within the wind farm, assessed to a depth of 45m) and the surrounding seabed. The results found extensive biofouling on all the wind turbines with signs of zonation and successional development. The zonation was dependent on depth and the dominance of a few key species. Across all wind turbines *Metridium senile* plumose anemones and *Spirobranchus triqueter* keel worms were the most abundant species, with the highest biomass found at mid depths of 40m with lower biomass above and below. The splash zone and top 5m of the foundations was dominated by algal turf and kelp, this gave way to cnidarian dominated community at around 5m to 10m and this transitioned to a keel worm dominated zone between 25m and 40m depth. At the base in the immediate vicinity of the wind turbines the *Pagurus bernhardus* hermit crabs, flatfish and *Echinus esculentus* common sea urchin were found with decreasing abundance further from the foundation indicating a source of food although no biological matter could be seen. Gadoid fish could also be seen but not identified to species level. The zonation pattern is likely to remain constant except for small scale changes. The zonation pattern may change if the communities are disturbed by the introduction of a new species such as the *M. edulis* which is notably absent as it commonly found in other wind farms.

7.8.5.17 The introduction of this hard substrate may also have potential impacts on the distribution of species as this kind of artificial infrastructure can influence larval dispersion. Research in this area comes from the oil and gas sector which examines the potential impact of infrastructure regarding the interception and production of larvae (McLean *et al*., 2022). The larvae can be triggered to settle on infrastructure by sound, chemical cues, light and vibrations. Where platforms exist in offshore waters far from natural reef features, their influence on larval dispersal and settlement may be comparatively high, relative to platforms in more naturally connected environments, therefore influencing geographic and population connectivity (McLean *et al*., 2022). As species become established on oil and gas structures, they can start producing larvae (e.g. Henry *et al*., 2018). One such example of this in the North Sea found interannual variability in the North Atlantic Oscillation results in larvae of the protected cold-water coral species, *Lophelia pertusa* being dispersed from oil and gas structures across distances of ~300km (Fox *et al*., 2016) and into marine protected areas (Henry *et al*., 2018). The influence of oceanographic features in species dispersal and distribution however emphasizes the importance in characterising the hydrodynamics underpinning potential connectivity (Boschetti *et al*., 2020). Potential barriers to settlement, growth, reproduction and survival of larvae on offshore energy infrastructure also exist, including cleaning regimes, surface coatings (e.g. antifoulant) and operational discharges.

7.8.5.18 All of the subtidal IEFs (the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF) are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore, considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.8.5.19 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the colonisation of hard structures impact in the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the localised nature of this impact which will be largely restricted to the wind turbine and OSP foundations, and the immediate surrounding area, as well as cable and scour protection.

7.8.6 Increased risk of introduction and spread of invasive non-native species

7.8.6.1 The increased risk of introduction and spread of INNS during the construction, operations and maintenance and decommissioning phases has been considered in this assessment.

7.8.6.2 The benchmark for the relevant MarESA pressure which has been used to inform this impact assessment is described here.

- Introduction or spread of INNS: The benchmark for which is the introduction of one or more INNS.

7.8.6.3 This pressure is relevant to the introduction of new substrates into an established community.

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.8.6.4 The installation of hard substrates and the presence of construction vessels may lead to an increased risk of introduction and spread of INNS. The MDS is represented by up to 1,878 vessel round trips during the construction phase, including those required during site preparation activities, which will occur over a maximum duration of up to four years (Table 7.14). There are however a number of existing vessel movements occurring within the Morgan benthic subtidal ecology study area. Ferries represent a large proportion of the vessel traffic in this region. These ferries primarily move between the mainland UK and Ireland or Northern Ireland. One of the busiest crossings from Liverpool or Heysham to Douglas on the Isle of Man resulted in approximately 1,1912 crossings in 2019 (Nash Maritime, 2022). Shipping is also a major contributor with busy ports such as Liverpool operating out of the region. There is also an active fishing industry in this region, with fishing ports such as Amlwch, Conwy, Holyhead and Fleetwood being the most active. During the offshore geophysical, environmental and geotechnical surveys in 2021 and 2022 34 fishing vessels were identified in the Mona Array Area or in the vicinity. The addition of Morgan Generation Assets construction traffic to this region does not represent a level of vessel activity uncommon to this area and, therefore, it does not represent a large increase in risk. Many of these vessels associated with the baseline vessel traffic will be travelling further afield than the construction vessels, and therefore at greater risk of exposure to INNS.

7.8.6.5 As presented in Table 7.14, the risk of introduction and spread of INNS will be increased through the construction period due to the introduction of 1,995,525m^2 of hard substrate from the installation of foundations, associated scour protection and any cable protection.

7.8.6.6 Several INNS have been recorded along the English coast to the east of the Morgan Generation Assets including species such as Wakame *Undaria pinnatifida*, carpet sea squirt *Didemnum vexillum*, Darwin's barnacle *Austrominius modestus*, orange cloak sea squirt *Botrylloides violaceus*, trumpet tubeworm *Ficopotamus enigmaticus* and leathery sea squirt *Styela clava* (North West Wildlife Trust, 2022). The species *F. enigmaticus* is a particular concern as they can become super abundant resulting in a significant biofouling hazard (North West Wildlife Trust, 2022). The government of the Isle of Man have identified that the killer shrimp (*Dikerogammarus villosus*) as well as the carpet sea squirt (*D. vexillum*) are of particular concern (gov.im, 2018).

7.8.6.7 Many of the vessels used during the construction phase of the Morgan Generation Assets are likely to be from the region, therefore, the introduction of species from outside the region is unlikely. Some of the species already in the region however are known to spread as fouling on ships hulls which could result in their introduction into the Morgan Array Area.

7.8.6.8 As a result of the likely movement of vessels around this region it is also possible that INNS which have been identified on the north Wales coast may also spread as a result of the Morgan Generation Assets. There are multiple marine INNS that are now widespread and well established in north Wales. The NBN Atlas Wales (2018) has records of five invasive species along the north Wales coast and in the waters to the north. The most common INNS found on the north Wales coast is the modest barnacle *A. modestus* which is native to New Zealand. Offshore the Chinese diatom *Odontella sinensis* is an INNS of interest to Wales as of August 2020 and can be found offshore all along the Welsh coast. A DEFRA and Marine Strategy Framework Directive database also had a record of the Atlantic Jack-knife clam *Ensis leei* on the north Wales coast; however there has been only one record of this species. The three other INNS (*Antithamnionella spirographidis, Asterocarpa humilis* and *Bonnemaisonia hamifera*) can be found on the west coast of Anglesey around Holyhead port. This distance from any construction activity makes them unlikely to be spread as a result of the Morgan Generation Assets.

7.8.6.9 The carpet sea squirt *D. vexillum* has also been identified in the Holyhead region and is of particular concern. It tends to colonise artificial structures, rocks, boulders and even tide pools. It is usually found in low energy environments where water motion is limited (Gibson-Hall and Bilewitch, 2018). In 2009 an experimental attempt to remove the *D. vexillum* from Holyhead harbour by isolating, smothering and killing the sea squirt using physical (plastic wrapping) and chemical (calcium hypochlorite) methods was documented by Holt and Cordingley (2011). These methods were largely successful following an eight-month treatment period however five months following cessation of removal activities survey work revealed large numbers of very small colonies of *D. vexillum* and rapidly growing larger colonies over a much larger proportion of the marina (Holt and Cordingley, 2011). Further efforts to remove the *D. vexillum* were not pursued. This study highlights the pervasive nature of this species once it is introduced. The slipper limpet *Crepidula fornicata* has also been identified in the north of Cardigan Bay, in the Menai Strait and off the north and west coast of Anglesey. They are typically found attached to shells and stones on sedimentary substrata around the low water mark and the shallow sublittoral (Rayment, 2008). The American piddock *Petricolaria pholadiformis* has also been identified along the north Wales coast. This species is a mechanical borer into hard clay, chalk, solid mud, peat-moss and limestone from the mid-tide level to low water (Budd, 2005).

7.8.6.10 As set out in Table 7.16, an Environmental Management Plan will be implemented for the Morgan Generation Assets, which will aim to manage and reduce the risk of potential introduction and spread of INNS. The plan will outline measures to ensure vessels comply with the IMO ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as specific measures to be adopted in the event that a high alert species is recorded (e.g. carpet sea squirt *D. vexillum*). This will ensure that the risk of potential introduction and spread of INNS will be minimised.

7.8.6.11 The impact is predicted to be of local spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.6.12 The sensitivities of the benthic subtidal IEFs to this impact are presented in Table 7.20 and are based on the information available to inform the MarESA.

7.8.6.13 The subtidal coarse and mixed sediments with diverse benthic communities IEF has been assessed by the MarESA as having a high sensitivity to the introduction of INNS.

Few non-indigenous species are able to colonise mobile sands due to the high level of disturbance (Tillin, 2016a). The assessment however highlights two specific species of concern, the slipper limpet *C. fornicata* which can settle on stones and other hard substrate such as bivalve shells to form dense carpets which smother the underlying bivalves (Tillin, 2016a). Ultimately this may result in a change to the overall substrate type which may make it unsuitable for the settlement of native larvae. The colonial ascidian *D. vexillum* is present in the UK but appears to be restricted to artificial surfaces, this species may, however, have the potential to colonise and smother offshore gravel habitats (Tillin, 2016a). Additionally, although not currently established in UK waters, the whelk *Rapana venosa* may spread to UK habitats from Europe (Tillin, 2016b). Both *C. fornicata* and *D. vexillum* have been identified on the north Wales coast and *C. fornicata* has also been identified on the northwest English coast (only one confirmed sighting near Crosby according to the NBN Atlas), therefore have the potential to extend into this biotope.

7.8.6.14 For the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the MarESA has no evidence to suggest a specific sensitivity however De-Bastos (2016) suggests this habitat could be very sensitive to INNS due to the ecological changes they can create and the difficulty in removing them.

7.8.6.15 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Table 7.20: Sensitivity of the relevant benthic IEFs to introduction or spread of INNS.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure Introduction or spread of INNS	Overall sensitivity (based on Table 7.12)
Subtidal biotopes			
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	No evidence	High
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	High	High

Significance of effect

Subtidal habitat IEFs

7.8.6.16 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the increased risk of introduction and spread of INNS impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This is due to the relatively small proportion of hard substate which may be introduced into the Morgan benthic subtidal ecology study area during the construction phase, and the small uplift in vessel traffic which could facilitate the introduction of INNS. Furthermore measures have been adopted as part of the Morgan Generation Assets to minimise the effects from introduction or spread of INNS.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.8.6.17 The installation of hard substrates and the presence of operations and maintenance vessels may lead to an increased risk of introduction and spread of INNS. The MDS is represented by up to 1,970 vessels return trips per year during the 35 year operations and maintenance phase (Table 7.14). Furthermore, the long term creation of 1,995,525m^2 hard substrate, in the form of jacket foundations, associated scour protection and cable protection/crossings, has the potential to contribute to the introduction and spread of INNS. As outlined in paragraph 7.8.5.3 the estimate for habitat creation is considered to be conservative as the lattice nature of jacket foundations will result in a smaller area of habitat created than has been assumed for a foundation with solid sides in the MDS.

7.8.6.18 Details of INNS of concern in this region are as outlined previously in paragraphs 7.8.6.6 to 7.8.6.9.

7.8.6.19 The removal of encrusted growth may also occur during the operations and maintenance phase; however, no quantitative assessment can be made as the volume of encrusting is not known. Removal of marine growth has the potential to release invasive species if the materials and equipment used in the process have not been properly cleaned after use at a previous location that may have had invasive species present. To control this however an Environmental Management Plan will be implemented to reduce the transmission of species through actions involved in the various phases of the Morgan Generation Assets (Table 7.16). The plan will outline measures to ensure vessels comply with the IMO ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as specific measures to be adopted in the event that a high alert species is recorded (e.g. carpet sea squirt *D. vexillum*). This will ensure that the risk of potential introduction and spread of INNS will be minimised.

7.8.6.20 The impact is predicted to be of local spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.6.21 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.8.6.22 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.8.6.23 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the increased risk of introduction and spread of INNS impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This is due to the relatively small proportion of hard substate which may be introduced into the Morgan benthic subtidal ecology study area during the operations and maintenance phase, and the small uplift in vessel traffic which could facilitate the introduction of INNS. Furthermore measures have been adopted as part of the Morgan Generation Assets to minimise the effects from introduction or spread of INNS.

Decommissioning phase

Magnitude of impact

7.8.6.24 The presence of decommissioning vessels may lead to an increased risk of introduction and spread of INNS. The MDS for the decommissioning phase is for the same number of vessel return trips per year as the construction phase (i.e. 1,878) over up to four years (see Table 7.15). Permanent habitat creation (i.e. persisting post-decommissioning) of up to 1,461,956m^2 due to the presence of scour and cable protection, including cable protection for cable crossings, being potentially left *in situ* (0.15% of the Morgan benthic subtidal ecology study area) may also contribute to an increased risk of introduction and spread of INNS.

7.8.6.25 As set out in Table 7.16, an Environmental Management Plan will be implemented as part of the Morgan Generation Assets, which will aim to manage and reduce the risk of potential introduction and spread of INNS. The plan will outline measures to ensure vessels comply with the IMO ballast water management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as specific measures to be adopted in the event that a high alert species is recorded (e.g. carpet seas squirt *D. vexillum*). This will ensure that the risk of potential introduction and spread of INNS will be minimised.

7.8.6.26 The impact is predicted to be of local spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.6.27 The sensitivity of the IEFs is as described previously for the construction phase assessment in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.8.6.28 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.8.6.29 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the increased risk of introduction and spread of INNS impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This is due to the very small proportion of hard substate which could persist post-decommissioning in the Morgan benthic subtidal ecology study area, and the small uplift in vessel traffic which could facilitate the introduction of INNS. Furthermore, measures have been adopted as part of the Morgan Generation Assets to minimise the effects from introduction or spread of INNS.

7.8.7 Removal of hard substrates

7.8.7.1 The removal of hard substrates associated with the decommissioning of foundations during the decommissioning phase will have a direct effect on benthic subtidal IEFs, with the seabed returning to the predominantly coarse and mixed sediments following removal of structures.

7.8.7.2 The relevant MarESA pressure and benchmark which has used to inform this impact assessment is described here.

- Physical change (to another substratum type): change in sediment type by one Folk class (Long, 2006) (based on UK SeaMap simplified classification) and change from sedimentary or soft rock substrata to hard rock or artificial substrata or vice-versa.

7.8.7.3 This pressure relates to the removal of wind turbine and OSP foundations during the decommissioning phase.

Decommissioning phase

Magnitude of impact

Subtidal habitat IEFs

7.8.7.4 The decommissioning of the Morgan Generation Assets may result in the removal of up to 533,569m^2 of hard substrate associated with the wind turbine and OSP foundations (see Table 7.14), resulting in the loss of the associated colonising communities. This equates to 0.06% of the Morgan benthic subtidal ecology study area.

7.8.7.5 The impact is predicted to be of local spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptors directly. The magnitude is therefore considered to be **low**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.7.6 The removal of wind turbine and OSP foundations during decommissioning would result in localised declines in biodiversity as it would remove any communities which had established themselves on the hard substrate. However, areas of seabed where the Morgan Generation Assets infrastructure was present prior to decommissioning would be expected to recover, with benthic communities in these areas recolonising habitats previously lost beneath the foundations. In time, these communities are predicted to revert to their pre-construction state. Recovery of the IEFs affected is likely to be high as a result of the recovery of their natural habitat (recovery will be similar to the temporary habitat disturbance impact which is described in paragraph 7.8.3.6). A review undertaken by RPS (2019) found communities in coarse and mixed sediments are likely to recover within five years of disturbance (Desprez, 2000; Newell *et al*., 1998; Pearce *et al*., 2007), but in some cases, recovery has been reported as taking up to nine years following cessation of dredging (Foden *et al*., 2009). Sandy sediments are likely to recover from disturbance (e.g. aggregate extraction or dredging) within a shorter time period (e.g. months to 1-2 years; Newell *et al*., 2004). Deeper holes such as those created by foundations may take longer to infill for example at Westernmost Rough Offshore Wind Farm the horizontal directional drilling exit pits which were >2m deep infilled at a rate of up to 1m per year (RPS, 2019). The degree to which these pits infill over time and the rate of infilling, is likely to be site specific and dependant on the direction of sediment transport processes in the vicinity of the project and these factors are shown to be variable over a relatively small area (RPS, 2019).

7.8.7.7 The subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of high vulnerability, high recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.8.7.8 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the removal of hard substrates impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion is based on the ability of these habitats to recover following decommissioning and the small scale of the change in relation to the wider Morgan benthic subtidal ecology study area.

7.8.8 Changes in physical processes

7.8.8.1 Changes in physical processes may arise from the installation of infrastructure into the water column within the Morgan Array Area, including scour effects and changes in the sediment transport and wave regimes resulting in potential effects on benthic receptors. Volume 4, appendix 6.1: Physical processes technical report of the PEIR provides a full description of the modelling used to inform this assessment.

