FIVE ESTUARIES OFFSHORE WIND FARM

ENVIRONMENTAL STATEMENT

VOLUME 6, PART 2, CHAPTER 5: BENTHIC AND INTERTIDAL ECOLOGY – REVISION B (CLEAN)

Application Reference	EN010115
Application Document Number	6.2.5
Revision	B
Pursuant to	Decision period
EcoDoc Number	005024200-02
Date	September 2025

In preparation of this document Five Estuaries Wind Farm Ltd has made reasonable efforts to ensure that the content is accurate, up to date and complete for the purpose.

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Mar-24	ES	GoBe	GoBe	VE OWFL
B	Sep-25	Decision Period	GoBe	GoBe	VE OWFL

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GLOSSARY OF TERMS

Term	Definition
Array areas	The areas where the wind turbines will be located
Array cables	Cables which connect the wind turbines to each other and to the offshore substation(s)
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	A region of habitat associated with a particular ecological community
Cumulative effects	The combined effect of Five Estuaries Offshore Wind Farm (VE) in combination with the effects from a number of different projects, on the same single receptor/resource. Cumulative impacts are those that result from changes caused by other past, present or reasonably foreseeable actions together with VE.
Design Envelope	A description of the range of possible elements that make up the Five Estuaries design options under consideration, as set out in detail in the project description. This envelope is used to define Five Estuaries for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the “Rochdale Envelope” approach.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement.
EUNIS habitat classification	A pan-European system which facilitates the harmonised description and classification of all types of habitats through the use of criteria for habitat identification.
Export cables	Cables that transfer power from the offshore substation(s) or the converter station(s) to shore.
Export cable corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Five

Term	Definition
	Estuaries array area to the proposed substation areas, within which the export cables will be located.
Geophysical	Relating to the physics of the earth.
Habitats of principle importance	Habitats of principal importance (Section 41 of the 2006 Natural Environmental and Rural Communities (NERC) Act)
Impact	An impact to the receiving environment is defined as any change to its baseline condition, either adverse or beneficial, resulting from the activities associated with the construction, operation and maintenance, or decommissioning of the project.
Interconnector cables	Cables that may be required to interconnect the offshore substations in order to provide redundancy in the case of cable failure elsewhere, or to connect to the offshore accommodation platforms in order to provide power for operation.
Intertidal	The area of the shoreline which is covered at high tide and uncovered at low tide.
Maximum design scenario (MDS)	The maximum design parameters of each asset (both on and offshore) considered to be a worst case for any given assessment.
Mitigation	Mitigation measures, or commitments, are commitments made by the project to reduce and/or eliminate the potential for significant effects to arise as a result of the project.
Offshore substation(s)	One or more offshore substations to convert the power to higher voltages and/or to HVDC and transmit this power to shore.
Order Limits	The extent of development including all works, access routes, TCCs, visibility splays and discharge points.
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Report to Inform Appropriate Assessment (RIAA)	A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European conservation sites and Ramsar sites. The process consists of up to four stages of assessment: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI) and compensatory measures.
Scour and cable protection	In order to prevent seabed scour around foundation structures and cables, cable protection may be placed on the seabed to protect from current and wave action.
Side Scan Sonar (SSS)	Side-imaging sonar used to create an image of the seafloor.
Single-beam and multi-beam echo sounders (SBES and MBES)	A type of sonar which transmits soundwaves, using the time taken between emission and return to establish a depth. This can be done using singular or multiple beams.
Subtidal	The region of shallow waters which are below the level of low tide.

Term	Definition
Wind turbine	All of the components of a wind turbine, including the tower, nacelle, and rotor.
Wind turbine foundation	The wind turbines are attached to the seabed with a foundation structure typically fabricated from steel or concrete.

DEFINITION OF ACRONYMS

Term	Definition
AoS	Area of Study
BAC	Background Assessment Concentration
BAP	Biodiversity Action Plan
BEIS	Business, Energy and Industrial Strategy (now DESNZ)
BGS	British Geological Survey
BNG	Biodiversity Net Gain
BSH	Broad Scale Habitat
CBRA	Cable Burial Risk Assessment
CEA	Cumulative Effects Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CMACS	Centre for Marine and Coastal Studies
CPEMMP	Construction Project Environmental Management and Mitigation Plan
CSIP	Cable Specification and Installation Plan
DCO	Development Consent Order
DBT	Dibutyltin
DDV	Drop-down Video
DESNZ	Department of Energy Security and Net Zero
DEP	Dudgeon Extension Project
Defra	Department of Environmental Food and Rural Affairs
EA	Environment Agency
ECC	Export Cable Corridor
ECR	Export Cable Route
EEA	European Economic Area
EEZ	Exclusive Economic Zones
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union

Term	Definition
EUNIS	European Nature Information System
FEQC	Federal Environmental Quality Guidelines
FOCI	Features of Conservation Interest
GBS	Gravity Base Structure
GES	Good Environmental Status
HDD	Horizontal Directional Drilling
HOCI	Habitat of Conservation Importance
HVDC	High Voltage Direct Current
HRA	Habitats Regulation Assessment
INNS	Invasive Non-Native Species
IMO	International Maritime Organisation
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
JUV	Jack-up vessels
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effects
MarESA	Marine Evidence Based Sensitivity Assessment
MarLIN	Marine Life Information Network
MBES	Multi-beam Echo Sounder
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MCCIP	Marine Climate Change Impacts Partnership
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenario
MHWS	Mean High Water Springs
MINNS	Marine Invasive Non-Native Species
MMO	Marine Management Organisation
MNCR	Marine Nature Conservation Review
MPI	Multi-Purpose Interconnector
MPS	Marine Policy Statement

Term	Definition
MSFD	Marine Strategy Framework Directive
NE	Natural England
NERC	Natural Environment Research Council
NNR	National Nature Reserve
NPS	National Policy Statement
O&M	Operation and maintenance
OCP	Organochlorine pesticides
OESEA	Offshore Energy Strategic Environmental Assessment
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
PLONOR	Pose Little Or No Risk
POL	Proposed Order Limits
PSA	Particle Size Analysis
RIAA	Report to Inform Appropriate Assessment
RPSS	Route Planning and Site Selection
RSMP	Regional Seabed Monitoring Programme
SAC	Special Area of Conservation
SBES	Single-beam Echo Sounder
SBP	Sub-bottom Profiler
SCIs	Sites of Community Importance
SEP	Sheringham Shoal Extension Project
SoS	Secretary of State
SPA	Special Protection Area
SPP	Scour Protection Plan
SSC	Suspended Sediment Concentrations

Term	Definition
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
SQG	Sediment Quality Guidelines
UXO	Unexploded Ordinance
TBT	Tributylin
THC	Total Hydrocarbon Content
VE	Five Estuaries Offshore Wind Farm
VE OWFL	Five Estuaries Offshore Wind Farm Limited
VER	Value of Ecological Features
WTG	Wind Turbine Generator
ZoI	Zone of Influence

5 BENTHIC AND INTERTIDAL ECOLOGY

5.1 INTRODUCTION

5.1.1 This chapter has been prepared by GoBe Consultants Ltd and presents an assessment of the potential effects on benthic and intertidal ecology of the offshore works (including construction, operation and maintenance (O&M) and decommissioning) associated with the Five Estuaries Offshore Wind Farm (hereafter referred to as VE).