7.8.8.2 The relevant MarESA pressures and benchmarks used to inform this impact assessment are described here.

- Changes in local water flow (tidal current): change in peak mean spring bed flow velocity between 0.1m/s to 0.2m/s for more than one year. The pressure is associated with activities that have the potential to modify hydrological energy flows. This pressure corresponds to the impacts associated with the presence of wind turbine and OSP foundations and cable protection
- Local wave exposure changes: change in nearshore significant wave height > 3% but < 5% for one year. This pressure corresponds to the impacts associated with the presence of wind turbine and OSP foundations and scour protection.

7.8.8.3 These pressures are relevant to the installation of wind turbine and OSP foundations into the water column potentially changing the predominant wave and tidal regime on a small scale.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.8.8.4 The presence of the Morgan Generation Assets infrastructure may obstruct tidal flow and lead to changes in the wave regime. As outlined in Table 7.14, the MDS in terms of hydrographic impacts is for up to 68 wind turbines with 4-legged suction bucket foundations for each jacket leg at 5m diameter and scour protection covering a total footprint of 10,816m^2 per wind turbine. Additionally, the MDS includes four OSP installations with gravity base foundations each with a diameter of 14m at the surface and a slab base 52.5m diameter at the bed. Associated scour protection extends from the slab base by 18.3m at a height of 2.6m giving rise to 6,236m^2 footprint per unit.

7.8.8.5 The parameters in terms of seabed footprint and water column obstruction are similar between each wind turbine unit, as modelled, and each of the four OSP units. Therefore, it is appropriate to infer the impacts on tidal flows due to each of the OSPs would be of the same extent and order of magnitude as those modelled wind turbine sites and to occur at the OSP locations.

7.8.8.6 The results of the modelling presented in volume 4, annex 6.1: Physical processes technical report of the PEIR indicated that peak tidal flows are redirected in the immediate proximity of foundations by a maximum variation of 4cm/s which constitutes less than 3% of the peak flow and reduces significantly with distance from the structures. These changes are also limited to the immediate Morgan Array Area where they 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 variation beyond the immediate vicinity of the Morgan Array Area. Within 500m of the installation, changes are predicted to be <2mm/s which would be indiscernible for baseline conditions and would be reversible on decommissioning. The limited nature of these changes would not significantly influence the tidal regime which underpins sediment transport.

7.8.8.7 Examination of a 1in1 year storm from the west (of greatest influence of approaching storms) shows the deflection of waves by the structures is predicted to result in a reduction in the lee and increases where the waves are deflected either side of each structure. Changes in the wave height are modelled to be in the order of 3.5cm equating to <1% of the baseline significant wave height. For a 1in20 year storm event, the pattern is similar however the change in wave height at the foundations is 3cm. For these scenarios the effect of the presence of the infrastructure is much smaller with changes in wave height typically less than 0.25%.

7.8.8.8 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 1in1 year storm from the north, during the flood tide the wave climate is in concert with tidal flow and the resultant littoral current is reduced in magnitude. The presence of the structures is predicted to have a limited influence on the wave climate and the modelling showed little difference between changes in littoral current magnitude and the tidal flows alone due to the installation during the flood tide. The extent of the change is predicted to be larger for the ebb tide condition particularly at the locations where the alignment of the array is in concert with both the tidal flow and wave direction, although it should be noted that these are still <1% of baseline tidal flow. Overall, the magnitude of these changes remains limited to ±6% of the baseline currents at 300m and reduces significantly with increased distance from each structure.

7.8.8.9 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 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 (volume 4, annex 6.1: Physical processes technical report of the PEIR). 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). The modelling demonstrated that the residual currents, and resulting sediment transport pathways, will adjust to accommodate the structures and the transport pathways will not be cut off.

7.8.8.10 The natural hydrodynamic regime is highly variable throughout the tidal cycles due to meteorological conditions, as a result the scale of the predicted impacts is well within the natural variation. The changes to tidal currents, wave climate, littoral currents, and sediment transport are insignificant in terms of the hydrodynamic regime. It is predicted that there will be no impact on coastal environments. Effects on tidal current and wave climate would be reversible on decommissioning (i.e. following removal of the wind turbine structures).

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

West of Walney MCZ

7.8.8.12 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 western edge of the West of Walney MCZ. However these values amount to changes of less than ±0.025% 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.

7.8.8.13 During a 1in20 year storm from 270º the change in significant wave height on the southwest edge of the West of Walney MCZ may be circa 5mm, similarly. 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*. The effects of changes in physical processes on the West of Walney MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

West of Copeland MCZ

7.8.8.15 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 western edge of the West of Copeland MCZ. However these values amount to changes of less than ±0.025% 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.

7.8.8.16 During a 1in20 year storm from 210º the change in significant wave height at the south boundary of the West of Copeland MCZ is circa 6mm. 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*. The effects of changes in physical processes on the West of Copeland MCZ is also considered within the Morgan Generation Assets MCZ Screening Assessment.

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

Sensitivity of receptor

Subtidal habitat IEFs

7.8.8.18 Subtidal IEFs which are expected to be affected by the changes in physical processes, and the sensitivity of the IEFs to the pressures associated with changes in physical processes, are presented in Table 7.21. These sensitivities are based on assessments made by the MarESA.

7.8.8.19 The representative biotopes of the subtidal coarse and mixed sediments with diverse benthic communities IEF have been identified as not sensitive to the relevant pressures as most of these biotopes are exposed to a variety of tidal regimes. The minimal level of predicted change associated with these impacts makes it highly unlikely these biotopes will be challenged physiologically by these conditions even where specific environmental conditions are required for a biotope. Changes in water flow may alter the topography of the habitat and may cause some shifts in abundance (Tillin, 2016a) resulting in a spatial and demographic shift which is unlikely to lead to any notable changes in these biotopes as a whole. In the Morgan Array Area this IEF occurs subtidally and therefore will not be exposed to any change in wave patterns.

7.8.8.20 The representative biotope for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF has also been assessed by the MarESA as not sensitive to the pressures associated with this impact. The most damaging effect of increased flow rate would be the erosion of the substratum as this could eventually lead to loss of the habitat, primarily by resuspending and preventing deposition of finer particles (Hiscock, 1983). The very low level of change predicted to arise as a result of the Morgan Generation Assets, however, makes this an unlikely outcome (e.g. sand particles are most easily eroded and likely to be eroded at about 0.20m/s (Sundborg, 1956), higher than the levels of change expected from the Morgan Generation Assets). Furthermore, the impact of changes in wave conditions is likely to be low as wave action reduces with depth, and the biotope occurs below 10m where wave mediated flow will be reduced (De-Bastos, 2016).

7.8.8.21 The low resemblance stony reef IEF is assessed as being not sensitive to the relevant pressures because only a substantial decrease in water flow would result in the decline in this biotope. The characteristic fauna of this biotope are predominantly passive filter feeders which require a strong enough current to carry food into their range. They are therefore adapted to moderate tidal streams but maladapted to low level currents. The minimal level of change associated with this impact however makes it unlikely conditions detrimental to this biotope will be produced. Additionally in the Morgan ZOI this IEF occurs subtidally and therefore will not be exposed to any change in wave exposure.

7.8.8.22 The subtidal coarse and mixed sediments with diverse benthic communities IEF, subtidal sand and muddy sand sediments with benthic communities dominated by

Lagis koreni and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore considered to be **negligible**.

West of Walney MCZ

7.8.8.23 The subtidal mud IEF and subtidal sand IEF are assessed by the MarESA as not sensitive to the pressures associated with this impact. The sensitivity of these IEFs is likely to be similar to those expected for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF (paragraph 7.8.8.20). Sand and mud particles can be eroded with increased water flow rates or wave exposure however the characteristic species of this biotope, *Amphiura filiformis, Mysella bidentata* and *Thyasira sp.* has been found in a range of tidal flow rates and *A. filiformis* are capable of changing from filter to deposit feeding depending on the conditions (Ockelmann and Muus, 1978). Furthermore, as these biotopes occurs in circalittoral habitats, they are not directly exposed to the action of breaking waves and therefore unlikely to be affected by changes in wave patterns. The adaptable nature of this community alongside the predicted small scale changes in tidal currents and wave patterns makes it unlikely that these IEFs will be adversely affected.

7.8.8.24 The sea-pens and burrowing megafauna communities IEF is also assessed as not sensitive to changes in wave exposure and it has a high sensitivity to water flow changes. This high sensitivity is due to the specialised nature of this community which is adapted to low energy environments. As water flow rates increase, *Virgularia mirabilis* first responds by swinging polyps around the axial rod to face away from the current. With further increase in flow, the stalk bends over and >0.5m/s tentacles retract, and the stalk retracts into the mud (Hiscock, 1983). In addition, long-term increases in water flow are likely to modify the sediment, removing the fine sediments the sea pens require in favour of sandier, coarser sediments. The predicted small scale changes, especially at the edge of the ZOI for the Morgan Array Area, mean it is unlikely that the habitat and communities will be adversely affected. Wave exposure change is not considered likely to affect this community because this biotope only occurs in wave sheltered environments.

7.8.8.25 The subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore considered to be **negligible**.

7.8.8.26 The sea-pens and burrowing megafauna communities IEF is deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptor is therefore considered to be **high**.

West of Copeland MCZ

7.8.8.27 The sensitivity of the subtidal coarse sediment IEF and subtidal mixed sediment IEF is likely to be the same as the subtidal coarse and mixed sediment IEF (paragraph 7.8.8.19). These IEFs are unlikely to be affected by changes in physical processes as they are found in a variety of conditions and the modelled level of change is very small.

7.8.8.28 The sensitivity of the subtidal sand IEF is the same described for this IEF in the West of Walney MCZ (paragraph 7.8.8.23). This habitat could be adversely affected by an increase in tidal currents which may erode the sediment however the scale of the change which has been modelled to result from the Morgan Generation Assets is unlikely to result in any adverse effect.

7.8.8.29 The subtidal coarse sediment IEF, subtidal mixed sediment IEF and subtidal sand IEF are deemed to not be sensitive and are of national value. The sensitivity of the receptor is therefore considered to be **negligible**.

Table 7.21: Sensitivity of all of the relevant IEFs to changes in physical processes.

IEF	Representative biotope	Sensitivity to defined MarESA pressure		Overall sensitivity (based on Table 7.12)
		Water flow (tidal current) changes (local)	Wave exposure changes (local)	
Subtidal biotopes				
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	Not sensitive	Not sensitive	Negligible
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Not sensitive	Not sensitive	Negligible
Low resemblance stony reef	Cobbles and boulders with indicator species such as *A. digitatum*, *Nemertesia* sp. and *Tubularia* sp. • CR.HCR.XFa.SpNemAdia.	Not sensitive	Not sensitive	Negligible
West of Walney MCZ				
Subtidal mud	Muds and sandy muds in extremely sheltered areas with very weak tidal currents. High numbers of polychaetes, bivalve and echinoderms such as urchins and brittle stars. • SS.SMu.CSaMu.AfilKurAnit	Not sensitive	Not sensitive	Negligible
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit • SS.SMx.CMx.KurThyMx	Not sensitive - Medium	Not sensitive	Negligible
Sea-pen and burrowing megafauna communities	Fine mud heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature with conspicuous populations of sea pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. • SS.SMu.CFiMu.SpnMeg	High	Not sensitive	High
West of Copeland MCZ				
Subtidal coarse sediment	Coarse sand and gravel or shell fragments. Largely characterised by infaunal communities include bristleworms, sand mason worms, burrowing anemones and bivalves. • SS.SCS.CCS	Not sensitive	Not sensitive	Negligible
Subtidal mixed sediment	A range of different types of sediments. Animals found here include worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. • SS.SMx.OMx • SS.SMx.OMx.PoVen	Not sensitive	Not sensitive	Negligible
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit	Not sensitive	Not sensitive	Negligible

Significance of effect

Subtidal Habitat IEFs

7.8.8.30 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF, the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the changes in physical processes impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

West of Walney MCZ

7.8.8.31 Overall, for the subtidal sand IEF and subtidal mud IEF the magnitude of the changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

7.8.8.32 Overall, for the sea-pens and burrowing megafauna communities IEF the magnitude of the changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the small magnitude of physical processes changes associated with the activities in this phase of the project and the distance of this MCZ from these activities.

West of Copeland MCZ

7.8.8.33 Overall, for the subtidal coarse sediment IEF, subtidal mixed sediment IEF and the subtidal sand IEF the magnitude of the changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

7.8.9 Electromagnetic fields from subsea electrical cables

7.8.9.1 The presence and operation of inter-array and interconnector cables within the Morgan Array Area may lead to localised EMF affecting benthic subtidal receptors.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.8.9.2 EMF comprise both the electrical fields, measured in volts per metre (V/m), and the magnetic fields, measured in microtesla (μT) or milligauss (mG). Background measurements of the magnetic field are approximately 50μT for example in Ireland (EIR grid group, 2015). It is common practice to block the direct electrical field using conductive sheathing, meaning that the only EMFs that are emitted into the marine environment are the magnetic field and the resultant induced electrical field. It is generally considered impractical to assume that cables can be buried at depths that will reduce the magnitude of the magnetic field, and hence the sediment-sea water interface induced electrical field, to below that at which these fields could be detected by certain marine organisms on or close to the seabed (Gill *et al*., 2005; Gill *et al*., 2009). By burying a cable, the magnetic field at the seabed is reduced due to the distance between the cable and the seabed surface as a result of field decay with distance from the cable (CSA, 2019). The magnetic field is about 10μT/m with a cable that is buried 1.5m down in the sea floor (Hutchison *et al*., 2021).

7.8.9.3 A variety of design and installation factors affect EMF levels in the vicinity of the cables. These include current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. The flow of electricity associated with an alternating current (AC) cable (proposed for the Proposed Development) changes direction (as per the frequency of the AC transmission) and creates a constantly varying electric field in the surrounding marine environment (Huang, 2005).

7.8.9.4 The strength of the magnetic field (and consequently, induced electrical fields) decreases rapidly horizontally and vertically with distance from source. A recent study conducted by CSA (2019) found that inter-array and export cables buried between depths of 1m to 2m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

7.8.9.5 CSA (2019) investigated the relationship between voltage, current, and burial depth, the results of which are presented in Table 7.22 which shows the magnetic and induced electric field levels expected directly over the undersea power cables and at distance from the cable for inter-array and export cables. Directly above the cable, EMF levels decrease with increasing distance from the seafloor to 1m above the cable, while as you move laterally away from the cable, at distances greater than 3m the magnetic fields at the seafloor and at 1m above the seafloor are comparable.

Table 7.22: Typical EMF levels over AC undersea power cables from offshore wind energy projects (CSA, 2019).

Power Cable Type	Magnetic Field Levels (mT)			
	Directly above cable		3 to 7.5m laterally away from cable	
	1 m above seafloor	At seafloor	1 m above seafloor	At seafloor
Inter-array	0.0005 to 0.0015	0.002 to 0.0065	<0.00001 to 0.0007	<0.00001 to 0.0010
Export cable	0.001 to 0.004	0.002 to 0.0165	<0.00001 to 0.0012	0.0001 to 0.0015
Power Cable Type	**Induced Field Levels (mT)**			
	Directly Above Cable		**3 to 7.5 m laterally away from cable**	
	1 m above seafloor	At seafloor	1 m above seafloor	At seafloor
Inter-array	0.00001 to 0.00012	0.0001 to 0.00017	0.000001 to 0.00009	0.000001 to 0.00011
Export cable	0.00002 to 0.0002	0.00019 to 0.00037	0.000002 to 1.1	0.000004 to 0.00013

7.8.9.6 During the operations and maintenance phase of the Morgan Generation Assets there will be up to 500km of 66kV to 132kV HVAC inter-array cables and up to 60km of 275kV HVAC interconnector cables (Table 7.14). The minimum burial depth for cables will be 0.5m.

7.8.9.7 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility (when the cables cease transmitting electricity post-decommissioning). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.9.8 Gill and Desender (2020) summarised current research on the impact of EMF emissions on organisms and acknowledged that relatively little is known about the effects of EMF on invertebrates such as those common in benthic communities. This is supported by a recent evaluation of knowledge of the impacts of EMF on invertebrates which concluded, globally, no direct impact on survival has been identified in the literature (Hervé, 2021). Furthermore, the methods to assess benthic invertebrates are variable therefore creating the same variability in results, as well as, in some cases, contradiction (Hutchinson *et al*., 2020). Some studies found that benthic communities which grow along cable routes were generally similar to those in the nearby area (Gill and Desender, 2020). These communities however are not exposed to the maximum EMF emissions due to cable burial creating a physical distance between the cable and the seabed surface. The EMF which reaches the surface however is measurable at biologically relevant scales at the seabed and in the water column (Hutchinson *et al*., 2020). Although whether these levels are detectable by benthic species is a topic of research.

7.8.9.9 Experimental evidence has demonstrated that exposure to EMF did not change the distribution of the ragworm *H. diversicolor* (Jakubowska *et al*., 2019). Experimental evidence has however demonstrated magnetoreception in marine molluscs and arthropods and biogenic magnetite has been known to occur in marine molluscs for over five decades (Normandeau, 2011). Magneto-receptive and electro-receptive species have evolved to respond to small changes in the Earth's geomagnetic fields and bioelectric fields making the presence of an EMF more perceivable to receptive species (Hutchinson *et al*., 2020). Reported sensitivities to electric fields for invertebrates range from around 3 mV/cm to 20 mV/cm (Steullet *et al*., 2007). Research conducted on the edible crab *Cancer pagurus* by Scott *et al* (2021) found that EMF strength of 250 µT were found to have limited physiological and behavioural impacts, far above levels expected to be generated from cables from the Morgan Generation Assets. Exposure to 500 µT and 1000 µT were found to disrupt internal stress response and crabs showed a clear attraction to EMF exposed (500 µT and 1000 µT) shelters with a significant reduction in time spent roaming (Scott *et al*, 2021). Further research by Harsanyi et al (2022) examined the effect of EMF on crab (*Cancer pagurus*) and lobster (*Homarus gammarus*) early development. Chronic exposure to 2.8 mT EMF throughout embryonic development resulted in significant differences in stage-specific egg volume and resulted in stage I lobster and zoea I crab larvae exhibiting decreased carapace height, total length, and maximum eye diameter. These traits may ultimately affect larval mortality, recruitment and dispersal. The levels of EMF exposure which is simulated by Harsanyi *et al* (2022) is likely to only be found directly above and a few meters either side of the cable reducing the area this impact could occur over. Normandeau (2011) summarised that, despite these sensitivities, no direct evidence of impacts to invertebrates from undersea cable EMFs exists. What is known about invertebrate sensitivities to EMF does provides some guidance for considering likely significant effects. Likely significant effects would depend on the sensory capabilities of a species, the life functions that it's magnetic or electric sensory systems support, and the natural history characteristics of the species. Life functions supported by the electric and magnetic sense indicate that species capable of detecting magnetic fields face likely significant effects different from those that detect electric fields.

7.8.9.10 The conclusion that the impact of EMF is negligible is popular amongst the international community. For example in Germany The Federal Maritime and Hydrographic Agency stated in its guidance on the design of offshore wind turbines that the expected magnetic field produced by a submarine power cable will be well below the geomagnetic field on the surface, and the effect therefore assumed to be negligible (Olsson *et al*., 2010). Similar conclusions have been drawn in Sweden and Norway (Olsson *et al*., 2010).

7.8.9.11 Shellfish which also inhabit the sea floor, are anticipated to be more sensitive to EMF. Scott *et al*. (2021), investigated the effects of different strength EMF exposure on the commercially important edible crab *Cancer pagurus*. This investigation measured stress related parameters as well as behavioural and response parameters over a 24-hour period. The results of this investigation indicated that exposure to 500 µT and 1,000µT were found to attract crabs, limiting their time spent roaming as well as disrupt some stress related parameters leading to increased physiological stress when exposed to EMF of 500µT or above. These results however are not directly applicable to the cables used in the Morgan Generation Assets as the magnetic field levels tested are an order of magnitude higher than what you would expect for a buried cable such as those at the Morgan Generation Assets. Effects of EMF on shellfish receptors are fully considered in volume 2, chapter 8: Fish and shellfish ecology of the PEIR.

7.8.9.12 Research regarding the impact of EMF on invertebrates still has a number of knowledge gaps which hinder the ability to fully understand the effects. Hervé (2021) identifies that establishing the impact on groups such as Molluscs is highly underdeveloped, the impact on species relative to the strength of the EMF as well as the impact of different types of cable are key knowledge gaps.

7.8.9.13 In summary, the current literature suggests that EMF influenced behavioural and physiological effects in benthic invertebrates, if any are observed, will be closely related to the proximity of the individual to the source. Despite this, and due to the low confidence in the assessment of sensitivity due to a lack of data, a precautionary approach has been taken to the conclusion of sensitivity below.

7.8.9.14 The subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of low vulnerability (recoverability is not applicable to this impact) and national value. The sensitivity of the IEFs is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.8.9.15 Overall, for the subtidal coarse and mixed sediment with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the EMF from subsea cables impact in the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached due to the limited effects associated with EMF which have been described only affecting a small group of organisms as well as the small area over which potentially EMF effects will occur.

7.8.10 Heat from subsea electrical cables

7.8.10.1 The presence and operation of inter-array and interconnector cables within the Morgan Array Area may lead to localised heating of seabed affecting benthic subtidal receptors.

7.8.10.2 The benchmark for the relevant MarESA pressure which has been used to inform this impact assessment is described here.

- Temperature increase (local): An increase of 5°C for one month, or 2°C for one year.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.8.10.3 Submarine power cables such as those to be installed for the Morgan Generation Assets generate heat through resistive heating. It is caused by energy loss as electrical currents flow and leads to the heating of the cable surface and the warming of the surrounding environment. High voltage cables are used to minimise the amount of energy lost as heat which in turn minimises the environmental warming effect.

7.8.10.4 Where submarine power cables are buried, the surrounding sediment may be heated. The cables, however, have negligible capability to heat the overlying water column because of the very high heat capacity of water (the amount of energy needed to result in a temperature change). There is little research on the heat dissipation effect resulting from subsea cables in the field as well as its effect on benthic receptors. Meißner *et al*. (2007) conducted a field study at Nysted Offshore Windfarm in Denmark. This study tested the difference in sediment temperature between a control site and a site 25cm away from the cable. Results showed a 2°C maximum difference between sites with a mean difference of 1°C, with similar results for a HVAC 33kV cable and HVAC 132kV cable (low and high voltage cables respectively).

7.8.10.5 Additionally the impact of seabed temperature rise as a result of buried cables has been considered during a project to bury a submarine High Voltage Direct Current (HVDC) cable between New England and Long Island, New York. The project estimated that the rise in temperature at the seabed immediately above the buried cable to be just 0.19°C (BERR, 2008). The seasonal temperature range in the Irish Sea is 11°C – 5°C (Howarth, 2004), therefore any change similar to those observed by the previously described studies would fall within the natural seasonal variation of this region. Furthermore, the effects of climate change are likely to result in higher average temperatures being the norm.

7.8.10.6 A number of environmental factors have been identified which change the way that heat from subsea cables will dissipate. One of them being the nature of sediment that the cable is buried in. A lab-based study by Emeana *et al.* (2016) investigated the thermal regime around high voltage submarine cables using a heat source in a large tank to simulate seafloor conditions. The research identified that when the heat source was buried in fine clay/silt sediments it had a conductive heat transfer mode, only raising temperatures in the immediate radius of the cable. When the heat source was buried in fine permeable sands they observed convective heat transfer when the heat sources surface temperature reached over 20°C above the ambient temperature resulting in temperature change up to 1m above the heat sources surface (when the heat source was buried at 1m). In coarse sands convection occurred at a lower temperature (>9°C) and increases in fluid temp were detectable over 1m above the heat sources surface. This study however was conducted in a laboratory without the influence of water flow which, in an offshore environment, would quickly dissipate the effects of heat emissions (Worzyk, 2009).

7.8.10.7 During the operations and maintenance phase of the Morgan Generation Assets there will be up to 500km of 66kV to 132kV HVAC inter-array cables and up to 60km of 275kV HVAC interconnector cables (Table 7.14). The minimum burial depth for cables will be 0.5m.

7.8.10.8 The impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility (when the cables cease transmitting electricity post-decommissioning). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Sensitivity of receptor

Subtidal habitat IEFs

7.8.10.9 The sensitivities of the benthic subtidal IEFs to this impact are presented in Table 7.23 and based on the information available to inform the MarESA.

7.8.10.10 The sensitivity of the subtidal coarse and mixed sediments with diverse benthic communities IEF representative biotopes is based on the thermal limits of their characteristic benthic species. For example the characterising bivalve *Timoclea ovata* has a wide distribution from northern Norway and Iceland south to west Africa. It is also recorded from the Canary Islands, the Azores and the Mediterranean and Black Sea (Morton, 2009) adapting to the temperature regime at each location as well as local seasonal variations. Temperature cues influence the timing of gametogenesis and spawning in several species present in the biotope. Many polychaete species including *Mediomastus fragilis, Owenia fusiformis* and *Protodorvillea kefersteini* recruit in spring/early summer recruitment (Sardá *et al*., 1999). As the sediment temperature change expected in relation to the presence of cables is anticipated to be minimal and within the thermal range of species residing in UK waters it is unlikely that there will be any notable effects on the characteristic species and therefore the biotopes as a whole.

7.8.10.11 The sensitivity of the representative biotope of the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is assessed as low by the MarESA. The characteristic species of this biotope, *Lagis koreni* and *Phaxas pellucidus*, both have a wide distribution and are likely to be found in the north and south of the UK where typical surface water temperatures vary seasonally from 4-19°C (Huthnance, 2010). Elevated temperatures may affect growth of some of the characterising species, but no mortality is expected (De-Bastos, 2016). It is therefore likely that *Lagis koreni* and *Phaxas pellucidus* are able to resist a long-term increase in temperature of 2°C (De-Bastos, 2016) which is well within the potential temperature rise which may result from offshore subsea cables.

7.8.10.12 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of low vulnerability, high recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **low**.

Table 7.23: Sensitivity of the relevant benthic IEFs to heat from cables.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure Temperature increase (local)	Overall sensitivity (based on Table 7.12)
Subtidal biotopes			
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SMu.CSaMu.LkorPpel.	Low	Low
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Not sensitive - Low	Low

Significance of effect

Subtidal habitat IEFs

7.8.10.13 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the heat from electrical cables impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This significance has been determined due to the highly localised and very low levels of heat which are expected from the cables, creating conditions well within the natural variability experienced by the characteristic communities of these IEFs.

7.8.11 Future monitoring

7.8.11.1 No benthic subtidal ecology monitoring to test the predictions made within the impact assessment is considered necessary.

7.9 Cumulative effect assessment methodology

7.9.1 Methodology

7.9.1.1 The Cumulative Effects Assessment (CEA) takes into account the impacts associated with the Morgan Generation Assets together with 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 PEIR). 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.

7.9.1.2 The benthic subtidal ecology CEA methodology has followed the methodology set out in volume 1, chapter 5: EIA methodology of the PEIR. As part of the assessment, all projects and plans considered alongside the Morgan Generation Assets have been allocated into 'tiers' reflecting their current stage within the planning and development process, these are listed below.

7.9.1.3 A tiered approach to the assessment has been adopted, as follows:

- Tier 1
  - 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 on-going impact
- Tier 2
  - Scoping report has been submitted and is in the public domain
- Tier 3
  - 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.

7.9.1.4 This tiered approach is adopted to provide a clear assessment of the Morgan Generation Assets alongside other projects, plans and activities.

7.9.1.5 The specific projects, plans and activities scoped into the CEA, are outlined in Table 7.24.

7.9.1.6 A number of the impacts considered for the Morgan Generation Assets alone, as outlined in Table 7.14 and section 7.7, have not been considered within the CEA due to the localised and temporally restricted nature of these impacts. These impacts include:

- Disturbance/remobilisation of sediment-bound contaminants
- EMF from subsea electrical cabling
- Heat from subsea electrical cables.

Table 7.24: List of other projects, plans and activities considered within the CEA.

Project/Plan	Status	Distance from the Morgan array area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Morgan Generation Assets	-	-	-	**Q1 2026 – Q4 2029**	**Q1 2030 – Q4 2065**	-
Tier 1						
Offshore renewables projects						
Walney (3 and 4) Extension Offshore Wind Farm	Operational (with ongoing activities)	7.6	Up to 659MW (87 wind turbines)	2015 - 2018	2018 – 3038	The operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney 2 Offshore Wind Farm	Operational (with ongoing activities)	11.9	Up to 367MW (51 wind turbines)	2010 - 2012	2012 - 2032	The operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney 2 Offshore Wind Farm Operational Marine Licence - composite operations and maintenance activities (MLA/2017/00429/1)	Operational	11.9	Operations and maintenance events including removal of marine growth and/ or guano from substation, export cable repair events, with associated anchoring/jacking-up/vessel beaching, remediation events (via jetting and/or mass flow excavator) of up to 7 km length per event, potential jacking-up to and removal and/or replacement of cable/scour protection and deployment of additional cable protection adjacent to existing cable protection to resolve secondary scour issues.	n/a	2018 - 2038	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney 1 and 2 Offshore Wind Farms Operational Marine Licence - operations and maintenance activities (MLA/2016/00151/3)	Operational	11.9	Covers licensable O&M activities to be carried out as and when required over the lifetime of the wind farms.	n/a	2016 - 2032	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney Extension pontoon/jetty dredging and disposal (DC10142)	Operational	15.1	A Marine Licence is being sought for dredging and associated disposal activities for the Walney Extension Offshore Wind Farm operations and maintenance base at the Port of Barrow.	n/a	2019 - 2029	The operations and maintenance phase of this project will overlap with the construction phase of the Morgan Generation Assets.
West of Duddon Sands Offshore Wind Farm	Operational (with ongoing activities)	15.2	Up to 389MW (108 wind turbines)	2012 - 2014	2014 - 2034	The operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
West of Duddon Sands Offshore Wind Farm Operational Marine Licence operations and maintenance activities (MLA/2016/00150/3)	Operational	15.2	Covers licensable operations and maintenance activities to be carried out as and when required over the lifetime of the wind farm.	n/a	2016 - 2037	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney 1 Offshore Wind Farm	Operational (with ongoing activities)	15.5	Up to 367MW (51 wind turbines)	2010 - 2011	2011 - 2031	The operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney Offshore Wind Farm Operational Marine Licence - inter array cable repair (MLA/2013/00426/2)	Operational	15.5	Emergency inter array cable repairs over the operational life time of the Walney Offshore Wind Farm (1 and 2). To ensure adequate contingency plans are in place to react to a major breakage/fault in an inter array cable.	n/a	2018 - 2032	Cable repair/remediation activities associated with this project overlaps with the construction and operations and maintenance phases of the Morgan Generation Assets.

Project/Plan	Status	Distance from the Morgan array area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Walney Offshore Wind Farm Operational Marine Licence - phase 2 export cable (MLA/2014/00027/7)	Operational	16.8	Emergency export cable repairs over the operational life time of the Walney Offshore Wind Farm export cables (2) to ensure adequate contingency plans are in place to react to a major breakage/fault within a reasonable period of time.	n/a	2014 - 2027	Cable repair/remediation activities associated with this project overlaps with the construction and operations and maintenance phases of the Morgan Generation Assets.
Walney Offshore Wind Farm Operational Marine Licence - phase 1 export cable (MLA/2014/00028/5)	Operational	19.6	Emergency export cable repairs over the operational life time of the Walney Offshore Wind Farm export cables (2) to ensure adequate contingency plans are in place to react to a major breakage/fault in a reasonable period of time.	n/a	2014 - 2027	Cable repair/remediation activities associated with this project overlaps with the construction phase of the Morgan Generation Assets.
Walney Offshore Wind Farm Operational Marine Licence - composite operations and maintenance activities (MLA/2017/00081/2)	Operational	19.6	For future cable repair/remediation/protection works on the Walney 1 export cable and also for potential repair works on the Walney 1 Offshore Substation Platform.	n/a	2017 - 2037	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Ormonde Offshore Wind Farm	Operational (with ongoing activities)	23.3	Up to 150MW (30 wind turbines)	2009 - 2010	2011 - 2036	The operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Ormonde Offshore Wind Farm Operational Marine Licence - operations and maintenance activities (MLA/2016/00224/2)	Operational	23.3	Operations and maintenance activities to be carried out as and when required over the lifetime of the wind farm.	n/a	2017 - 2037	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Barrow Offshore Wind Farm	Operational (with ongoing activities)	30.0	Up to 90MW (30 wind turbines)	2004 - 2006	2006 - 2026	The operations and maintenance and decommissioning phases of this project will overlap with the construction phase of the Morgan Generation Assets.
Barrow Offshore Wind Farm Operational Marine Licence - operations and maintenance (MLA/2016/00149/3)	Operational	30.0	This licence permits a number of operations and maintenance activities including - Removal of marine growth and/or guano - Replacement of access ladders	n/a	2016 - 2026	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Barrow Offshore Wind Farm Operational Marine Licence - export cable repair and remediation (MLA/2015/00077)[5]	Operational	34.66	5 x cable repair events, with associated jacking-up; and 10 x cable remediation events (via jetting).	n/a	2015 - 2030	Cable repair/remediation activities associated with this project overlaps with the construction and operations and maintenance phases of the Morgan Generation Assets.
Awel y Môr Offshore Wind Farm	Application Submitted	47.24	Up to 100MW (48 to 91 wind turbines)	2026 - 2030	2030 - 2055	The construction, operations and maintenance and decommissioning phases of this project will overlap with the construction and operations and maintenance of the Morgan Generation Assets.