5.1.2 This chapter has been informed by the following Environmental Statement (ES) chapters and annexes:

- Volume 6, Part 1, Chapter 4: Site Selection and Alternatives;
- Volume 6, Part 2, Chapter 1: Offshore Project Description;
- Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes;
- Volume 6, Part 2, Chapter 3: Marine Water and Sediment Quality;
- Volume 6, Part 2, Annex 2.3: Physical Processes Technical Assessment;
- Volume 6, Part 5, Annex 2.4: Main Array and ECR - Environmental Features Report;
- Volume 6, Part 5, Annex 5.1: Main Array – Benthic Ecology Monitoring Report; and
- Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.

5.2 STATUTORY AND POLICY CONTEXT

5.2.1 This section identifies legislation and national and local policy of particular relevance to benthic subtidal and intertidal ecology.

5.2.2 In undertaking the assessment, the following legislation and policy has been considered:

- The Infrastructure Planning (Environmental Impact Assessment) (EIA) Regulations 2017;
- The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended);
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979);
- EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna (the 'Habitats Directive')[1];
- The Conservation of Habitats and Species Regulations 2017 (as amended);

[1] The Habitats Directive (Council Directive 92/43/EEC) and certain elements of the Wild Birds Directive (Directive 2009/147/EC) (known as the Nature Directives) were transposed into domestic law by the 2017 Regulations. Following the UK's exit from the EU the Regulations were updated by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 to reflect that the UK was no longer part of the EU. Any references to Natura 2000 in the 2017 Regulations and in guidance now refers to the new national site network.

- The Conservation of Offshore Marine Habitats and Species Regulations 2017;
- Marine and Coastal Access Act 2009; and
- The Wildlife and Countryside Act 1981 (as amended).

5.2.3 Guidance on the issues to be assessed for offshore renewable energy developments has been obtained through reference to:

- The Overarching National Policy Statement (NPS) for Energy (NPS EN-1; Department for Energy and Climate Change (DECC), 2023a);
- The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3, DECC, 2023b);
- Overarching NPS EN-1 (Department for Energy Security & Net Zero (DESNZ, 2023a));
- National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b); and
- The UK Marine Policy Statement (MPS; HM Government, 2011).

5.2.4 Table 5.1 provides a summary of the key provisions of relevance to this assessment.

Table 5.1: Legislation and policy context.

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
Overarching National Policy Statement for Energy NPS EN-1 (DESNZ, 2023a)	Paragraph 5.4.51 of the NPS EN-1 states: *"The SoS is bound by the duties in relation to Marine Conservation Zones (MCZs) imposed by sections 125 and 126 of the Marine and Coastal Access Act 2009".*	The VE offshore ECC and array areas do not cross any MCZs. An MCZ assessment is presented within Volume 5, Report 6: Marine Conservation Zone (MCZ) Assessment, with a summary of the relevant habitats presented within this chapter for completeness. Where any potential indirect impacts might occur to neighbouring Kentish Knock East MCZ and Blackwater, Crouch, Roach and Colne Estuaries MCZ, this has been discussed within the assessment of indirect impacts within Section 5.11 and 5.12.
National Policy Statement for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b)	Paragraph 2.8.101 of NPS EN-3 states: *"Applicant must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their*	Consideration of the construction, operation and decommissioning phases of the scheme are set out in Section 5.11 and 5.12 of this chapter.

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, [Habitats Regulation Assessments (HRAs)] and MCZ assessments".	
	Paragraph 2.8.104 of NPS EN-3 states: *"Applicants should consult at an early stage of pre-application with relevant statutory consultees, as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken".*	Consultation has been undertaken through the scoping process and is ongoing through the EIA Evidence Plan process as set out in Section 5.3
	Paragraph 2.8.106 of NPS EN-3 states: *"Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational OWFs should be referred to where appropriate".*	Relevant data collected as part of post-construction monitoring from other OWFs has informed the assessment of Section 5.11 and 5.12 of this chapter. The Marine Management Organisation (MMO) has produced a review (MMO, 2014) on post-construction monitoring that has been undertaken for OWFs within which it is noted that there have been limited effects arising on benthic communities from certain impacts.
	Paragraph 2.11.40 of NPS EN-3 states: *"Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity as well as negative ".*	An assessment of both the positive and negative effects of VE is provided in Section 5.11 and 5.12 of this chapter.
	Paragraph 2.8.116 of NPS EN-3 states:	An assessment of the effects from all development phases on benthic and intertidal

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	"Applicant assessment of the effects on the subtidal environment should include: loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes, e.g.,sandwave/boulder/UXO clearance".	habitats and species in the vicinity of VE is provided in Section 5.11 and 5.12 of this chapter. These assessments included all likely effects from temporary and permanent habitat loss and the effects of changes in physical processes.
	Paragraph 2.8.116 of NPS EN-3 states *"Applicant assessment of the effects on the subtidal environment should include: habitat disturbance from construction and maintenance/repair vessels' extendable legs and anchors".*	An assessment of the effects of benthic and intertidal disturbances throughout the whole of the development (Section 5.11 and 5.12), with specific reference to construction vessels and anchors and habitat disturbance within the intertidal zone in Table 5.12.
	Paragraph 2.8.116 of NPS EN-3 states: *"Applicant assessment of the effects on the subtidal environment should include: increased suspended sediment loads during construction and from maintenance/repairs".*	Consideration of the specific effects of increased suspended sediment load and the associated sediment deposition on benthic and intertidal ecology are set out in Section 5.11 and 5.12.
	Paragraph 2.8.116 of NPS EN-3 states: *"Applicant assessment of the effects on the subtidal environment should include: Where necessary, the assessment on the subtidal environment should include: predicted rates at which the subtidal zone might recover from temporary effects".*	The likely rates of recovery of benthic and intertidal habitats/ species have been presented for each impact assessed, and are based on the Marine Evidence Based Sensitivity Assessment (MarESA) which has been used to inform the assessment as set out in Section 5.11 and 5.12 of this chapter.
	Paragraph 2.8.119 of NPS EN-3 states: *"Applicant assessment of the effects of installing transmission*	Consideration of the potential effects upon intertidal habitats during construction is