[5] MMO marine licence case reference

Project/Plan	Status	Distance from the Morgan array area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Routine operations and maintenance activities at five OSPs (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands) (MLA/2017/00100/1)	Operational	49.9	Repainting of offshore structures, removal of algal growth/bird guano and removal of growth around J Tubes.	n/a	2017 - 2038	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Dredging activities and dredge disposal sites						
Douglas Harbour, Isle of Man	Operational (with ongoing activities)	22.7	Dredging to deepen harbour channels and capital dredging in front of the proposed terminal to create a berth pocket.	n/a	2016 - 2031	Dredging and disposal activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Castletown Bay, Isle of Man	Operational (with ongoing activities)	29.5	Dredging to deepen harbour channels and capital dredging in front of the proposed terminal to create a berth pocket.	n/a	2016 -2026	Dredging and disposal activities associated with this project will overlap with the construction phase of the Morgan Generation Assets.
Port of Barrow maintenance dredging disposal licence (MLA/2015/00458/1)	Operational (with ongoing activities)	35.9	Dredging is required to maintain the Port of Barrow and its approach channel at its advertised navigational depth for all vessels entering and leaving the port.	n/a	2016 -2026	Dredging and disposal activities associated with this project will overlap with the construction phase of the Morgan Generation Assets.
West of Duddon Sands Pontoon Dredging Marine Licence	Operational (with ongoing activities)	38.4	Sedimentation can cause the pontoon edge adjacent to the harbour wall to be raised during spring low tides. The scope of the marine licence application covers dredging which will be required annually based on the current observed rates of accumulation.	n/a	2018 - 2028	The operations and maintenance activities associated with this project will overlap with the construction phase of the Morgan Generation Assets.
Annual Maintenance Dredging Peel Harbour Isle of Man	Operational (with ongoing activities)	39.7	Capital harbour dredging, and maintenance dredging. Extracted amount: 400,000m^3 annually.	n/a	2022 - 2037	The operations and maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Mersey channel and river maintenance dredge disposal renewal (MLA/2021/00202)	Operational (with ongoing activities)	44.5	The Mersey Docks and Harbour Company Ltd, as the Harbour Authority for the Port of Liverpool has an obligation to dredge the approaches to Liverpool in order to maintain navigation into the Mersey Estuary for all river users.	n/a	2021 - 2031	Dredging and disposal activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Liverpool 2 and River Mersey Approach Channel Dredging	Operational (with ongoing activities)	44.5	Capital dredging in front of the proposed terminal to create a berth pocket.	n/a	2019 - 2028	The operations and maintenance activities associated with this project will overlap with the construction phase of the Morgan Generation Assets.
Heysham 1 & 2 dredging activities	Operational (with ongoing activities)	47.8	Maintenance at cooling water outflows for nuclear power station. Dredging of up to 150,000m^3 silt and 6000,000m^3 sand. Disposal of up to 28,000m^3 per year.	n/a	2017 - 2027	The operations and maintenance activities associated with this project will overlap with the construction phase of the Morgan Generation Assets.

Project/Plan	Status	Distance from the Morgan array area (km)	Description of project/plan	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with the Morgan Generation Assets
Remedial works						
Isle of Man to UK Interconnector Cable - maintenance and repair (MLA/2016/00211)	Operational	0	This licence is for depositing additional armouring or protection whilst carrying out contingency repair and maintenance works on the Isle of Man interconnector cable.	n/a	2018 - 2033	Maintenance activities associated with this project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.
Isle of Man Interconnector Cable - Cable Protection Remedial Works (MLA/2014/00201)	Operational	6.8	Maintenance works on the Isle of Man Interconnector cable protection.	n/a	2014 - 2065	Project operational phase overlaps with the Morgan Generation Assets construction and operations and maintenance phases.
Tier 2						
Offshore renewables projects						
Mona Offshore Wind Project	Pre-application	5.5	1.5GW (Up to 107 wind turbines)	2028 - 2029	2030 - 2065	The construction, operations and maintenance and decommissioning phases of this project will overlap with the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets.
Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets)	Pre-application	11.2	12 -24MW (Up to 40 wind turbines)	2026 - 2028	2029 -2089	The construction, operations and maintenance and decommissioning phases of this project will overlap with the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets.
Cables and pipelines						
Morgan and Morecambe Transmission Assets (scoping search area)	Pre- application	11.24	Morgan Transmission Assets	2028 - 2029	2030 - 2065	Project construction phase overlaps with Morgan Generation Assets construction phase.
Tier 3						
Cables and pipelines						
MaresConnect – Wales-Ireland Interconnector Cable	Permitted but not yet implemented	48.2	A proposed 750MW subsea and underground electricity interconnector system linking the existing electricity grids in Ireland and Great Britain.	2025	2027 - 2037	This project will overlap with the construction and operations and maintenance phases of the Morgan Generation Assets.

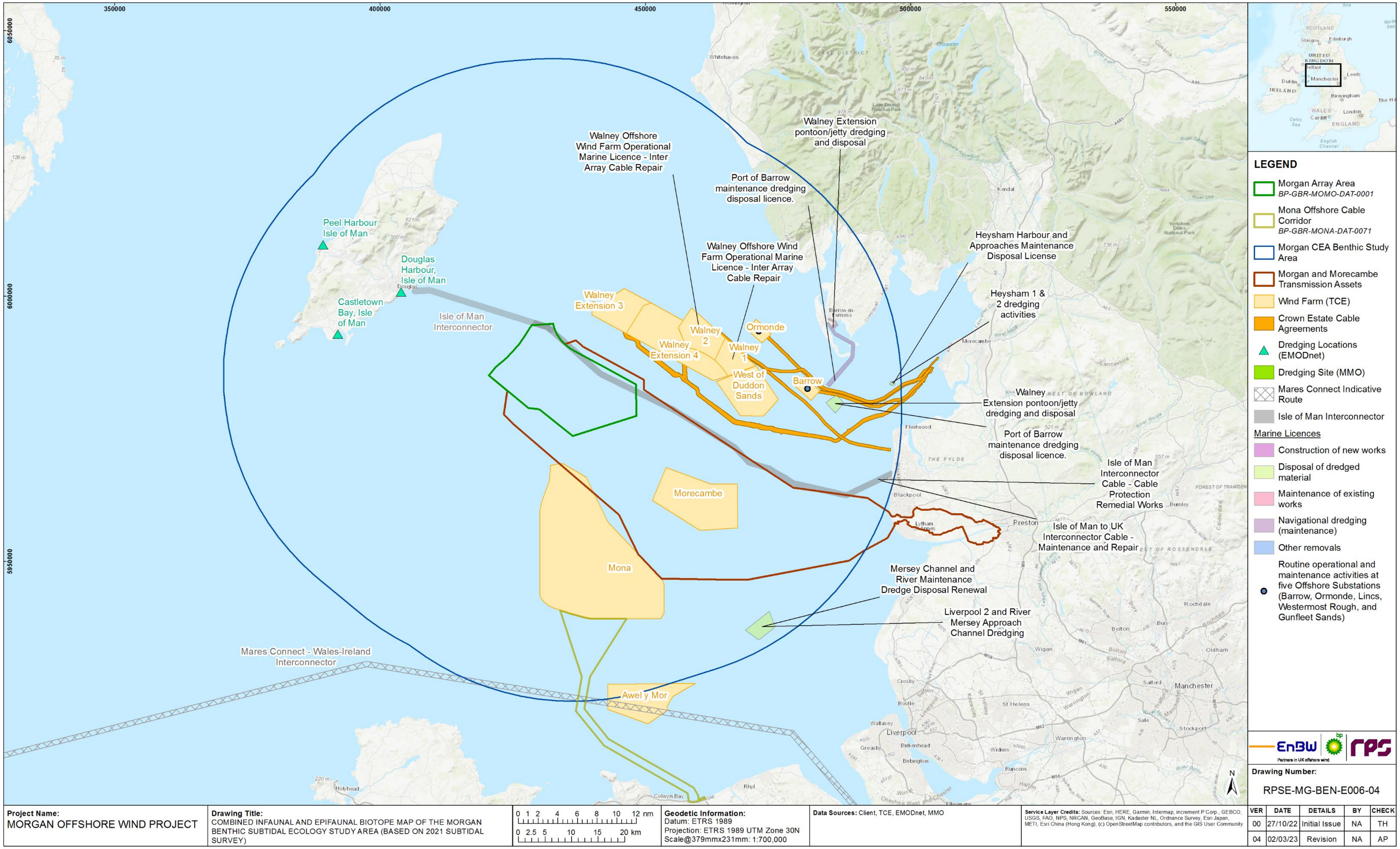


Figure 7.6: Other projects, plans and activities screened into the cumulative effects assessment.

7.9.2 Maximum design scenario

7.9.2.1 The MDSs identified in Table 7.25 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. 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 PEIR as well as the information available on other projects and plans, in order to inform a 'maximum design scenario'. 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 7.25: Maximum design scenario considered for the assessment of potential cumulative effects on benthic subtidal ecology.

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

Potential cumulative effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
Temporary habitat disturbance/loss	✓	×	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore Wind Farm projects: – Walney Extension Offshore Wind Farm operations and maintenance phase – Walney 2 Offshore Wind Farm operations and maintenance phase – Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1) – Walney Extension pontoon/jetty dredging and disposal – West of Duddon Sands Offshore Wind Farm operations and maintenance phase – West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3) – Walney 1 Offshore Wind Farm operations and maintenance phase – Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3) – Ormonde Offshore Wind Farm operations and maintenance phase – Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2) – Barrow Offshore Wind Farm operations and maintenance and decommissioning phases – Barrow Offshore Wind Farm – operations and maintenance marine licences (MLA/2015/00077 and MLA/2016/00149/3) – Awel y Môr Offshore Wind Farm construction phase – Routine operations and maintenance activities at five OSPs (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands) • Dredging projects: – Douglas Harbour, Isle of Man – Castletown Bay, Isle of Man – Port of Barrow maintenance dredging disposal licence – West of Duddon Sands pontoon dredging marine licence – Annual maintenance dredging Peel Harbour Isle of Man – Mersey channel and river maintenance dredge disposal renewal – Liverpool 2 and River Mersey approach channel dredging – Heysham 1 and 2 dredging activities • Remedial works – Isle of Man to UK Interconnector Cable - maintenance and repair (MLA/2016/00211 and MLA/2014/00201/2) **Tier 2** • Tier 1 projects • Offshore Wind Farm projects: – Mona Offshore Wind Project construction phase	These projects all involve activities which will result in temporary habitat disturbance/loss which may contribute to the impact upon a habitat that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase C	Phase O	Phase D	Maximum Design Scenario	Justification
				– Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) construction and operations and maintenance phases • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) construction phase **Tier 3** • Tier 1 and 2 projects • Cables and pipelines: – MaresConnect construction and operations and maintenance	
	×	✓	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore Wind Farm projects: – Walney Extension Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 2 Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1) – West of Duddon Sands Offshore Wind Farm operations and maintenance and decommissioning phases – West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3) – Walney 1 Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3) – Ormonde Offshore Wind Farm operations and maintenance and decommissioning phases – Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2) – Awel y Môr Offshore Wind Farm operations and maintenance and decommissioning phases – Routine operations and maintenance activities at five Offshore Substations (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands) • Dredging projects: – Douglas Harbour, Isle of Man – Annual maintenance dredging Peel Harbour Isle of Man – Mersey channel and river maintenance dredge disposal renewal • Remedial works – Isle of Man to UK Interconnector Cable - maintenance and repair (MLA/2016/00211 and MLA/2014/00201/2) **Tier 2** • Tier 1 projects • Offshore Wind Farm projects: – Mona Offshore Wind Project operations and maintenance phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) operations and maintenance phase • Cables and pipelines:	These projects all involve activities which will result in temporary habitat disturbance/loss which may contribute to the impact upon a habitat that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase C	Phase O	Phase D	Maximum Design Scenario	Justification
				– Morgan and Morecambe Transmission Assets (scoping search area) operations and maintenance phase **Tier 3** • Tier 1 and 2 projects • Cables/pipelines: – MaresConnect operations and maintenance phase	
	×	×	✓	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** There are no tier 1 projects operational in this phase of the Morgan Generation Assets. **Tier 2** • Tier 1 projects • Offshore wind farm projects: – Mona Offshore Wind Project decommissioning phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) operations and maintenance phase • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) decommissioning phase	These projects all involve activities which will result in temporary habitat disturbance/loss which may contribute to the impact upon a habitat that the Morgan Generation Assets will also affect.
Increase in SSC and associated deposition	✓	×	×	MDS as described for the Morgan Generation Assets Table 7.14 assessed cumulatively with the following other projects/plans: **Tier 1** • 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 • Use of Walney Extension pontoon/jetty dredging and disposal site **Tier 2** • Tier 1 Projects • Construction of Mona Offshore Wind Project • Construction of Morecambe Offshore Windfarm Generation Assets • Construction of the Morgan and Morecambe Transmission Assets	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 impact the tidal/ wave regime and sediment transport 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 C	Phase O	Phase D	Maximum Design Scenario	Justification
	×	✓	×	**Tier 1** • 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 • Use of Walney Extension pontoon/jetty dredging and disposal site **Tier 2** • Tier 1 Projects • Maintenance of Mona Offshore Wind Project • Maintenance of Morecambe Offshore Windfarm Generation Assets • Maintenance of the Morgan and Morecambe Transmission Assets	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 impact the tidal/ wave regime and sediment transport during the temporal overlap with the Morgan Generation Assets phases have been included as these may create a cumulative impact on physical features/ receptors.
	×	×	✓	**Tier 1** • Use of Walney Extension pontoon/jetty dredging and disposal site **Tier 2** • Tier 1 Projects • Mona Offshore Wind Project residual structures • Morecambe Offshore Windfarm Generation Assets residual structures	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 impact the tidal/ wave regime and sediment transport during the temporal overlap with the Morgan Generation Assets phases have been included as these may create a cumulative impact on physical features/ receptors.
Long term habitat loss	✓	✓	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore wind farm projects: – Awel y Môr Offshore Wind Farm **Tier 2** • Tier 1 projects • Offshore wind farm projects: – Mona Offshore Wind Project – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) **Tier 3** • Tier 1 and 2 projects • Cables and pipelines: – MaresConnect	These projects will all result in the installation of hard structures on the seabed which will lead to long term habitat loss within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
	×	×	✓	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** No tier 1 projects are predicted to overlap with the decommissioning phase of the Morgan Generation Assets. **Tier 2** • Offshore wind farm projects: – Mona Offshore Wind Project – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area)	These projects will all result in the installation of hard structures on the seabed which will lead to long term habitat loss within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.
Colonisation of hard substrates	×	✓	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore wind farm projects: – Awel y Môr Offshore Wind Farm – **Tier 2** • Tier 1 projects • Offshore wind farm projects: – Mona Offshore Wind Project – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) **Tier 3** • Tier 1 and 2 projects • Cables/pipelines: – MaresConnect	These projects will all result in the installation of hard structures on the seabed which could be colonised by new communities within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
Increased risk of introduction and spread of INNS	✓	×	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore Wind Farm projects: – Walney Extension Offshore Wind Farm operations and maintenance phase – Walney 2 Offshore Wind Farm operations and maintenance phase – Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1) – Walney Extension pontoon/jetty dredging and disposal – West of Duddon Sands Offshore Wind Farm operations and maintenance phase – West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3) – Walney 1 Offshore Wind Farm operations and maintenance phase – Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3) – Ormonde Offshore Wind Farm operations and maintenance phase – Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2) – Barrow Offshore Wind Farm operations and maintenance and decommissioning phases – Barrow Offshore Wind Farm – operations and maintenance marine licences (MLA/2015/00077 and MLA/2016/00149/3) – Awel y Môr Offshore Wind Farm construction phase – Routine operations and maintenance activities at five OSPs (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands) **Tier 2** • Tier 1 projects • Offshore Wind projects: – Mona Offshore Wind Project construction phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) construction and operations and maintenance phase • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) **Tier 3** • Tier 1 and 2 projects • Cables/pipelines: – MaresConnect	These projects will all result in the installation of hard structures on the seabed which could be colonised by new communities composed of INNS within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
	×	✓	×	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** • Offshore Wind Farm projects: – Walney Extension Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 2 Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1) – West of Duddon Sands Offshore Wind Farm operations and maintenance and decommissioning phases – West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3) – Walney 1 Offshore Wind Farm operations and maintenance and decommissioning phases – Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3) – Ormonde Offshore Wind Farm operations and maintenance and decommissioning phases – Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2) – Awel y Môr Offshore Wind Farm operations and maintenance and decommissioning phases – Routine operations and maintenance activities at five Offshore Substations (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands) **Tier 2** • Offshore Wind Farm projects: – Mona Offshore Wind Project operations and maintenance phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) operations and maintenance phase • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) **Tier 3** • Tier 1 projects • Cables/pipelines: – MaresConnect	These projects will all result in the installation of hard structures on the seabed which could be colonised by new communities composed of INNS within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.

Potential cumulative effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
	×	×	✓	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** No tier 1 projects are predicted to overlap with the decommissioning phase of the Morgan Generation Assets. **Tier 2** • Tier 1 projects • Offshore wind farm projects: – Mona Offshore Wind Project decommissioning phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) operations and maintenance phase • Cables and pipelines: – Morgan and Morecambe Transmission Assets (scoping search area) decommissioning phase	These projects will all result in the installation of hard structures on the seabed which could be colonised by new communities composed of INNS within the CEA benthic subtidal ecology study area meaning they may also affect habitats that the Morgan Generation Assets will also affect.
Removal of hard substrate	×	×	✓	MDS as described for the Morgan Generation Assets (Table 7.14) assessed cumulatively with the following other projects/plans: **Tier 1** No tier 1 projects are predicted to overlap with the decommissioning phase of the Morgan Generation Assets. **Tier 2** • Offshore wind farm projects: – Mona Offshore Wind Project decommissioning phase – Round 4 Preferred Project 5 (Morecambe Offshore Windfarm Generation Assets) operations and maintenance phase	These projects will also undergo the removal of hard substrate within the period of decommissioning for the Morgan Generation Assets.
Changes in physical processes.	×	✓	×	**Tier 1** There are no tier 1 projects associated with this impact. **Tier 2** • Tier 1 Projects • Operations and maintenance of Mona Offshore Wind Project • Operations and maintenance of Morecambe Offshore Windfarm Generation Assets • Operations and maintenance of Morgan and Morecambe Transmission Assets	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 operations and maintenance phase. Activities from schemes that potentially impact the tidal/ wave regime and sediment transport during the temporal overlap with the Morgan Generation Assets phases have been included as these may create a cumulative impact on physical features/ receptors.

7.10 Cumulative effects assessment

7.10.1.1 A description of the significance of cumulative effects upon benthic subtidal ecology receptors arising from each identified impact is given below.

7.10.2 Temporary habitat loss/disturbance

7.10.2.1 There is the potential for cumulative temporary habitat loss as a result of construction activities associated with the Morgan Generation Assets and other offshore wind farms (i.e. from cable burial, jack-up activities, anchor placements and seabed preparation), dredging activities, aggregate extraction activities, cables and pipelines and remedial work (see Figure 7.6). For the purposes of this PEIR, this additive impact has been assessed within the CEA benthic subtidal ecology study area, defined as the area within a 50km buffer of the Morgan Generation Assets, using the tiered approach outlined above in paragraph 7.1.3.1. The 50 km buffer area captures a fair representation of benthic habitats within the Morgan CEA benthic subtidal ecology study area in proximity to the Morgan Generation Assets.

7.10.2.2 All plans/projects/activities screened into the assessment for cumulative effects from temporary habitat loss/disturbance are either on-going activities (i.e. licensed and application aggregate extraction areas) or other offshore wind farms which are consented, submitted or under construction (i.e. tier 1). Three tier 2 projects (Mona Offshore Wind Project, Morecambe Offshore Wind Project and Morgan and Morecambe Transmission Assets) and one tier 3 project (MaresConnect) have been identified within the CEA benthic subtidal ecology study area.

<u>Tier 1</u>

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.10.2.3 Predicted cumulative temporary habitat loss/disturbance from each of the tier 1 plans/projects/activities during the construction phase of the Morgan Generation Assets is presented in Table 7.26 together with a breakdown of the sources of this data from the relevant Environmental Statements and any assumptions made where necessary information was not presented in these Environmental Statements. Table 7.26 shows that for all projects/plans/activities in the tier 1 assessment, the cumulative temporary habitat loss/disturbance during the construction phase of the Morgan Generation Assets is estimated at 103.63km^2 (including the Morgan Generation Assets).

7.10.2.4 The maximum total temporary habitat loss/disturbance associated with all tier 1 offshore wind farms (i.e. construction of the Awel y Môr Offshore Wind Farm, maintenance and decommissioning of the Barrow Offshore Wind Farm and the operations maintenance phases for the other offshore wind farm projects) within the CEA benthic subtidal ecology study area is 12.05km^2. The values of temporary habitat loss for Morgan Generation Assets are comparably larger than for many of the other offshore wind farms presented in Table 7.26, as the Morgan Generation Assets assessment includes habitat affected as a result of seabed preparation and all of the construction activities while most of the tier 1 projects will be in their operations and maintenance phases during the construction phase of the Morgan Generation Assets.

7.10.2.5 Temporary habitat loss/disturbance from tier 1 dredge and disposal activities is likely to result in intermittent disturbance throughout the licenced periods resulting in the disturbance of approximately 4.22km^2 of seabed over the construction period and potentially beyond (Table 7.26). There are also a number of dredge licences without readily available environmental information (i.e. West of Duddon Sands Pontoon Dredging Marine Licence, Annual Maintenance Dredging Peel Harbour Isle of Man, Douglas Harbour dredging Isle of Man and Heysham 1 and 2 dredging activities; see Table 7.26). The dredging is however of a small scale, at port locations at the edge of the CEA benthic subtidal study area, and likely to be short term and intermittent throughout the Morgan Generation Assets construction phase affecting relatively small areas in comparison with the Morgan Generation Assets.

7.10.2.6 There are a few cables and pipelines in the CEA benthic subtidal ecology study area, some of which will require maintenance during the construction phase of the Morgan Generation Assets. The Isle of Man Interconnector project, which is scoped into this tier 1 assessment, will involve maintenance or remedial work on cables. This project doesn't quantify the area affected by these activities (i.e. cable maintenance) however it is likely to be similar to those associated with the operations and maintenance activities at offshore wind farms resulting in low level intermittent disturbance throughout their licence period.

Table 7.26: Cumulative temporary habitat loss for the Morgan Generation Assets construction phase and other tier 1 plans/projects/activities in the CEA benthic subtidal ecology study area.

Project	Predicted temporary habitat disturbance/loss (km^2)	Component parts of temporary habitat disturbance/loss	Source
Morgan Generation Assets	87.36	See Table 7.14	n/a
Offshore renewables			
Walney Extension Offshore Wind Farm	Operations and maintenance: 0.24	Temporary habitat disturbance/loss may result from: • Jack-up events	Dong Energy (2013b)
Walney 2 Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Dong Energy (2006)
Walney Offshore Wind Farm Operational Marine Licence - phase 2 export cable	0.01	Temporary habitat disturbance/loss may result from: • Cable repair/remediation	Dong Energy (2014b)

Project	Predicted temporary habitat disturbance/loss (km²)	Component parts of temporary habitat disturbance/loss	Source
Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1)	0.24	Temporary habitat disturbance/loss may result from: • Jack-up events	Dong Energy (2013b)
Walney Extension pontoon/jetty dredging and disposal	0.01	Temporary habitat disturbance/loss may result from: • Material deposition	Orsted (2018)
West of Duddon Sands Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	RSKENSR Ltd (2006)
West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3)	0.001	Temporary habitat disturbance/loss may result from: • Jack-up events	Dong Energy (2016c)
Walney 1 Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Dong Energy (2006)
Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3)	1.13	Temporary habitat disturbance/loss may result from: • Cable repair/remediation • Jetting for cable repair and/or remediation works • Jack-up/moored vessels	Dong Energy (2014b) Marine Space (2017a) Dong Energy (2013c) Dong Energy (2016b)
Ormonde Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Eclipse Energy Company Ltd (2005)
Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2)	0.07	Temporary habitat disturbance/loss may result from: • Jetting for cable repair and/or remediation works • Jack-up events	Marine Space (2015b) Vattenfall Wind Power Ltd (2016)

Project	Predicted temporary habitat disturbance/loss (km²)	Component parts of temporary habitat disturbance/loss	Source
Barrow Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Warwick Energy (2005)
	Decommissioning: No official figure given	Potential total removal of wind turbines, scour protection and subsea cables.	
Barrow Offshore Wind Farm – operations and maintenance marine licences (MLA/2015/00077 and MLA/2016/00149/3)	0.07	Temporary habitat disturbance/loss may result from: • Jetting for cable repair and/or remediation works • Jack-up/moored vessels	Marine Space (2015a) Dong Energy (2016a)
Awel y Môr Offshore Wind Farm	Construction: 10.02	Temporary habitat disturbance/loss may result from: • Jack-up events • Anchoring • Intertidal HDD	REW (2022)
	Operations and maintenance: 0.26	Temporary habitat disturbance/loss may result from: Cable repair/reburial	
Routine operations and maintenance activities at five Offshore Substations (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands)	No official figure given.	Temporary habitat disturbance/loss may result from: • Removal of algal growth	Transmission Capital Partners Ltd (2017)
Dredging activities and dredge disposal sites			
Douglas Harbour dredging Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a
Castletown Bay dredging Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a

Project	Predicted temporary habitat disturbance/loss (km^2)	Component parts of temporary habitat disturbance/loss	Source
Port of Barrow maintenance dredging disposal licence.	0.01	Temporary habitat disturbance/loss may result from: • Dredging of silt, sand and gravel The values provided for this project represent the area of the project as not temporary habitat disturbance/loss values were provided	Associated British Ports (2016)
West of Duddon Sands Pontoon Dredging Marine Licence	No official figures given	Dredging of the channel leading to the maintenance facility.	n/a
Annual Maintenance Dredging Peel Harbour Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a
Mersey channel and river maintenance dredge disposal renewal	0.50	Temporary habitat disturbance/loss may result from: • Dredging of silt and sand	Royal Haskoning (2018)
Liverpool 2 and River Mersey approach channel dredging	3.71	Temporary habitat disturbance/loss may result from: • Dredging of silt The values provided for this project represent the area of the project as not temporary habitat disturbance/loss values were provided	Royal Haskoning (2012)
Annual Maintenance Dredging Peel Harbour Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a
Heysham 1 and 2 dredging activities	No official figures given	Dredging of the channel outside of the power station by the coolant outflow.	n/a
Remedial works			
Isle of Man Interconnector Cable - cable protection remedial works	No official figure given.	Temporary habitat disturbance/loss may result from: • Anchoring • Concrete mattress installation	Intertek (2014)
Isle of Man to UK Interconnector Cable - maintenance and repair	No official figure given.	Temporary habitat disturbance/loss may result from: • Cable repair/reburial	Intertek (2016)
Total	103.63		

7.10.2.7 The cumulative effect is predicted to be of regional spatial extent, medium term duration (i.e. the construction phase for the Morgan Generation Assets is up to four years), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.8 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraphs 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.9 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.10 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.11 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.12 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

7.10.2.13 Predicted cumulative temporary habitat loss/disturbance from each of the tier 1 plans/projects/activities is presented in Table 7.27 together with a breakdown of the sources of this data from the relevant Environmental Statements and any assumptions made where necessary information was not presented in these Environmental Statements. Table 7.27 shows that, for all projects/plans/activities in the tier 1 assessment, the cumulative temporary habitat loss/disturbance during the operations and maintenance phase of the Morgan Generation Assets is estimated at 31.30km^2 (including the Morgan Generation Assets).

7.10.2.14 The maximum total temporary habitat loss/disturbance associated with all other offshore wind farms, which are in their operations and maintenance and/or decommissioning phases, within the tier 1 assessment is 19.24km^2. The values of temporary habitat loss for Morgan Generation Assets are comparably larger than for many of the other offshore wind farms presented in Table 7.27, as many do not quantify the temporary habitat disturbance in the operations and maintenance phase or break it down in to a number of different licences which are active over different periods of the wind farms lifetime.

7.10.2.15 Temporary habitat loss/disturbance from tier 1 dredge and disposal activities will be intermittent disturbance throughout the licenced period resulting in disturbance of approximately 0.50km^2 of seabed spread over the overlap with the operations and maintenance phase of Morgan Generation Assets (this value is the sum of all the offshore wind farm values in Table 7.27). There are also a number of dredge licences without readily available environmental information (i.e. Douglas Harbour dredging Isle of Man, annual maintenance dredging Peel Harbour Isle of Man and Mersey channel and river maintenance dredge disposal renewal). The dredging associated with these projects is however of a small scale and is likely to occur intermittently throughout the Morgan Generation Assets operations and maintenance phase affecting relatively small areas.

7.10.2.16 There are a number of cables and pipelines in the CEA benthic subtidal ecology study area, some of which will require maintenance during the construction phase of the Morgan Generation Assets. The one project scoped into this tier 1 assessment, the Isle of Man Interconnector Cable, may require maintenance or remedial work to cables. This project does not quantify the area affected by these activities however it is likely to be similar to those associated with maintenance activities for cables at offshore wind farms resulting in low level intermittent disturbance throughout its licence period.

Table 7.27: Cumulative temporary habitat loss for the Morgan Generation Assets operations and maintenance phase and other tier 1 plans/projects/activities in the CEA benthic subtidal ecology study area.

Project	Predicted temporary habitat disturbance/loss (km^2)	Component parts of temporary habitat disturbance/loss	Source
Morgan Generation Assets	11.57	See Table 7.14	n/a
Offshore renewables			
Walney Extension Offshore Wind Farm	Operations and maintenance: 0.24	Temporary habitat disturbance/loss may result from: • Jack-up events	Dong Energy (2013b)
	Decommissioning: 1.43	Temporary habitat disturbance/loss may result from: • Jack-up events	
Walney 2 Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Dong Energy (2006)
	Decommissioning: 0.09	Temporary habitat disturbance/loss may result from: • Jack-up events • Foundation removal • Scour protection removal	
Walney 2 Offshore Wind farm – operations and maintenance marine licences (MLA/2017/00429/1)	0.01	Temporary habitat disturbance/loss may result from: • Cable repair/remediation	Dong Energy (2014b)
Walney Extension pontoon/jetty dredging and disposal	0.01	Temporary habitat disturbance/loss may result from: • Material deposition	Orsted (2018)
West of Duddon Sands Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	RSKENSR Ltd (2006)
	Decommissioning: 0.68	Temporary habitat disturbance/loss may result from: • Jack-up events	

Project	Predicted temporary habitat disturbance/loss (km^2)	Component parts of temporary habitat disturbance/loss	Source
West of Duddon Sands Offshore Wind Farm operations and maintenance marine licence (MLA/2016/00150/3)	0.001	Temporary habitat disturbance/loss may result from: • Jack-up events	Dong Energy (2016c)
Walney 1 Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Dong Energy (2006)
	Decommissioning: 0.05	Temporary habitat disturbance/loss may result from: • Jack-up events • Foundation removal Scour protection removal	
Walney 1 Offshore Wind farm – operations and maintenance marine licences (MLA/2014/00028/5, MLA/2017/00081/2, MLA/2014/00027/7, MLA/2013/00426/2 and MLA/2016/00151/3	1.13	Temporary habitat disturbance/loss may result from: • Cable repair/remediation • Jetting for cable repair and/or remediation works • Jack-up/moored vessels	Dong Energy (2014b) Marine Space (2017a) Dong Energy (2013c) Dong Energy (2016b)
Ormonde Offshore Wind Farm	Operations and maintenance: No official figure given	Temporary habitat disturbance/loss in the operations and maintenance phase has not been considered in this licence.	Eclipse Energy Company Ltd (2005)
	Decommissioning: 5.25	Temporary habitat disturbance/loss may result from: • Removal of wind turbines • Removal of scour protection	
Ormonde Offshore Wind farm – operations and maintenance marine licences (MLA/2015/00086/2 and MLA/2016/00224/2)	0.07	Temporary habitat disturbance/loss may result from: • Jetting for cable repair and/or remediation works • Jack-up/moored vessels	Marine Space (2015b) Vattenfall Wind Power Ltd (2016)

Project	Predicted temporary habitat disturbance/loss (km^2)	Component parts of temporary habitat disturbance/loss	Source
Awel y Môr Offshore Wind Farm	Operations and maintenance: 0.26	Temporary habitat disturbance/loss may result from: • Cable repair/reburial	RWE (2022)
	Decommissioning: 10.02	Temporary habitat disturbance/loss may result from: • Jack-up events • Anchoring	
Routine operations and maintenance activities at five Offshore Substations (Barrow, Ormonde, Lincs, Westermost Rough, and Gunfleet Sands)	No official figure given.	Temporary habitat disturbance/loss may result from: • Removal of algal growth	Transmission Capital Partners Ltd (2017)
Dredging activities and dredge disposal sites			
Douglas Harbour dredging Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a
Annual Maintenance Dredging Peel Harbour Isle of Man	No official figures given	Annual maintenance dredging of the harbour.	n/a
Mersey channel and river maintenance dredge disposal renewal	0.5	Temporary habitat disturbance/loss may result from: • Dredging of silt and sand	Royal Haskoning (2018)
Cables and pipelines			
Remedial works			
Isle of Man Interconnector Cable - cable protection remedial works	No official figure given.	Temporary habitat disturbance/loss may result from: • Anchoring • Concrete mattress installation	Intertek (2014)
Isle of Man to UK Interconnector Cable - maintenance and repair	No official figure given.	Temporary habitat disturbance/loss may result from: • Cable repair/reburial	Intertek (2016)
Total	31.30		

7.10.2.18 The cumulative effect is predicted to be of regional spatial extent, medium term duration (some of the decommissioning works may take a few years however most of the maintenance activities are likely to occur over a period of days to weeks, over the lifetime of the projects), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.19 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.20 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.21 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.22 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.23 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

7.10.2.24 There are no tier 1 projects active in the Morgan Generation Assets decommissioning phase to consider for cumulative impacts based on current knowledge.