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	infrastructure across the intertidal/coastal zone should demonstrate compliance with mitigation measures identified by The Crown Estate in any plan-level HRA produced as part of its leasing round and include information, where relevant, about: predicted rates at which the intertidal zone might recover from temporary effects, based on existing monitoring data".	considered further in Section 5.11, 5.11.40 and 5.11.81.
	Paragraph 2.8.126 of NPS EN-3 states: *"Applicant assessment of the effects on the subtidal environment should include protected sites"*	Consideration of protected sites and the potential effects on the relevant habitats associated with the construction, operation and decommissioning are set out in Section 5.11 and 5.12 of this chapter. Reference to Natura 2000 sites and their features are also made in the Volume 5, Report 4: Report to Inform Appropriate Assessment (RIAA).
	Paragraph 2.8.234 of NPS EN-3 states: *"Mitigation measures which applicants are expected to have considered may include:* > *surveying and micrositing of the turbines, or re-routing of the export and inter-array cables to avoid adverse effects on sensitive/protected habitats, biogenic reefs, or protected species;* > *burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and*	Where considered appropriate, and where effects associated with the project may be considered significant in the absence of mitigation, mitigation has been considered during the assessment.

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	> *the use of anti-fouling paint could be minimised on subtidal surfaces in certain environments, to encourage species colonisation on the structures, unless this is within a soft sediment MPA and thus would allow colonisation by species that would not normally be present".*	
	Paragraph 2.11.53 of NPS EN-3 states: *"The Secretary of State should consider the effects of a proposed development on marine ecology and biodiversity, considering all relevant information made available by the applicant SNCBs and any other relevant party".*	Where relevant to benthic ecology this has been described and considered within the assessment for VE.
	Paragraph 2.8.218 of NPS EN-3 states: *"Mitigation may be possible in the form of a careful design of the development itself and the construction techniques employed".*	Consideration of mitigation during the assessment, where considered appropriate and where effects associated with the project may be considered significant in the absence of mitigation are set out in Section 5.11 and 5.12 of this chapter.
	Paragraph 2.8.296 of NPS EN-3 states: *"The Secretary of State may consider that monitoring of any impact is appropriate."*	Where appropriate, and where sufficient uncertainty exists in the prediction of significance, monitoring has been considered during assessment of potential effects associated with the VE assessment, which includes a pre-construction survey in order to microsite around any habitats of principal importance (Section 41 of the 2006 Natural Environmental and Rural Communities (NERC)

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
		Act). Any monitoring commitment are set out in the Offshore In Principle Monitoring Plan (Volume 9, Report 32).
	Paragraphs 2.8.317 of NPS EN-3 state: *"The Secretary of State should be satisfied that activities have been designed considering sensitive subtidal environmental aspects and discussions with the relevant conservation bodies have taken place."*	Section 5.11 and 5.12 of this chapter present the assessment of the conservation status of intertidal and benthic receptors.
	Paragraph 2.8.352 of NPS EN-3 states: *"Where adverse effects are anticipated either during the construction or operational phases, in coming to a judgement, the Secretary of State should consider the extent to which the effects are temporary or reversible."*	Section 5.11 and 5.12 of this chapter include the duration and reversibility of effects in the assessment of effects.
	Paragraph 2.8.310 of revised NPS EN-3 states: *"the Secretary of State should also consider any negative impacts from external cable protection on benthic habitats, and a balance between protection of various receptors must be made, with all mitigation and alternatives reviewed."*	Offshore cables are proposed to be buried for the project. However, the potential need for cable protection (either for crossings and/ or where burial is not achievable) has been considered within the assessments in relation to the potential effects on the receiving benthic environment. An assessment of the nature, potential burial depth, and installation of export cables is provided in Section 5.11 and 5.12, in accordance with the cable design and specification as presented in Volume 6, Part 2, Chapter 1: Offshore Project Description and Volume 9, Report 13: Outline

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
		M&LS SAC Benthic Mitigation Plan and Volume 9, Report 9: Outline Cable Burial Risk Assessment.
Marine Strategy Framework Directive (MSFD) (2008)	Descriptor 1 – Biological diversity: *"Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions."*	Consideration of the effects on biological diversity for VE alone and the Cumulative Effects Assessment (CEA) are set out in Section 5.13 of this chapter.
	Descriptor 2 – Non-indigenous species: *"Non-indigenous species introduced by human activity are at levels that do not adversely alter the ecosystems."*	Consideration of the potential for effects associated with marine invasive non-native species (INNS) on benthic species and habitats that may be attributable to the VE project are set out in Section 5.11, 5.12 and 5.13 of this chapter.
	Descriptor 4 – Elements of marine food web: *"All elements of marine food webs, to the extent 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."*	Consideration of the effects on benthic and intertidal ecology, inclusive of the interlinkages with interdependent ecological receptors described in other chapters and wider ES with inter-relationships are set out in Section 5.15 of this chapter.
	Descriptor 6 – Sea floor integrity: *"Seafloor 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."*	Consideration of the effects on benthic and intertidal ecology, inclusive of any risk to ecological integrity, for VE alone and the CEA are set out in paragraphs Section 5.11, 5.12 and 5.13 of this chapter.
	Descriptor 7 – Alteration of hydrographical conditions: *"Permanent alteration of hydrographical conditions does not*	Consideration of the potential for permanent alterations to hydrographical conditions that may be attributable to VE to

Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	adversely affect marine ecosystems."	adversely affect marine ecosystems is set out in Section 5.12 of this chapter.
	Descriptor 8 – Contaminants: *"Concentrations of contaminants are at levels not giving rise to pollution effects."*	Consideration of the effects of contaminants on benthic and intertidal habitats and species are set out in Section 5.11 and 5.12 of this chapter.
	Descriptor 10 – Marine litter: *"Properties and quantities of marine litter do not cause harm to the coastal and marine environment."*	An Outline Project Environmental Management Plan (PEMP) (Volume 9, Report 18) has been produced for DCO Application. The PEMP will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. A Decommissioning Programme will be developed post consent to cover the decommissioning phase (Table 5.13).
East Inshore and East Offshore Marine Plans – ECO1	*"Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation."*	Cumulative effects are considered within section 5.13.
East Inshore and East Offshore Marine Plans – MPA1	*"Any impacts on the overall marine protected area network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network."*	Designated nature conservation sites within the VE study area have been described in section 5.7 and assessed in sections 5.11, 5.12, and 5.13.