Tier 2

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.10.2.25 The maximum total temporary habitat disturbance/loss associated with the tier 2 includes two offshore renewables projects within the CEA benthic subtidal ecology study area (i.e. the Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets) as well as the Morgan and Morecambe Transmission Assets. For the Mona Offshore Wind Project temporary habitat disturbance/loss is likely to result from site preparation activities in advance of installation activities, cable installation activities (including UXO detonation, pre-cabling seabed clearance and anchor placements), and placement of spud-can legs from jack-up operations. The temporary habitat disturbance/loss predicted to result from the Mona Offshore Wind Project is 131.07km^2 (Mona Offshore Wind Ltd, 2023).

7.10.2.26 No publicly available information was available, at the time of writing, which quantifies the extent of temporary habitat disturbance/loss associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 234.70km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the temporary habitat disturbance/loss associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.2.27 The construction of the Morgan and Morecambe Transmission Assets is likely to result in temporary habitat disturbance/loss as a result of the installation of cables. Currently there is only a scoping report available for this project therefore no specific values can be attributed to this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022).

7.10.2.28 The cumulative effect on the subtidal coarse and mixed sediments with diverse benthic communities IEF is predicted to be of regional spatial extent, medium term duration (i.e. the construction phase for the Morgan Generation Assets is up to four years), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **medium**.

7.10.2.29 The cumulative impact for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF however will be different from the other subtidal IEFs due to its limited distribution. Based on the site-specific surveys and EMODnet (2019) data, the sand and muddy sand habitat is located in the north of the Morgan Array Area and ZOI, this IEF has not been identified in the Mona Array Area and therefore due to the direct nature of this impact it is unlikely there will be a cumulative impact from the Mona Offshore Wind Project on this IEF.

7.10.2.30 The cumulative effect on the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is predicted to be of local spatial extent, medium term duration (i.e. the construction phase for the Morgan Generation Assets is up to four years), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.31 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.32 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.33 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.34 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.35 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be medium and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.10.2.36 The maximum total temporary habitat disturbance/loss associated with the tier 2 assessment includes two offshore renewables projects within the CEA benthic subtidal ecology study area (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets) as well as the Morgan and Morecambe Transmission Assets. For the Mona Offshore Wind Project temporary habitat disturbance loss is likely to result from cable repair and reburial. The temporary habitat disturbance predicted to result from the operations and maintenance of the Mona Offshore Wind Project is 17.61km^2 (Mona Offshore Wind Ltd, 2023).

7.10.2.37 No publicly available information was available, at the time of writing, which quantifies the extent of temporary habitat disturbance/loss associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 48.91km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the temporary habitat disturbance/loss associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.2.38 The operations and maintenance of the Morgan and Morecambe Transmission Assets project is likely to result in temporary habitat disturbance/loss as a result of the cable maintenance. Currently there is only a scoping report available for this project therefore no specific values can be attributed to this impact.

7.10.2.39 The cumulative effect is predicted to be of regional spatial extent, short term duration (the maintenance activities are likely to occur over a period of days to weeks, over the lifetime of the projects), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.40 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.41 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.42 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.43 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.44 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

7.10.2.45 The maximum total temporary habitat disturbance/loss associated with the tier 2 includes two offshore renewables projects within the CEA benthic subtidal ecology study area (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm

Generation Assets) and Morgan and Morecambe Transmission Assets. For the Mona Offshore Wind Project, temporary habitat disturbance loss is predicted to result from wind turbine and OSP foundation removal. The temporary habitat disturbance/loss predicted to result from the decommissioning of the Mona Offshore Wind Project will be similar to that arising during construction (Mona Offshore Wind Ltd, 2023) and is therefore similar to that arising from the Morgan Generation Assets (see section 7.8.1).

No publicly available information was available, at the time of writing, which quantifies the extent of temporary habitat disturbance/loss associated with the decommissioning of Morecambe Offshore Windfarm Generation Assets. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the temporary habitat disturbance/loss associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.2.46 The cumulative effect is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.47 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.48 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.49 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.50 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.51 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the small area impacted in this phase and the high likelihood of recovery given there would be no potential for any further disturbance to sediments resulting from the Morgan Generation Assets.

Tier 3

Construction phase

Magnitude of impact

Subtidal habitat IEFs

7.10.2.52 The only tier 3 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss/disturbance during the operations and maintenance phase of the Morgan Generation Assets is the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors; a planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2022).

7.10.2.53 The activities associated with the MaresConnect interconnector cable which are likely to result in temporary habitat disturbance/loss are similar to those expected for the installation of cables for the Morgan Generation Assets. Construction is likely to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect 2022), although it should be noted that these timeframes are only indicative at this stage. The construction activities are likely to involve cable installation such as jet trenching and the installation of cable protection. Maintenance activities are likely to involve the repair and reburial of cables.

7.10.2.54 The cumulative effect on the subtidal coarse and mixed sediments with diverse benthic communities IEF is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **medium**.

7.10.2.55 The cumulative effect on the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is predicted to be of local spatial extent, medium term duration (i.e. the construction phase for the Morgan Generation Assets is up to four years), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.56 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.57 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.58 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.59 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.60 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the construction phase is deemed to be medium and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

Subtidal habitat IEFs

7.10.2.61 The only tier 3 project which has been identified in the CEA with the potential to result in cumulative temporary habitat loss/disturbance during the operations and maintenance phase of the Morgan Generation Assets is the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors, a planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2022).

7.10.2.62 The activities associated with the MaresConnect interconnector cable which are likely to result in temporary habitat disturbance/loss are similar to those expected for the installation of cables for the Morgan Generation Assets. Construction is likely to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect 2022), although it should be noted that these timeframes are only indicative at this stage. Maintenance activities are likely to involve the repair and reburial of cables.

7.10.2.63 The cumulative effect is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.2.64 The sensitivity of the subtidal IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.1.11 to 7.8.1.14 and Table 7.17.

7.10.2.65 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of medium vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

7.10.2.66 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of low vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

Significance of effect

Subtidal habitat IEFs

7.10.2.67 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.10.2.68 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative temporary habitat disturbance/loss impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Decommissioning phase

7.10.2.69 There are no tier 3 projects active in the Morgan Generation Assets decommissioning phase to consider for cumulative impacts based on current knowledge.

7.10.3 Increase in suspended sediment concentrations and associated deposition

Construction phase

Magnitude of impact

7.10.3.1 The magnitude of the increase in SSCs arising from seabed preparation involving sandwave clearance, the installation of the wind turbines, OSP foundations and cables has been assessed as low for the Morgan Generation Assets alone, as described in section 7.8.2.

7.10.3.2 The construction phase of the Morgan Generation Assets coincides with the maintenance phases of the Barrow Offshore Wind Farm, Ormonde Offshore Wind Farm, Walney 1 Offshore Wind Farm, Walney 2, Walney Extension 3, Walney Extension 4 and West of Duddon Sands Offshore Wind Farm. The maintenance activities associated with these other offshore wind farm are likely to be of a similar nature to those associated with the Morgan Generation Assets, such as repair and reburial of inter-array, interconnector and (where applicable) offshore export cables. Maintenance activities may result in increased SSCs, however these activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Morgan Generation Assets.

7.10.3.3 The cumulative impact assessment also considers sea disposal of dredged material at the Walney Extension Offshore Wind Farm, located 15.15km from the Morgan Generation Assets. If the construction phase activities and dredge material disposal coincided, both resultant plumes would be advected on the tidal currents, they would travel in parallel, and not towards one another, and are unlikely to interact.

7.10.3.4 During the construction phase of the Morgan Generation Assets there is the potential for cumulative impacts with two proposed offshore wind farm installations (Mona and Morecambe) including the combined transmission assets for the Morgan and Morecambe wind farms. Construction activities may result in increased SSC; however, these activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Morgan Generation Assets as they would be advected on the tidal currents and would travel in parallel.

7.10.3.5 The cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptors directly. The magnitude is therefore, considered to be **low**.

West of Walney MCZ

7.10.3.6 It is predicted that the impact will affect the designated features of the West of Walney MCZ.

7.10.3.7 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

West of Copeland MCZ

7.10.3.8 It is predicted that the impact will affect the designated features of the West of Copeland MCZ.

7.10.3.9 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.3.10 The sensitivity of the subtidal habitat IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.20 to 7.8.2.24 and Table 7.18.

7.10.3.11 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

7.10.3.12 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.10.3.13 The sensitivity of the West of Walney MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.25 to 7.8.2.28 and Table 7.18.

7.10.3.14 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

West of Copeland MCZ

7.10.3.15 The sensitivity of the West of Copeland MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.29 to 7.8.2.31 and Table 7.18.

7.10.3.16 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

7.10.3.17 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

Significance of effect

Subtidal habitat IEFs

7.10.3.18 Overall, for the sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover from the relevant pressures.

7.10.3.19 Overall, for the subtidal coarse and mixed sediment with diverse benthic communities IEF the magnitude of the increase in SSC and associated deposition impact during the construction phase is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover from the relevant pressures.

West of Walney MCZ

7.10.3.20 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the increase in SSC and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the indirect effect of this impact and the high likelihood of recovery.

West of Copeland MCZ

7.10.3.21 Overall, for the subtidal sand IEF the magnitude of the increase in SSC and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the indirect effect of this impact and the high likelihood of recovery.

7.10.3.22 Overall, for the subtidal coarse sediment IEF and subtidal mixed sediment IEF the magnitude of the increase in SSC and associated deposition impact during the construction phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the indirect effect of this impact and the high likelihood of recovery.

Operations and maintenance phase

Magnitude of impact

7.10.3.23 The magnitude of the increase in SSCs arising from maintenance activities during operations and maintenance phase, has been assessed as negligible for the Morgan Generation Assets alone, as described in section 7.8.2.

7.10.3.24 The operations and maintenance phase of the Morgan Generation Assets coincides with the maintenance phase of the Barrow Offshore Wind Farm, Ormonde Offshore Wind Farm, Walney 1 Offshore Wind Farm, Walney 2, Walney Extension 3, Walney Extension 4 and West of Duddon Sands Offshore Wind Farm. Maintenance activities may result in increased SSC; however these activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Morgan Generation Assets. With resultant plumes from the Morgan Generation Assets being smaller in scale than during the construction phase potential cumulative impacts are less likely to occur during this operations and maintenance phase.

7.10.3.25 Potential cumulative impacts may relate to maintenance of inter-array and interconnector cables or wind turbine infrastructure. However, maintenance activities are both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

7.10.3.26 The cumulative impact assessment considers the operations and maintenance phase of the Mona Offshore Wind Project together with the tier 2 projects (i.e. operations and maintenance phases of the Morecambe Offshore Windfarm Generation Assets, the Morgan and Morecambe Transmission Assets and the Morgan Generation Assets). Maintenance activities associated with the tier 2 projects may temporally coincide with maintenance activities of the Morgan Generation Assets. Maintenance activities are intermittent and are of a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

7.10.3.27 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**.

West of Walney MCZ

7.10.3.28 It is predicted that the impact will affect the designated features of the West of Walney MCZ.

7.10.3.29 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

West of Copeland MCZ

7.10.3.30 It is predicted that the impact will affect the designated features of the West of Copeland MCZ.

7.10.3.31 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.3.32 The sensitivity of the subtidal habitat IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.20 to 7.8.2.24 and Table 7.18.

7.10.3.33 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible**.

7.10.3.34 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.10.3.35 The sensitivity of the West of Walney MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.25 to 7.8.2.28 and Table 7.18.

7.10.3.36 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

West of Copeland MCZ

7.10.3.37 The sensitivity of the West of Copeland MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.29 to 7.8.2.31 and Table 7.18.

7.10.3.38 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

7.10.3.39 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

Significance of effect

Subtidal Habitat IEFs

7.10.3.40 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets and the ability of the communities to recover.

7.10.3.41 Overall, for the subtidal coarse and mixed sediment with diverse benthic communities IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets and the ability of the communities to recover.

West of Walney MCZ

7.10.3.42 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and the very low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

West of Copeland MCZ

7.10.3.43 Overall, for the subtidal sand IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and based on the very low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

7.10.3.44 Overall, for the subtidal coarse sediment IEF and subtidal mixed sediment IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the distance of the MCZ from the Morgan Array Area and based on the very low levels of SSC and deposition associated with the activities in this phase of the Morgan Generation Assets that are likely to reach the MCZ.

Decommissioning phase

Magnitude of impact

7.10.3.45 The magnitude of the increase in SSCs arising from decommissioning activities has been described in section 7.10.3 as having a lesser impact than the construction phase. The SSC would however increase temporarily as inter-array, interconnector and offshore export cables are retrieved and if suction caissons were removed using overpressure to release. The SSC would however increase temporarily if suction caissons were removed using overpressure to release. The increase in SSC and the potential impact on physical features may persist during decommissioning, however they are localised in nature.

7.10.3.46 All the tier 1 offshore wind farms discussed above may already have been decommissioned due to similar operational lifespan with only residual infrastructure remaining on the seabed. Offshore wind farms decommisioned prior to the Morgan Generation Assets would not cause a cumulative increase in SSC.

7.10.3.47 Decommissioning of the Morecambe Offshore Windfarm Generation Assets and Mona Offshore Wind Project will most likely occur on the same projected timeline as the Morgan Generation Assets. Decommissioning activity may result in increased SSCs however this would be localised and of a lesser magnitude than the construction phase. Residual structures remaining from the decommissioning of the Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets would not have a cumulative impact on SSCs.

7.10.3.48 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**.

West of Walney MCZ

7.10.3.49 It is predicted that the impact will affect the designated features of the West of Walney MCZ.

7.10.3.50 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

West of Copeland MCZ

7.10.3.51 It is predicted that the impact will affect the designated features of the West of Copeland MCZ.

7.10.3.52 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 receptors directly. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.3.53 The sensitivity of the subtidal habitat IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.20 to 7.8.2.24 and Table 7.18.

7.10.3.54 The subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible**.

7.10.3.55 The subtidal coarse and mixed sediments with diverse benthic communities IEF is deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

West of Walney MCZ

7.10.3.56 The sensitivity of the West of Walney MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.25 to 7.8.2.28 and Table 7.18.

7.10.3.57 The sea-pens and burrowing megafauna communities IEF and subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

West of Copeland MCZ

7.10.3.58 The sensitivity of the West of Copeland MCZ IEFs is as described previously for the construction phase assessment in paragraph 7.8.2.29 to 7.8.2.31 and Table 7.18.

7.10.3.59 The subtidal coarse sediment IEF and subtidal mixed sediment IEF are deemed to be of medium vulnerability, high recoverability and national value. The sensitivity of the receptor is therefore, considered to be **low**.

7.10.3.60 The subtidal sand IEF is deemed not to be sensitive and of national value. The sensitivity of the receptor is therefore, considered to be **negligible.**

Significance of effect

Subtidal Habitat IEFs

7.10.3.61 Overall, for the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover.

7.10.3.62 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the ability of these habitats to recover.

West of Walney MCZ

7.10.3.63 Overall, for the subtidal sand IEF, subtidal mud IEF and the sea-pens and burrowing megafauna communities IEF the magnitude of the cumulative increase in SSC and associated deposition impact decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the distance of this MCZ from these activities.

West of Copeland MCZ

7.10.3.64 Overall, for the subtidal sand IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the distance of this MCZ from these activities.

7.10.3.65 Overall, for the subtidal coarse sediment IEF and subtidal mixed sediment IEF the magnitude of the cumulative increase in SSC and associated deposition impact during the decommissioning phase is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached based on the low levels of SSC and deposition associated with the activities in this phase of the project and the distance of this MCZ from these activities.

7.10.4 Long term habitat loss

7.10.4.1 Tier 1 cumulative long term habitat loss is predicted to occur as a result of the presence of the Morgan Generation Assets and the Awel y Môr Offshore Wind Farm which has submitted an application for consent and is within the CEA benthic subtidal ecology study area of Morgan Generation Assets (see Figure 7.6). Long term habitat loss may result from the physical presence of foundations, scour protection and cable protection.

7.10.4.2 Two tier 2 offshore wind farms have been identified within the CEA benthic subtidal ecology study area (Morecambe Offshore Windfarm Generation Assets and Mona Offshore Wind Project) as well as the Morgan and Morecambe Transmission Assets. One tier 3 project (i.e. MaresConnect) has been identified within the CEA benthic subtidal ecology study area.