5.3 CONSULTATION

5.3.1 As part of the Environmental Impact Assessment (EIA) for VE, consultation has been undertaken with various statutory and non-statutory authorities, through the agreed Evidence Plan process (being used for the EIA process as well as for the Habitats Regulation Assessment (HRA)). A formal Scoping Opinion was sought from the SoS following submission of the Scoping Report (VE OWF Ltd., 2021). The Scoping Opinion (PINS, 2021) was issued in November 2021 by PINS. A record of key areas of consultation, specific to benthic subtidal and intertidal ecology undertaken during the Scoping Opinion, Evidence Plan phases and informal consultation, is summarised within Table 5.2 and will be presented in full within Volume 5, Report 1: Consultation Report (to be submitted with the DCO Application).

Table 5.2: Summary of consultation relating to Benthic Subtidal and Intertidal ecology.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
January 2021 Benthic Survey Licensing Meeting with MMO, Cefas and Natural England	The geophysical survey and benthic characterisation survey methods were presented, and all parties were in agreement with the survey approach presented. Cefas requested the use of more recent data sets including Greater Gabbard and Galloper Wind Farm monitoring reports.	The full description of the site-specific survey methodologies is presented within Volume 6, Part 5, Annex 5.1: Main Array – Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report; and Volume 6, Part 5, Annex 2.4: Main Array and ECR - Environmental Features Report. Greater Gabbard and Galloper Wind Farm monitoring reports have informed the existing environment as presented in Table 5.6.
February 2021 Marine Ecology & Processes Expert Topic Group (ETG)	It was requested that biotope codes should be converted to the EUNIS equivalent.	EUNIS biotopes have been recorded using the new 2022 biotope codes (EUNIS, 2022).
May 2021 Marine Ecology & Processes ETG	The principles and scope of the benthic survey plan were agreed with consultees (Natural England, Cefas, MMO and Environment Agency). The rationale for the selection of grab and DDV sampling sites was presented and agreed.	The final survey scope is presented in Section 5.7. The full description of the site-specific survey methodologies and sample analysis is presented within Volume 6, Part 5, Annex 5.1: Main Array: Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report; and Volume 6, Part 5, Annex 2.4: Main Array and ECR - Environmental Features Report.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
November 2021 PINS on behalf of SoS Scoping Opinion	PINS agreed that VE can scope out noise pollution and transboundary effects as part of this assessment.	All impacts confirmed to be scoped out by PINS are not included within the assessment. With regards to transboundary effects these have been screened out following detailed transboundary screening, see Volume 6, Part 1, Chapter 3, Annex 3.2: Transboundary Screening for the purposes of regulation 32 of the 2017 EIA Regulations.
November 2021 PINS on behalf of SoS Scoping Opinion	PINS did not agree to scope out impacts related to accidental pollution as the Scoping Report does not contain sufficient information.	Table 5.13 details the mitigation in relation to pollution prevention.
November 2021 PINS on behalf of SoS Scoping Opinion	PINS reminded that following EU exit, reference should be made to the relevant UK regulations, rather than to the Directive.	Section 5.2 has sought to identify the most appropriate and relevant policy, including regulations, at the time of writing of this ES chapter.
November 2021 PINS on behalf of SoS Scoping Opinion	PINS raised concerns regarding the baseline data for the wider study area, where site-specific data are not collected. The Inspectorate assumes that baseline data for this wider area would be derived from the data sources. However, some of this data was collected in 2009 or 2011 and coverage across the study area is uneven. The Environmental Statement (ES) must provide a justification as to the validity of the baseline data used in the assessment.	Site-specific survey data was collected across the VE array areas and offshore ECC where there is a potential risk of significant effects occurring. To understand the wider study area, where indirect impacts are to benthic receptors are anticipated to be low risk, VE have relied on historic data and broadscale habitat data of variable sources and dates to build a comprehensive picture. An appraisal of this validity is provided in Section 5.6.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
November 2021 PINS on behalf of SoS Scoping Opinion	PINS requested that the assessment of effects during the operational phase should explain how the frequency of maintenance activities has been determined. If this remains to be determined at the point of assessment, then the assessment should be based on a worst-case scenario.	An assessment of maintenance activities is provided in Section 5.12. An estimate, based on experience, of analogous projects has been used to inform the potential repair and replacement activities anticipated throughout the lifetime of the project.
November 2021 PINS on behalf of SoS Scoping Opinion	PINS advise that these impacts (including those associated with site preparation) should be included in the ES but should be clearly badged as activities to be consented separately via a Marine Licence.	Details of the removal of UXO will be provided separately in a Marine Licence application, however an Outline UXO MMMP has been submitted at application for information (Volume 9, Report 14.2). Site preparation activities have been fully appraised within Section 5.11.
November 2021 Marine Management Organisation (MMO), Scoping Opinion	MMO requested confirmation on how the geophysical data would be used to select baseline benthic sampling stations and state whether biogenic reef will be targeted at the characterisation stage (to inform the impact assessment) or only at the pre-construction survey stage (to inform micro-siting).	Geophysical data was appraised for features of potential conservation interest as well as to determine the scope of the ground-truthing site specific survey assessment. Survey locations were positioned to obtain good coverage of representative habitats and to further investigate any potential features of conservation importance identified in the geophysical data. MMO were provided with the Scope of Works for the benthic surveys with comments from VE provided in May 2021. The approach to survey design was agreed by consultees (MMO, Cefas and Natural England) during the process).
November 2021 MMO, Scoping Opinion	MMO confirmed that they are happy for VE to scope out noise/ vibration and accidental	All impacts confirmed to be scoped out by MMO aren't included within the assessment. Note that this advice was not confirmed by Natural England or PINS.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	pollution in relation to benthic ecology receptors.	
November 2021 MMO, Scoping Opinion	MMO raised concerns regarding the offshore cable route having a small overlap with the Margate and Long Sands (M&LS) Special Area of Conservation (SAC). They confirmed that a small adjustment to the route would prevent any overlap with the site if practicable.	The Project has considered the guiding principles of site selection using a proportionate approach taking into account all relevant constraints, see Volume 6, Part 1, Chapter 4: Site selection and Alternatives. The conservation objectives for all designated sites will be referred to within the RIAA (Volume 5, Report 4) however, due to the small footprint of VE, no adverse effect on integrity is predicted. VE has progressed compensation options for any potential impact to the features of the M&LS SAC. Furthermore, Section 5.11 and 5.12 provides a thorough assessment of the impacts to protected features.
November 2021 MMO, Scoping Opinion	MMO agreed that impacts will generally be localised, though there may be potential for non-local, cumulative impacts if infrastructure from various projects acts as steppingstones for the spread of non-native species.	Cumulative impacts associated with MINNS is addressed within Section 5.13.
November 2021 MMO, Scoping Opinion	MMO agreed transboundary impacts are screened out due to the localised nature of any potential impacts. However, MMO stated that consideration should be given to whether the project could have transboundary effects by facilitating the spread of non-native species.	An assessment of the impacts of MINNS is provided within Sections 5.11, 5.12 and 5.13 and potential transboundary effects is provided in Section 5.16.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
November 2021 MMO, Scoping Opinion	MMO stated that additional data source for seahorses (benthic and intertidal ecology) is The Seahorse Trust (www.theseahorsetrust.org), which should be added to the data sources used. However, as this information is sensitive, we recommend that it is included as a separate confidential appendix to avoid release into the public domain.	Seahorse are discussed and appraised within Volume 6, Part 2, Chapter 6: Fish and Shellfish Ecology.
November 2021 Natural England, Scoping Opinion	Natural England stated there was a need to ensure that robust site-specific data is collected with more detail on the benthic survey plans to supplement existing data.	Specific survey methods were subject to consultation with Natural England and Cefas prior to commencement in August 2021. Natural England were provided with the Scope of Works for the benthic surveys with comments from VE provided in May 2021. The full results of site-specific surveys are presented within Volume 6, Part 5, Annex 5.1: Main Array: Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report and summarised within Section 5.7.
November 2021 Natural England, Scoping Opinion	Natural England stated that consideration has only been given to the extent in which the data points overlap with VE; age of data, type of data is also important, with the age of the data and, therefore, applicability becoming a key factor.	Site-specific survey data was collected across the VE array areas and offshore ECC where it is anticipated that the biggest risk to benthic ecology and intertidal receptors are likely. To understand the wider study area, where impacts are anticipated to be low risk VE have relied on historic data and broadscale habitat data of variable sources and dates to build a comprehensive picture. An appraisal of this validity is provided in Section 5.6.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
November 2021 Natural England, Scoping Opinion	Natural England advised for the impact of accidental pollution to be scoped into the HRA assessment due to regular pollution reports concerning leaks and spillages from support vessels and WTGs.	This impact has been screened into the RIAA (Volume 5, Report 4).
November 2021 Natural England, Scoping Opinion	Natural England stated that for all Annex I habitats there must be clear demonstration of how impacts will be avoided, reduced, and mitigated. In addition, cable protection should also be avoided in areas identified for reef management. There will need to be an assessment of the impacts for M&LS SAC.	Pre-construction surveys will be undertaken to determine the location, extent and composition of any habitats of principal importance and/or Annex I and impacts to the features will be avoided as far as reasonably practicable. A full assessment of potential impacts to protected features are presented within Section 5.11 and 5.12 and within the RIAA.
November 2021 Natural England, Scoping Opinion	Natural England advised that the JNCC Conserving Marine Protected Areas advice on operations and conservation objectives for designated sites are key to determining sensitivity of features.	The conservation objectives for designated sites will be referred to within the RIAA and Volume 5, Report 6: Marine Conservation Zone (MCZ) Assessment. The approach to determining sensitivity of features within this assessment is described in Section 5.5, whereby features of conservation significance are given higher weight within the sensitivity assessment.
November 2021 Natural England, Scoping Opinion	Natural England advised the assessment to include impacts on Special Protection Area (SPA) designations where the benthic habitats serve as supporting habitats for SPA bird features, including the Outer Thames Estuary SPA as several of the supporting habitats for	An assessment of SPA designations with regards to the benthic habitats acting as supporting habitats for bird features has been included in Section 5.11 and 5.12.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	Red-throated diver are present within the area of search AoS.	
November 2021 Natural England, Scoping Opinion	Natural England advised recoverability consideration of the impacts from repeated maintenance activities over the lifetime of the project is key when considering if impacts are temporary, or whether recovery is likely to be hindered further. The assessment should consider the effects of ongoing perturbations to benthic receptors as a result of maintenance activities.	The worst-case scenario for repeated maintenance activities over the lifetime of the project has been considered throughout the assessment and in Section 5.12.
November 2021 Natural England, Scoping Opinion	Measures adopted as part of the project as per advice provided on Norfolk Boreas, Natural England advises that the ability to microsite may not be feasible given all the other constraints, including Archaeology. Therefore, consideration of other constraints should be undertaken during the consenting phase.	Volume 6, Part 1, Chapter 4: Site selection and alternatives details all the known constraints in the area. There are currently no benthic features that VE are anticipating to microsite around, however this will be further considered at the pre-construction phase of works.
November 2021 Natural England, Scoping Opinion	Natural England stated there was a need to present cumulative ecosystem effects and advised that SPA designations should be included with regards to the benthic habitats acting as supporting habitats for bird features.	Cumulative ecosystem effects have been considered and SPA designations have been included within this assessment (Section 5.13).
November 2021 Natural England, Scoping Opinion	Natural England advised on the difficulties of using Horizontal Directional Drilling (HDD) under marsh areas due to the nature of the	As detailed within Volume 6, Part 3, Chapter 7: Onshore Archaeology and Cultural Heritage, geotechnical works have provided information to inform HDD feasibility.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	marsh sediment and stated the submission should provide geotechnical information to support the technical feasibility of HDD, and in parallel consider the merits of all landfall options from an ecological perspective and identify the scale and significance of any likely impacts.	
November 2021 Essex County Council, Scoping Opinion	Essex County Council are concerned that, despite reference to Biodiversity Net Gain (BNG) in the mitigation hierarchy, there is no statement about BNG assessment in the Scoping Report. We recommend that this report demonstrates the baseline assessment and details of losses and compensatory habitat as well as biodiversity enhancements to demonstrate net gain of habitats in both the Terrestrial Ecology and Benthic ecology ES chapters.	BNG is not currently a statutory or policy requirement within the marine environment, however VE are committed to following the outcome of recent Defra consultation, industry discussions and therefore the evolution of this topic.
December 2021 Marine Ecology & Processes ETG	Natural England expressed a concern regarding the time of year the site-specific survey was carried out (November 2021). This concern particularly related to the DDV surveys, since they were undertaken in November 2021, with poor visibility, low quality imagery, and a small number of images/video footage clips obtained, in addition to the high percentage of sites with no imagery at all.	This was discussed with the survey contractor Fugro Ltd., who stated that they have completed numerous surveys in the region and were not able to obtain clear images in the summer months at similar locations. Therefore, the seasonality of the survey is unlikely to be the driving factor for unsuccessful imagery, rather it is the naturally turbid environment. A freshwater lens was used.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
December 2021 Marine Ecology & Processes ETG	The Cefas Benthic Renewables team note the low number of samples in both Arrays and requested information on whether this is due to the homogeneous nature of the sediments/habitats identified during the geophysical survey. If there are several habitats present within the Array and along the export cable corridor, The Cefas Benthic Renewables team would like assurance that these have been sampled in sufficient quantity for the characterisation.	Five Estuaries Offshore Wind Farm Limited (hereafter the Applicant') confirms that the site-specific sample locations were informed by the Side Scan Sonar (SSS) data to ensure adequate sampling across all habitat types and seabed features. This process was undertaken in line with the Scope of Works for the benthic surveys with comments from VE provided in May 2021. A sufficient quantity of samples were located across the representative habitats as detailed within Volume 6, Part 5, Annex 5.1: Main Array: Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.
October 2022 Marine Ecology & Processes ETG	Cefas suggested that long term habitat loss should be assessed as a permanent impact and OneBenthic Database should be included as part of the baseline characterisation.	The terminology has been updated and the assessment of permanent habitat loss is assessed in Section 5.12. The Cefas OneBenthic comprehensive dataset of macrofaunal data and baseline model (Cooper *et al.* 2019) has been used to demonstrate the macrofaunal assemblages across the VE array areas and offshore ECC as detailed within Section 5.7.
October 2022 Marine Ecology & Processes ETG	Natural England commented that there may be some additional information that can be taken from M&LS SAC data.	Natural England has provided VE with M&LS SAC data. This data will be used to inform the ES.
December 2022	Natural England had previously raised concerns regarding the scope of the benthic	The Applicant provided the following responses to concerns during the December consultation:

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
Pre-PEIR Project Update with Natural England	ecology subtidal survey. The following subjects were raised in a letter dated 05 October 2022:- > Temporal limitations > Geophysical Data > ZoI > Meiofauna > *Sabellaria spinulosa*	Temporal limitations: The main temporal limitations will be sites within the photic zone (the few inshore sites), however the biotopes that have been recorded across the array areas and offshore ECC should fundamentally be the same despite the survey being conducted in winter months. Whilst we acknowledge that the optimal time for these surveys is spring/summer, practical constraints have dictated sampling. As per the JNCC guidance '*Where this is necessary, the temporal disparity should be acknowledged in analysis and reporting'*. Geophysical Data: The Applicant provided evidence of the survey design overlaying the geophysical data and demonstrated the representative sample locations against this data. ZoI: Site specific samples were not located within the secondary ZoI. Industry stance is that this is not normally sampled because the impacts to benthos beyond the footprint are not significant. However, as detailed within Section 5.7, there is a wealth of historic data in the public domain to support characterisation of the wider ZoI. Meiofauna: For characterisation surveys all guidance advise that a 1mm mesh sieve is sufficient for subtidal sediments (including sand from sandbanks). In the

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		Applicant's experience, 1mm mesh is always used apart for intertidal muddy sediments (using a handcore). Furthermore, grab samples are generally unsuitable for meiofauna studies, with the upper sediment layer potentially flushed away during sampling. Instead, typically sampled with diver-operated corers, tube corers such as the Craib corer, or as sub-samples from box core samples. *Sabellaria spinulosa*: It is the Applicant's position that survey timing should not fundamentally disturb the assessment of reef features, particularly those that are longstanding and high quality (Annex 1) habitat.
May 2023 Natural England, S42 consultation	NE expressed concern that existing pressures in the MLS SAC are already hindering the conservation objectives (CO) of the site. The construction, maintenance and decommissioning of Ves may move the site further from these CO. NE stated that cabling activities should be firstly avoided in MLS SAC. The estimated overlap of the ECC and MLS SAC of 0.11 % cannot be viewed in isolation – number of other projects / pressures in that area / SAC and the overall impact / predicted impact is considered significant and may lead to an AeoI. NE draw Ves attention to Hornsea 3	The Applicant has worked with Natural England's advice to develop the Outline M&LS SAC Benthic Mitigation Plan (Volume 9, Report 13) which aims to reduce pressures on benthic features of the M&LS SAC. Furthermore, a 'without prejudice' compensation case (Volume 5, Report 5, Annex 5.1: Benthic Compensation Strategy Roadmap) has been developed to support the application in the event AEoI is concluded.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	decision where AeoI on the Wash and North Norfolk coast SAC could not be ruled out.	
May 2023 Natural England, S42 consultation	Consideration of MLS SAC – existing pressures on the interest features of M&LS SAC are likely to be hindering the conservation objectives for the site. Accordingly, every effort must be made to mitigate project impacts to not only reduce the project alone effects, but also the contribution made to existing pressures/cumulative impacts. Otherwise, the site is likely to be taken further away from meeting those conservation objectives. NE draw the Project's attention to the many anthropogenic pressures already operating across a considerable proportion of MLS SAC (e.g. London Array OWF, BritNed, marine aggregates etc), in addition to several planned activities (e.g. NeuConnect, Sea Link), which will further add to the pressures on the interest features of the SAC. Thus, whilst the spatial extent of the area impacted by the VE ECC may be small relative to the SAC as a whole, when all pressures are summed, it may lead to an adverse effect on the site integrity. We advise that these pressures should be fully	The Applicant has worked with Natural England's advice to develop the Outline M&LS SAC Benthic Mitigation Plan (Volume 9, Report 13) which reduces pressures on Annex I sandbank features of the M&LS SAC. Furthermore, a 'without prejudice' compensation case (Volume 5, Report 5, Annex 5.1: Benthic Compensation Strategy Roadmap) has been developed to support the application in the event AEoI is concluded.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	considered in the cumulative impacts assessment. NE draw attention to:- - Recent Hornsea 3 decision – concluded cable protection within 0.0026 % of the Wash and North Norfolk SAC was an AeoI due to site having a restore objective. Advise that impacts to MLS SAC are thoroughly considered and an In-principle compensation package is provided.	
May 2023 Natural England, S42 consultation	Natural England highlighted that it was unclear if cable protection will be required within the M&LS SAC. This impact constitutes a lasting impact over the lifetime of the project which is potentially irreversible. Unless demonstrated otherwise, scale of impacts likely to hinder the "maintain" habitat feature of the site which cannot be restored whilst the protection is in situ. Natural England advised that a Cable Burial Risk Assessment (CBRA) is provided as part of the Application. All options should be explored by VE to avoid, reduce and mitigate the impacts from the placement of cable protection including (but not exclusively), reducing the number of cables,	Table 5.12 details the maximum design scenario for cable protection within the M&LS SAC. This information informs the impact assessment presented in Section 5.12. The Outline CBRA and the Outline CSIP are presented in (Volume 9, Report 9 and Volume 9, Report 12, respectively). The Applicant also defers to Volume 9, Report 13: M&LS SAC Benthic Mitigation Plan. This plan details where mitigation has been employed to reduce pressures on the benthic features of the M&LS SAC. This plan provides clear evidence in response to Natural England's mitigation hierarchy. Furthermore, a 'without prejudice' compensation case has been developed to support the application in the event AEoI is concluded (Volume 5, Report 5, Annex 5.1: Benthic Compensation Strategy Roadmap).