Tier 1

Construction and operations and maintenance phases

Magnitude of impact

7.10.4.3 For the projects in the tier 1 assessment, the cumulative long term habitat loss within the CEA benthic subtidal ecology study area is estimated to be up to 2.59km^2. Of this total the Awel Y Môr Offshore Wind Farm is predicted to contribute up to 1.07m^2 of long term habitat loss as a result of structures such as wind turbine, OSP and met mast foundations, scour protection and cable protection for cables and cable crossings. It should be noted that this figure is likely to reduce over the lifetime of the Morgan Generation Assets as the Awel y Môr Offshore Wind Farm will enter its decommissioning phase during the operations and maintenance phase of the Morgan Generation Assets. This may result in the gradual removal of infrastructure such as wind turbine and OSP foundations and therefore a reduction in long term habitat loss.The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.4.4 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.4.8 to 7.8.4.11 and above in Table 7.19.

7.10.4.5 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.4.6 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative long term subtidal habitat loss impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The cumulative long term habitat loss will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

Decommissioning phase

7.10.4.7 There are no tier 1 projects active in the Morgan Generation Assets decommissioning phase to consider for cumulative impacts based on current knowledge.

Tier 2

Construction and operations and maintenance phases

Magnitude of impact

7.10.4.8 The maximum total long term habitat loss associated with the tier 2 assessment includes two offshore renewables projects within the CEA benthic subtidal ecology study area (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets) as well as the Morgan and Morecambe Transmission Assets. There may be up to 4.95km^2 of long term habitat loss arising from the tier 2 projects in the construction and operations and maintenance phases. For the Mona Offshore Wind Project, long term habitat loss is likely to arise under foundation structures and associated scour protection, and under any cable protection required. The long term habitat loss predicted to result from the Mona Offshore Wind Project is 2.36km^2 (Mona Offshore Wind Ltd, 2023) and is therefore similar to that arising from the Morgan Generation Assets (see section 7.8.4).

7.10.4.9 No publicly available information was available, at the time of writing, which quantifies the extent of long term habitat loss associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 11.93km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Mona Offshore Wind Project and therefore the scale of the long term habitat loss associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.4.10 The Morgan and Morecambe Transmission Assets are likely to result in long term habitat loss as a result of the presence of cable protection. Currently there is only a scoping report available for this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022) therefore no specific values can be attributed to this impact for this project.

7.10.4.11 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.4.12 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.4.8 to 7.8.4.11 and above in Table 7.19.

7.10.4.13 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptors is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.4.14 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative long term subtidal habitat loss impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The cumulative long term habitat loss will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

Decommissioning phase

Magnitude of impact

7.10.4.15 The maximum total long term habitat loss/permanent habitat alteration associated with the tier 2 assessment includes the permanent habitat alteration resulting from the cable and scour protection remaining *in situ* for the Morgan Generation Assets together with two offshore renewables projects within the CEA benthic subtidal ecology study (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets) as well as the Morgan and Morecambe Transmission Assets. There may be up to 2.31km^2 of permanent habitat alteration arising from the Mona Offshore Wind Project after decommissioning.

7.10.4.16 No publicly available information was available, at the time of writing, which quantifies the extent of long term habitat loss associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 3.75km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the long term/permanent habitat loss associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.4.17 The Morgan and Morecambe Transmission Assets are likely to result in long term/permanent habitat loss as a result of the presence of cable protection. Currently there is only a scoping report available for this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022) therefore no specific values can be attributed to this impact for this project.

7.10.4.18 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.4.19 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.4.8 to 7.8.4.11 and above in Table 7.19.

7.10.4.20 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.4.21 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative long term subtidal habitat loss/permanent habitat alteration impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The long term habitat loss/permanent habitat alteration will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

Tier 3

Construction and operations and maintenance phases

Magnitude of impact

Subtidal habitat IEFs

7.10.4.22 The only tier 3 project which has been identified in the CEA with the potential to result in cumulative long term habitat loss with the Morgan Generation Assets is the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors; a planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2022).

7.10.4.23 Cable protection associated with the MaresConnect interconnector cable is likely to result in long term habitat loss similar to those expected for the cables of the Morgan Generation Assets. Construction is likely to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect 2022), although it should be noted that these timeframes are only indicative at this stage.

7.10.4.24 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.4.25 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.4.8 to 7.8.4.11 and above in Table 7.19.

7.10.4.26 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptor is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.4.27 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF the magnitude of the cumulative long term subtidal habitat loss impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. The long term habitat loss will only affect a small proportion of the total area of these IEFs in the Morgan benthic subtidal ecology study area which is unlikely to compromise the integrity of these habitats and communities such that they would not be able to support their characterising communities or perform their ecosystem function.

7.10.5 Colonisation of hard substrate

7.10.5.1 The introduction of hard substrate into areas of predominantly soft sediments, as a result of multiple plans and projects, has the potential to alter community composition and biodiversity within the CEA benthic subtidal ecology study area.

7.10.5.2 The only project which is screened into the tier 1 assessment for cumulative effects from the introduction of hard substrate is the Awel y Môr offshore wind farm which has submitted an application for consent and is within the CEA benthic subtidal ecology study area (i.e. tier 1) (see Table 7.25).

7.10.5.3 The only tier 2 projects which have been identified within the CEA benthic subtidal ecology study area are offshore renewable projects (i.e. Morecambe Offshore Windfarm Generation Assets, Mona Offshore Wind Project and Morgan and Morecambe Transmission Assets). In tier 3 there is only one project, the MaresConnect interconnector cable.

Tier 1

Construction and operations and maintenance phases

Magnitude of impact

7.10.5.4 The maximum cumulative tier 1 habitat creation is estimated at 3.07km^2. Awel y Môr Offshore Wind Farm is the only tier 1 project and it is likely to result in 1.07km^2 of hard substrate from wind turbine and OSP foundations, scour protection, met masts, cable protection and cable crossings.

7.10.5.5 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and irreversible during the lifetime of the offshore wind farm projects. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.5.6 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.5.10 to 7.8.5.18.

7.10.5.7 All of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF) are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore, considered to be **high**.

Significance of effect

7.10.5.8 Overall for all of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF), the magnitude of the cumulative colonisation of hard substrate impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached because of the localised extent of the impact, the large area over which this impact is dispersed and the likely gradual reduction in magnitude throughout the operations and maintenance phase of the Morgan Generation Assets.

Tier 2

Construction and operations and maintenance phases

Magnitude of impact

7.10.5.9 The maximum predicted extent of introduced hard substrate associated with the tier 2 assessment which includes two offshore renewables projects within the CEA benthic subtidal ecology study (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets) as well as the Morgan and Morecambe Transmission

Assets, is estimated at up to 5.92km^2. This value considers the hard substrate resulting from the cable and scour protection remaining *in situ* for the Morgan Generation Assets, together with the infrastructure associated with the Mona Offshore Wind Project and the Morecambe Offshore Windfarm Generation Assets.

7.10.5.10 No publicly available information was available, at the time of writing, which quantifies the extent of hard substrate associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 5.92km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the hard substrate associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.5.11 The Morgan and Morecambe Transmission Assets are likely to create hard substrate as a result of the cable protection. Currently there is only a scoping report available for this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022,) therefore no specific values can be attributed to this impact.

7.10.5.12 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and irreversible during the lifetime of the offshore wind farm projects. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.5.13 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.5.10 to 7.8.5.18.

7.10.5.14 All of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF) are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore, considered to be **high**.

Significance of effect

7.10.5.15 Overall for all of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF), the magnitude of the cumulative colonisation of hard substrate impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached because of the localised extent of the impact, the large area over which this impact is dispersed and the likely gradual reduction in magnitude throughout the operations and maintenance phase of the Morgan Generation Assets.

Tier 3

Construction and operations and maintenance phases

Magnitude of impact

Subtidal habitat IEFs

7.10.5.16 The only tier 3 project which has been identified in the CEA with the potential to result in cumulative colonisation of hard substrate with the Morgan Generation Assets is the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors. A planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2022).

7.10.5.17 Cable protection associated with the MaresConnect interconnector cable is likely to result in the introduction of hard substrate similar to that expected for the cables of the Morgan Generation Assets. Construction is likely to occur in 2025 and the project is likely to become operational in 2027 (MaresConnect 2022) although it should be noted that these timeframes are only indicative at this stage.

7.10.5.18 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and irreversible during the lifetime of the offshore wind farm projects. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.5.19 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.5.10 to 7.8.5.18.

7.10.5.20 All of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF) are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore, considered to be **high**.

Significance of effect

7.10.5.21 Overall for all of the subtidal IEFs (subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF), the magnitude of the cumulative colonisation of hard substrate impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached because of the localised extent of the impact, the large area over which this impact is dispersed and the likely gradual reduction in magnitude throughout the operations and maintenance phase of the Morgan Generation Assets.

7.10.6 Increased risk of introduction and spread of invasive non-native species

7.10.6.1 Cumulative increased risk of introduction or spread of INNS may result from the physical presence of infrastructure as well as increased boat activity in the region associated with other projects. Cumulative increased risk of introduction or spread of INNS is predicted to occur as a result of the presence of the Morgan Generation Assets, as well as Awel y Môr Offshore Wind Farm within the CEA benthic subtidal ecology study area.

7.10.6.2 Three tier 2 projects have been identified within the CEA benthic subtidal ecology study area (Morecambe Offshore Windfarm Generation Assets, Mona Offshore Wind Project and Morgan and Morecambe Transmission Assets) as well as one tier 3 project, the MaresConnect interconnector cable.

Tier 1

Construction and operations and maintenance phases

Magnitude of impact

7.10.6.3 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity and to facilitate the introduction and spread of INNS. The latter may be particularly important with regards to cumulative impacts as several offshore structures in relatively close proximity could enable the spread of INNS. The tier 1 project, Awel y Môr Offshore Wind Farm, will introduce 1.07km^2 of new hard substrate to the seabed which, together with the Morgan Generation Assets, will result in a total of up to 3.07km^2 of new hard substrate.

7.10.6.4 Maintenance vessel movement associated with the operations and maintenance of the Awel y Môr Offshore Wind Farm may facilitate the introduction and spread of INNS in the region on the hull of vessels or in ballast water. The construction of Awel y Môr Offshore Wind Farm is likely to result in up to 3,961 round trips, the operations and maintenance phase is likely to result in 1,232 vessel round trips and the number of round trips for decommissioning has not been defined however is likely to be similar to the 3,961 round trips anticipated during construction (RWE, 2022). The Awel y Môr Offshore Wind Farm will have plans and measures in place to reduce the spread of INNS such as those proposed for the Morgan Generation Assets in Table 7.16. For example, Awel y Môr will ensure a biosecurity plan is implemented to ensure relevant best practice guidelines are followed (RWE, 2022). The extent of hard substrate available for colonisation by INNS is also likely to decline throughout the operations and maintenance phase as some of the projects enter their decommissioning phases.

7.10.6.5 The cumulative effect is predicted to be of regional spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.6.6 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.10.6.7 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.6.8 Overall for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF, the magnitude of the cumulative increased risk of introduction and spread of INNS impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the likelihood that most offshore projects will implement designed-in measures that will ensure that the risk of potential introduction and spread of INNS is minimised including the Morgan Generation Assets.

Decommissioning phase

7.10.6.9 There are no tier 1 projects active in the Morgan Generation Assets decommissioning phase to consider for cumulative impacts based on current knowledge.

Tier 2

Construction and operations and maintenance phases

Magnitude of impact

7.10.6.10 The maximum extent of hard substrate which could be introduced and colonised by INNS as a result of projects in the tier 2 assessment is 5.92 km^2. The tier 2 projects include the Mona Offshore Wind Project, Morecambe Offshore Windfarm Generation Assets and the Morgan and Morecambe Transmission Assets.

7.10.6.11 No publicly available information was available, at the time of writing, which quantifies the extent of hard substrate associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 5.92km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the hard substrate associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.6.12 Furthermore it is likely that both of these projects will have measures in place to reduce the potential for the introduction and spread of INNS based on national and international guidance.

7.10.6.13 The Morgan and Morecambe Transmission Assets have the potential to facilitate the introduction and spread of INNS as a result of the cable protection. Currently there is only a scoping report available for this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022) therefore no specific values can be attributed to this impact.

7.10.6.14 The cumulative effect is predicted to be of regional spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.6.15 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.10.6.16 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.6.17 Overall for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF, the magnitude of the cumulative increased risk of introduction and spread of INNS impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the likelihood that most offshore projects will implement designed-in measures that will ensure that the risk of potential introduction and spread of INNS is minimised including the Morgan Generation Assets (Table 7.16).

Decommissioning phase

Magnitude of impact

7.10.6.18 The maximum total hard substrate available for colonisation by INNS associated with the tier 2 assessment and which may remain *in situ* post-decommissioning is estimated at up to 3.77km^2 and includes three offshore renewables projects within the CEA benthic subtidal ecology study (i.e. Mona Offshore Wind Project, Morecambe Offshore Windfarm Generation Assets and Morgan and Morecambe Transmission Assets). This impact considers the hard substrate resulting from the cable and scour protection remaining *in situ* for Morgan Generation Assets, together with the permanent habitat alteration from the Mona Offshore Wind Project as it enters the decommissioning phase and the hard substrate associated with the operation of the Morecambe Offshore Windfarm Generation Assets. The Morecambe Offshore Windfarm Generation Assets is estimated to undergo decommissioning in 2089 (14 years after Morgan Generation Assets), therefore the amount of long term habitat loss associated with this project is likely to decrease with time.

7.10.6.19 No publicly available information was available, at the time of writing, which quantifies the extent of hard substrate associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 3.77km^2. The indicative capacity of the Morecambe Offshore Windfarm Generation Assets (Table 7.24) is however much smaller than the Morgan Generation Assets and therefore the scale of the hard substrate associated with the tier 2 project is likely to be less than that associated with the Morgan Generation Assets.

7.10.6.20 The Morgan and Morecambe Transmission Assets have the potential to facilitate the introduction and spread of INNS as a result of the cable protection which may be left *in situ* following decommissioning. Currently there is only a scoping report available for this project (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd., 2022) therefore no specific values can be attributed to this impact.

7.10.6.21 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.6.22 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.10.6.23 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.6.24 Overall for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF, the magnitude of the cumulative increased risk of introduction and spread of INNS impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the likelihood that most offshore projects will implement designed-in measures that will ensure that the risk of potential introduction and spread of INNS is minimised including the Morgan Generation Assets.

Tier 3

Construction and operations and maintenance phases

Magnitude of impact

Subtidal habitat IEFs

7.10.6.25 The only tier 3 project which has been identified in the CEA with the potential to result in cumulative increased risk of introduction and spread of INNS with the Morgan Generation Assets is the MaresConnect interconnector cable. There is, however, currently no information on the impact that the MaresConnect interconnector cable will have on benthic ecology receptors; a planning application is predicted to be submitted in 2024 which will identify and assess these impacts (MaresConnect, 2022).

7.10.6.26 Cable protection associated with the MaresConnect interconnector cable is likely to result in the facilitation of the introduction and spread of INNS (e.g. introduction of new hard substrate through cable protection and vessel movements which are likely to be greatest during the construction phase) are similar to those expected for the cables of the Morgan Generation Assets. Construction is likely to occur in 2025 and the project is anticipated to become operational in 2027 (MaresConnect 2022), although it should be noted that these timeframes are only indicative at this stage.

7.10.6.27 The cumulative effect is predicted to be of regional spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.6.28 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.6.12 to 7.8.6.15 and above in Table 7.20.

7.10.6.29 The subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF are deemed to be of high vulnerability, low recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **high**.

Significance of effect

Subtidal habitat IEFs

7.10.6.30 Overall for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF, the magnitude of the cumulative increased risk of introduction and spread of INNS impact during the construction and operations and maintenance phases is deemed to be low and the sensitivity of the receptor is considered to be high. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the likelihood that most offshore projects will implement designed-in measures that will ensure that the risk of potential introduction and spread of INNS is minimised including the Morgan Generation Assets (Table 7.16).

7.10.7 Removal of hard substrates

7.10.7.1 Cumulative removal of hard substrate may result from the removal of infrastructure such as foundations, cable protection and scour protection, wind turbines and OSPs. Three tier 2 offshore wind farms have been identified within the CEA benthic subtidal ecology study area (Morecambe Offshore Windfarm Generation Assets, Mona Offshore Wind Project and Morgan and Morecambe Transmission Assets). No relevant projects have been identified in tiers 1 or 3 (see Table 7.25).

Tier 1

Decommissioning phase

7.10.7.2 There are no tier 1 projects which are predicted to overlap with the decommissioning phase of the Morgan Generation Assets based on current knowledge.

Tier 2

Decommissioning phase

Magnitude of impact

7.10.7.3 The maximum total removal of hard substrate associated with the tier 2 assessment is estimated at up to 1.08km^2. This includes the removal of hard substrate associated with two offshore renewables projects within the CEA benthic subtidal ecology study (i.e. Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets). This impact considers the hard substrate removed during the Morgan Generation Assets decommissioning phase. The Morecambe Offshore Windfarm Generation Assets will decommission 14 years after the decommissioning of the Morgan Generation Assets (i.e. 2086) and therefore won't overlap temporally with this phase.

7.10.7.4 No publicly available information was available, at the time of writing, which quantifies the extent of hard substrate associated with the Morecambe Offshore Windfarm Generation Assets and so this is not represented in the cumulative tier 2 total of 1.08km^2.

7.10.7.5 The cumulative effect is predicted to be of regional spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.7.6 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.7.6 to 7.8.7.7.

7.10.7.7 The subtidal coarse and mixed sediments with diverse benthic communities IEF and subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF is deemed to be of high vulnerability, high recoverability, and national value. The sensitivity of the IEFs is therefore considered to be **low**.

Significance of effect

7.10.7.8 Overall for the subtidal coarse and mixed sediments with diverse benthic communities IEF and the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF, the magnitude of the cumulative removal of hard substrate impact during the decommissioning phase is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion is based on the ability of soft sediment habitats to recover following the removal of hard structures and the likely small scale of the change in relation to the wider CEA benthic subtidal ecology study area.

7.10.8 Changes in physical processes

Operations and maintenance phase

Magnitude of impact

7.10.8.1 The presence of infrastructure within the Morgan Array Area may lead to changes in tidal regime during the operations and maintenance phase of the Morgan Generation Assets. The magnitude of increased infrastructure leading to changes in the tidal regime and the associated potential impacts along the shoreline during the operations and maintenance phase, has been assessed as low for the Morgan Generation Assets alone as described in section 7.8.8.

7.10.8.2 The Mona Offshore Wind Project wind turbines may be in operation during the operations and maintenance phase of the Morgan Generation Assets. The Mona Offshore Wind Project array is 5.5km from the Morgan Array Area. The modelling carried out for Morgan Generation Assets concluded that the impact on tidal and wave regime was low when considering the development alone. Changes are observed in close proximity to the wind turbine structures with tides returning to baseline levels beyond the array area. Furthermore, the increase in infrastructure will not cause a cumulative change on the wave regime as the impacts caused by the wind turbines are localised and return to baseline levels just beyond the infrastructure. Additionally changes in flow patterns are aligned with tidal flow and therefore, no overlap is expected to create cumulative changes in the tidal and wave regime between the two wind farm developments.

7.10.8.3 Regarding changes in wave climate under storm conditions from the north the change in wave climate due to the Morgan Generation Assets may extend to the limit of the Mona Offshore Wind Project however at this distance the change is diminutive (i.e. circa 0.2% reduction in significant wave height during a 1in20 storm from the north). Storms approaching from the north may influence the wave climate in the Morgan Array Area to a small degree. The changes in wave climate due to storms from the southwest and west interacting with Morgan Array infrastructure do not extend to the Morecambe site due to the influence of Anglesey. The limited frequency and fetch length would reduce the likelihood of storms from the east giving rise to a change in wave climate in the Morgan Array Area due to the presence of the Morecambe Offshore Windfarm Generation Assets. Furthermore, under storm conditions from the north, the change in sediment transport and sediment transport pathways due to the Morgan Generation Assets may extend to the limit of the Mona Generation Assets however at this distance the change is diminutive.

7.10.8.4 On similar project timelines, the construction and operation of the Round 4 Morecambe Offshore Windfarm Generation Assets alongside the Morgan and Morecambe Transmission Assets are expected to coincide with the operations and maintenance phase of the Morgan Generation Assets. The impact of Morgan Generation Assets on the sediment transport and sediment transport pathways has been modelled on its own, with a low magnitude of impact discussed in section 7.8.8. As highlighted above the increase in infrastructure will not cause a cumulative change on the sediment transport regime as the impacts caused by the turbines are localised and return to baseline levels just beyond the infrastructure. An overlap of these changes in the sediment transport and sediment transport pathways is not expected as they are limited to the immediate vicinity of the Morgan Array Area.

7.10.8.5 The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low**.

West of Walney MCZ

7.10.8.6 It is predicted that the impact will affect the designated features of the West of Walney MCZ.

7.10.8.7 The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. The magnitude is therefore, considered to be **negligible**.

West of Copeland MCZ

7.10.8.8 It is predicted that the impact will affect the designated features of the West of Copeland MCZ.

7.10.8.9 The cumulative effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. The magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

Subtidal habitat IEFs

7.10.8.10 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.8.15 to 7.8.8.22 and above in Table 7.21.

7.10.8.11 The subtidal coarse and mixed sediments with diverse benthic communities IEF, subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptor is therefore considered to be **negligible**.

West of Walney MCZ

7.10.8.12 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.8.23 to 7.8.8.26 and above in Table 7.21.

7.10.8.13 The subtidal mud IEF and subtidal sand IEF are deemed not to be sensitive and are of national value. The sensitivity of the receptors is therefore considered to be **negligible**.

7.10.8.14 The sea-pens and burrowing megafauna communities IEF is deemed to be of high vulnerability, low recoverability and national value. The sensitivity of the receptors is therefore considered to be **high**.

West of Copeland MCZ

7.10.8.15 The sensitivity of the IEFs is as described previously for the construction phase assessment for the Morgan Generation Assets alone in paragraph 7.8.8.27 to 7.8.8.29 and above in Table 7.21.

7.10.8.16 The subtidal coarse sediment IEF, subtidal mixed sediment IEF and subtidal sand IEF are deemed to not be sensitive and are of national value. The sensitivity of the receptors is therefore considered to be **negligible**.

Significance of effect

Subtidal Habitat IEFs

7.10.8.17 Overall, for the subtidal coarse and mixed sediments with diverse benthic communities IEF, the subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes IEF and the low resemblance stony reef IEF the magnitude of the cumulative changes in physical processes impact during the operations and maintenance phase is deemed to be low and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

West of Walney MCZ

7.10.8.18 Overall, for the subtidal sand IEF and subtidal mud IEF the magnitude of the cumulative changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

7.10.8.19 Overall, for the sea-pens and burrowing megafauna communities IEF the magnitude of the cumulative changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms. This conclusion has been reached based on the small magnitude of physical processes changes associated with the activities in this phase of the project and the distance of this MCZ from these activities.

West of Copeland MCZ

7.10.8.20 Overall, for the subtidal coarse sediment IEF, subtidal mixed sediment IEF and the subtidal sand IEF the magnitude of the cumulative changes in physical processes impact during the operations and maintenance phase is deemed to be negligible and the sensitivity of the receptor is considered to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms. This conclusion has been reached on the basis of the small magnitude and highly localised changes in physical processes predicted as a result of the Morgan Generation Assets and the high resistance of these IEFs to this impact.

7.10.9 Future monitoring

7.10.9.1 No benthic subtidal ecology monitoring to test the predictions made within the impact assessment is considered necessary.

7.11 Transboundary effects

7.11.1.1 A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to benthic subtidal ecology from the Morgan Generation Assets upon the interests of other states.

7.12 Inter-related effects

7.12.1.1 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 wind 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 benthic subtidal ecology, such as direct habitat loss or disturbance, increased SSC, 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.

7.12.1.2 A description of the likely interactive effects arising from the Morgan Generation Assets on benthic subtidal ecology is provided in volume 2, chapter 15: Inter-related effects of the PEIR.

7.13 Summary of impacts, mitigation measures and monitoring

7.13.1.1 Information on benthic subtidal ecology within the benthic subtidal ecology study area was collected through desktop and site-specific surveys. Information and assessment of the Morgan Array Area ZOI will be added later following results of the 2022 survey campaign.

- Table 7.28 presents a summary of the potential impacts, measures adopted as part of the Morgan Generation Assets and residual effects in respect to benthic subtidal ecology. The impacts assessed include: temporary habitat loss/disturbance, increased SSC and associated deposition, disturbance/remobilisation of sediment-bound contaminants, long term habitat loss, colonisation of hard structures, increased risk of introduction and spread of INNS, removal of hard substrates, changes in physical processes, EMF from subsea electrical cabling and heat from subsea electrical cables. 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 7.29 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include: temporary habitat loss/disturbance, increased SSC and associated deposition, long term habitat loss, colonisation of hard structures, increased risk of introduction and spread of INNS, removal of hard substrate and changes in physical processes. 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 regard to effects of the Morgan Generation Assets.

Table 7.28: Summary of potential environmental effects, mitigation and monitoring.

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

Description of impact	Phase[a]			Measures adopted as part of the project	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
	C	O	D							
Temporary habitat loss/disturbance	✓	✓	✓	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Development of, and adherence, to a CMS.	Subtidal habitat IEFs C: Low O: Negligible D: Low	Subtidal habitat IEFs • Low - Medium	Subtidal habitat IEFs C: Minor O: Negligible D: Negligible - Minor	N/A	Minor/Negligible	None
Increased SSC and associated deposition	✓	✓	✓	None	Subtidal habitat IEFs C: Low O: Negligible D: Low West of Walney MCZ IEFs C: Negligible O: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible O: Negligible D: Negligible	Subtidal habitat IEFs • Negligible - Low West of Walney MCZ IEFs • Negligible West of Copeland MCZ IEFs • Negligible - Low	Subtidal habitat IEFs C: Negligible O: Negligible D: Negligible - Minor West of Walney MCZ IEFs C: Negligible O: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible O: Negligible D: Negligible	N/A	Minor/Negligible	None
Disturbance/remobilisation of sediment-bound contaminants	✓	×	✓	None	Subtidal habitat IEFs C: Negligible D: Negligible West of Walney MCZ IEFs C: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible D: Negligible	Subtidal habitat IEFs • Low West of Walney IEFs • Low West of Copeland IEFs • Low	Subtidal habitat IEFs C: Negligible D: Negligible West of Walney MCZ IEFs C: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible D: Negligible	N/A	Negligible	None
Long term habitat loss	✓	✓	✓	None	Subtidal habitat IEFs C: Low O: Low D: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C: Minor O: Minor D: Minor	N/A	Minor	None
Colonisation of hard structures	✓	✓	×	None	Subtidal habitat IEFs C: Low O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C: Minor O: Minor	N/A	Minor	None
Increased risk of introduction and spread of invasive non-native species (INNS).	✓	✓	✓	Development of, and adherence to, an Environmental Management Plan, including actions to minimise INNS.	Subtidal habitat IEFs C: Low O: Low D: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C: Minor O: Minor D: Minor	N/A	Minor	None

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 effect	Proposed monitoring
Removal of hard substrates.	×	×	✓	None	Subtidal habitat IEFs D: Low	Subtidal habitat IEFs • Low	Subtidal habitat IEFs C: Minor	N/A	Minor	None
Changes in physical processes.	×	✓	×	None	Subtidal habitat IEFs O: Low West of Walney MCZ IEFs O: Negligible West of Copeland MCZ IEFs O: Negligible	Subtidal habitat IEFs • Negligible West of Walney MCZ IEFs • Negligible - High West of Copeland MCZ IEFs • Negligible	Subtidal habitat IEFs O: Negligible West of Walney MCZ IEFs O: Negligible - Minor West of Copeland MCZ IEFs O: Negligible	N/A	Minor/Negligible	None
Electromagnetic Fields (EMF) from subsea electrical cabling	×	✓	×	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Commitment to cable burial where possible.	Subtidal habitat IEFs O: Negligible	Subtidal habitat IEFs • Low	Subtidal habitat IEFs O: Negligible	N/A	Negligible	None
Heat from subsea electrical cables	×	✓	×	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Commitment to cable burial where possible.	Subtidal habitat IEFs O: Negligible	Subtidal habitat IEFs • Low	Subtidal habitat IEFs O: Negligible	N/A	Negligible	None

Table 7.29: Summary of potential cumulative environmental effects, mitigation and monitoring.

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

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 effect	Proposed monitoring
Tier 1										
Temporary habitat loss/disturbance	✓	✓	✓	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Development of, and adherence, to a Construction Method Statement (CMS).	C: Low O: Low	Subtidal habitat IEFs • Low - Medium	Subtidal habitat IEFs C: Minor O: Minor	N/A	Minor	None
Increased SSC and associated deposition	✓	✓	✓	None	Subtidal Habitat IEFs C: Low O: Negligible D: Negligible West of Walney C: Negligible O: Negligible D: Negligible West of Copeland C: Negligible O: Negligible D: Negligible	Subtidal habitat IEFs • Negligible - Low West of Walney IEFs • Negligible West of Copeland IEFs • Negligible - Low	Subtidal Habitat IEFs C: Negligible O: Negligible D: Negligible West of Walney C: Negligible O: Negligible D: Negligible West of Copeland C: Negligible O: Negligible D: Negligible	N/A	Negligible	None
Long term habitat loss.	✓	✓	✓	None	C and O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor	N/A	Minor	None
Colonisation of hard structures.	✓	✓	×	None	C and O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor	N/A	Minor	None
Increased risk of introduction and spread of invasive non-native species (INNS).	✓	✓	✓	Development of, and adherence to, an Environmental Management Plan, including actions to minimise INNS.	O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs O: Minor	N/A	Minor	None
Removal of hard substrates.	×	×	✓	None	N/A	• N/A	N/A	N/A	N/A	N/A
Changes in physical processes.	×	✓	×	None	Subtidal Habitat IEFs O: Low West of Walney MCZ IEFs O: Negligible West of Copeland MCZ IEFs O: Negligible	Subtidal habitat IEFs • Negligible West of Walney MCZ IEFs • Negligible - High West of Copeland MCZ IEFs • Negligible	Subtidal Habitat IEFs O: Negligible West of Walney MCZ IEFs O: Negligible - Minor West of Copeland MCZ IEFs O: Negligible	N/A	Negligible	None

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 effect	Proposed monitoring
Tier 2										
Temporary habitat loss/disturbance	✓	✓	✓	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Development of, and adherence, to a Construction Method Statement (CMS).	C: Low - Medium O: Low D: Low	Subtidal habitat IEFs • Low - Medium	Subtidal habitat IEFs C: Minor O: Minor D: Negligible - Minor	N/A	Minor/Negligible	N/A
Increased SSC and associated deposition	✓	✓	✓	None	Subtidal Habitat IEFs C: Low O: Negligible D: Negligible West of Walney MCZ IEFs C: Negligible O: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible O: Negligible D: Negligible	Subtidal habitat IEFs • Negligible - Low West of Walney MCZ IEFs • Negligible West of Copeland MCZ IEFs • Negligible - Low	Subtidal Habitat IEFs C: Minor - Negligible O: Minor - Negligible D: Minor - Negligible West of Walney MCZ IEFs C: Negligible O: Negligible D: Negligible West of Copeland MCZ IEFs C: Negligible O: Negligible D: Negligible	N/A	Minor/Negligible	None
Long term habitat loss.	✓	✓	✓	None	C and O: Low D: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor D: Minor	N/A	Minor	None
Colonisation of hard structures.	✓	✓	×	None	C and O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor	N/A	Minor	None
Increased risk of introduction and spread of invasive non-native species (INNS).	✓	✓	✓	Development of, and adherence to, an Environmental Management Plan, including actions to minimise INNS.	O: Low D: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs O: Minor D: Minor	N/A	Minor	None
Removal of hard substrates.	×	×	✓	None	D: Low	Subtidal habitat IEFs • Low	D: Minor	N/A	Minor	None
Changes in physical processes.	×	✓	×	None	Subtidal Habitat IEFs O: Negligible West of Walney MCZ IEFs O: Negligible West of Copeland MCZ IEFs O: Negligible	Subtidal habitat IEFs • Negligible West of Walney MCZ IEFs • Negligible - High West of Copeland MCZ IEFs • Negligible	Subtidal Habitat IEFs O: Negligible West of Walney MCZ IEF O: Negligible -Minor West of Copeland MCZ IEF O: Negligible	N/A	Minor/Negligible	None

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 effect	Proposed monitoring
Tier 3										
Temporary habitat loss/disturbance	✓	✓	✓	Development and adherence to a CSIP which will include cables to be buried to where possible and cable protection as necessary. Development of, and adherence, to a Construction Method Statement (CMS).	C: Low - Medium O: Low	Subtidal habitat IEFs • Low - Medium	Subtidal habitat IEFs C: Minor O: Minor	N/A	Minor	None
Long term habitat loss.	✓	✓	✓	None	C and O: Low D: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor D: Minor	N/A	Minor	None
Colonisation of hard structures.	✓	✓	×	None	C and O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs C and O: Minor	N/A	Minor	None
Increased risk of introduction and spread of invasive non-native species (INNS).	✓	✓	✓	Development of, and adherence to, an Environmental Management Plan, including actions to minimise INNS.	O: Low	Subtidal habitat IEFs • High	Subtidal habitat IEFs O: Minor	N/A	Minor	None
Removal of hard substrates.	×	×	✓	None	D: Low	Subtidal habitat IEFs • Low	D: Minor	N/A	Minor	None

7.14 Next steps

7.14.1.1 As outlined in section 7.1.3, to date, only the site-specific surveys within the Morgan Array Area have been completed and were available to inform this chapter for the purposes of the PEIR. Further site-specific surveys were undertaken in the summer of 2022 to include the ZOI around the Morgan Array Area. The baseline description and impact assessments in this chapter will therefore be updated with this additional data for the final Environmental Statement.

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