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	reducing cable crossings within designated sites, minimising the cable protection requirement along the cable length within the SAC, modifying cable installation, avoiding placing cable in fisheries byelaw areas, adoption of the reburial hierarchy and using cable protection which has the greatest likelihood of successful removal.	
May 2023 Natural England, S42 consultation	Natural England advised that further work needed to be done in relation to sand wave levelling. For examples, the –Larsen *et al*., 2019 paper provides useful evidence from Race Bank OWF which indicates complete natural generation of different types of sandbanks will be achieved within 3 years after levelling if sediment is retained within the system. From NE's experience complete regeneration is likely to occur on dynamic sandbank systems if appropriate measures are implemented to retain sediment in the system. Lack of evidence to support this in more static sandbank systems e.g. Dogger Bank. Natural England advises that mitigation measures are adopted and monitoring similar in scope to the Larsen *et al*., 2019 surveys is undertaken of all areas where sand wave sweeping/levelling occurs within M&LS SAC	A detailed analysis and discussion of sandwave clearance and recovery is presented within Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 6, Part 5, Annex 2.3: Physical Processes Technical Assessment, including numerous examples of pre-dredge, post-dredge and partial recovery surveys of the Race Bank Offshore Wind Farm was produced as part of the Habitats Regulation Appraisal for the Hornsea Project Three Offshore Wind Farm (ABPmer, 2018a). Similar analysis was also undertaken for the Norfolk Vanguard and Norfolk Boreas Export Cable Route (ABPmer, 2018b). Additional mitigation will be applied where sandwave levelling might be required across the M&LSC SAC (Table 5.14) whereby, any material removed from within the SAC will be deposited back within the SAC or the same sediment cell. Following re-settlement of the deposited sediments, they will be immediately available again for transport at the naturally occurring rate and direction,

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	and is secured in the In Principle Monitoring Plan. The initial survey of the impacts should be repeated until such time that the sandbanks are considered by the regulator, in consultation with Natural England, to have satisfactorily regenerated and are providing the same structure and function as to the surrounding sandbanks.	controlled entirely by natural processes. As such, the sediment will have immediately re-joined the natural sedimentary environment within the local area and so by definition is not 'lost from the system' due to the dredging/spoil disposal process. Due to the dynamic nature of the sandwaves, these morphological features are considered to have moderate levels of recoverability. Furthermore, the Applicant will develop a monitoring scope in view of the advice from Natural England for areas where sand wave sweeping/levelling occurs within M&LS SAC. It is proposed this will be secured in the Offshore In Principle Monitoring Plan (Volume 9, Report 32).
May 2023 Natural England, S42 consultation	Natural England provided guidance on benthic mitigation measures, to reduce pressures on the SAC. This included: > Avoid Designated Site; > Reduce number of export cables though use of HV/DC system or coordinated approach with other projects; > Reduce the number of cable crossing within a designed site to avoid the requirement for cable protection; > Cutting and removing sections of disused cables to avoid cable crossings;	As detailed above, the Applicant has produced a mitigation document which provides clear evidence and application of this mitigation hierarchy. Details on migration in relation to the SAC is detailed within Volume 9, Report 13: M&LS SAC Benthic Mitigation Plan.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	> Micro siting cables around reef and other features of ecological importance; > Sand wave levelling to reduce risk of free spanning cables and requirement for external cable protection; > Adoption of the reburial hierarchy with external cable protection being last resort; > Pre-consent – finalise CBRA using Geotech. Data to focus cable protection requirements to areas where cables are likely to be sub-optimally buried; > Use of guard vessels and/or advance mapping to avoid sub-optimally buried/surface laid cables negating the need for physical cable protection; > Requirement to install cable protection with the minimal footprint; > Requirement to install cable protection with the greatest likely of removal; > No use of jack up barges along export cable routes through benthic SACs; > No cable protection in fisheries byelaw areas to avoid hindering reef recovery,	

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	noting that cable may still go through the outskirts of these areas; > Designing rock armouring to mirror the structure and function of geogenic reef; > Detonation of UXO outside of designated sites to avoid the creation of a crater; and > Cable bundling.	
May 2023 Natural England, S42 consultation	NE stated that more information is needed on the rationale behind the analysis and experimental design re: benthic communities, in particular the rationale around the number of sampling sites selected. Appropriate power analysis showing the minimum number of surveys needed to produce an appropriate confidence of statistical representation.	Section 5.7 details the wealth of data available from existing literature, data sources and site-specific surveys. The regional habitat mapping demonstrates that seabed substrates are relatively homogenous across the array areas and the further offshore on the ECC. The site-specific surveys were designed so that a representative number of sample locations were positioned across benthic habitats identified across the study area; noting that there are full coverage geophysical data to complement ground-truthing (the value and robustness of a characterisation survey is greatly improved where acoustic data of sufficient resolution and quality has been collected to inform and contribute to habitat mapping and characterisation). The Applicant considers that the survey strategy is sufficient spatial resolution to allow confidence in

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		identifying the presence and extent of benthic habitats and species for the purposes of baseline characterisation.
May 2023 Natural England, S42 consultation	Natural England state a clear set of statistical result driven parameters should be used to define magnitude. This would eliminate any subjective understanding of the definitions and allow for long term comparisons. Natural England note that the MarESA four-point classification scale has been taken into account, but additional data/ result driven categorisation would be appreciated.	The magnitude criteria follows the guidance for EIA, as detailed within Volume 6, Part 1, Chapter 3: EIA Methodology. The Applicant notes Natural England's concerns regarding subjective understanding however, it would be unachievable to have an overall result-driven magnitude for pressure. For each individual pressure, the magnitude is parameterised in relation to the defined benchmarks in the MarESA sensitivity assessments. The justification for each pressure magnitude is further discussed and assessed within Section 5.11 providing robust evidence for the final magnitude conclusion. Furthermore, the sensitivity assessment is parametrised based on resilience and resistance quantification. This follows the same process as other OWF DCO Applications to date.
May 2023 Natural England, S42 consultation	Natural England state that the use of multivariate analysis would have allowed for better representation of community dynamics. Additionally, that there is no mention of what type of statistical test was used.	The Applicant can confirm that robust univariate and multivariate statistical testing was applied during the characterisation of the baseline and determining macrofaunal assemblages, as presented within Volume 6, Part 5, Annex 5.1: Main Array: Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report. As detailed within these technical appendices the following multivariate analyses were applied to the data: Hierarchical clustering, 'Cluster' analysis, dendrogram and

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		non-metric multidimensional scaling ordinations, SIMPER and SIMPROF analyses as well as principal component analysis. The outputs of these statistics are not presented within this Chapter as this would duplicate effort, however, the analyses forms the basis of the characterisation and subsequent EIA.
May 2023 Natural England, S42 consultation	NE detailed that to assess wider variability control/reference sites will need to be included within the preconstruction baseline surveys in conjunction with the affected designated sites. This will need to be included in the In Principle Monitoring Plan.	Based on the findings presented within Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes, Section 5.11 and 5.12 and evidence from the offshore wind industry, it is clear that significant secondary impacts associated with the development are typically restricted to close to the site of impact, which is why benthic samples for faunal and physical samples outside the project boundary are not normally collected. In relation to designated features the proposed monitoring plan is presented within Volume 9, Report 9.32: Offshore In Principle Monitoring Plan.
May 2023 Natural England, S42 consultation	Natural England advised that they consider the –number of samples within the array area to be comparatively low, with the addition of only one sample taken from each site. They question whether power analysis was used to justify the number of selected sites, noting there is no mention of the statistical confidence. They state that JNCC advise states that three replicates should be undertake, highlighting there is no justification as to why one replicate was taken.	Section 5.7 details the wealth of data available from existing literature, data sources and site-specific surveys. The regional habitat mapping demonstrates that seabed substrates are relatively homogenous across the array areas and the further offshore on the ECC. The site-specific surveys were designed to allow a representative number across habitats identified across the study area; noting that there are full coverage geophysical data to complement ground-truthing (the value and robustness of a characterisation survey is greatly improved where

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	Overall, they have low / no confidence to demonstrate that an appropriate statistical and evidence survey has been carried out.	acoustic data of sufficient resolution and quality has been collected to inform and contribute to habitat mapping and characterisation). The Applicant believes that the survey strategy is sufficient spatial resolution to allow confidence in identifying the presence and extent of benthic habitats and species for the purposes of baseline characterisation. Furthermore, whilst replicate samples would provide additional statistical confidence, this strategy has not been applied to any recent OWF applications (Norfolk Vanguard, Hornsea Four, SEP, DEP, East Anglia 3 and many more) and is not deemed proportionate for the aims of the investigation.
May 2023 Natural England, S42 consultation	As above, lack of confidence in sufficient sampling number. NE advise that more sampling is needed and/or adequate justification for small sample size and lack of replicates.	See further justification regarding this issue above.
May 2023 Natural England, S42 consultation	NE advised that a long-term monitoring plan needs to be included in the In Principle Monitoring Plan. Typically, for designated sites the stages of monitoring are Pre-construction, 1 year post construction, 3 years, 5 years, 10 years post construction, with the scope of longer monitoring if required.	The Applicant has prepared a benthic monitoring plan, which is included within Volume 9, Report 32: Offshore In Principle Monitoring Plan. The final version of this plan will be consulted on in discussion with Natural England.

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
May 2023 MMO, S42 consultation	MMO requested further information relating to the scoping out of the following impacts: accidental pollution and noise pollution.	The Scoping Opinion detailed that in relation to accidental pollution that MMO have agreed to scope this out, however Natural England stated it should be scoped in. Additional rationale and evidence to support the scoping out of accidental pollution is presented within Section 5.4, based on this conflicting advice. Furthermore, this impact has been screened into the RIAA (Volume 5, Report 4). In relation to noise pollution, PINS and MMO agreed that this could be scoped out.
May 2023 MMO, S42 consultation	MMO note that impacts of noise pollution have been scoped out. They note the applicant states "that “a number of impacts have been scoped out in agreement with stakeholders”. However, in Section 5.3, when presenting the consultation to date, it is recognised that “this advice was not confirmed by Natural England”. Furthermore, the Applicant states in Table 5.2 that “All impacts confirmed to be scoped out by MMO are not included within the assessment”. Whilst we agree with the scoping out of the impacts from Noise/Vibration on the benthic receptors, we would have expected to see evidence justifying this decision within the PEIR.	PINS and MMO agreed that this could be scoped out, however further information has been provided in Section 5.4.4.
May 2023	The MMO recommend that inclusion of the potential impacts to benthic ecology during	Paint will be in line with the project chemical risk assessment and final paint specifications will be

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
MMO, S42 consultation	O&M from paint flakes deriving from the corrosion protection regime for the proposed development is included in the assessment in combination with other projects.	determined as suitable for use based on the information provided on the relevant material safety data sheet (MSDS) that will confirm that the paint is suitable for marine use. It is impossible to quantify the quantum of paint flakes that may be released over the lifetime of the project. Certainly, the scale of material released will be extremely small in the context of such material that comes from general vessel traffic in the North Sea.
May 2023 MMO, S42 consultation	The MMO welcome the use of the Regional Seabed Monitoring Programme Benthic Dataset and the OneBenthic Database.	The Applicant welcomes this feedback.
May 2023 MMO, S42 consultation	Table 5.13 of the PEIR includes several embedded mitigations. The MMO welcome the Applicants proposal of micro-siting infrastructure to avoid habitats of principle importance as a mitigation measure for consideration during construction.	The Applicant welcomes this feedback.
May 2023 MMO, S42 consultation	MMO note that the applicant states that “Further consultation and engagement that will be undertaken to inform the benthic subtidal and intertidal ecology assessment and presented within the ES”. The MMO welcome the Applicants commitment to re-evaluate the impacts on benthic ecology should they arise.	The Applicant welcomes this feedback.
September 2023	Cefas stated that the issues surrounding paint flakes have been noticed as a potential	Paint will be in line with the project chemical risk assessment and final paint specifications will be

Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
Cefas, Marine Ecology & Processes ETG	emerging issue in the literature, especially due to cumulative number of OWFs undergoing maintenance. Cefas queried if mitigation could be developed to reduce plastic input into the water.	determined as suitable for use based on the information provided on the relevant material safety data sheet (MSDS) that will confirm that the paint is suitable for marine use. It is impossible to quantify the quantum of paint flakes that may be released over the lifetime of the project. Certainly, the scale of material released will be extremely small in the context of such material that comes from general vessel traffic in the North Sea.
September 2023 Cefas, Marine Ecology & Processes ETG	Cefas stated that it would be good to explain why VE have had to move the ECC further south as a result of shipping and navigation and therefore result in an impact to the Margate and Longsands SAC.	Volume 6, Part 2, Chapter 9: Shipping and Navigation provides details of the shipping and navigation constraints along the ECC. The area to the north of Margate and Long Sands SAC is where pilots board large vessels that are accessing the ports of Harwich and Thames ports. Pilot boarding is a sensitive activity, particularly as this area is complex with high levels of vessel traffic, restricted water depths and various traffic management measures. Shipping and navigation stakeholders have advised that cable installation directly north of the SAC will impact decision making and safety in the event of an emergency and therefore have requested that the pilot boarding area is avoided by 1km. This results in the ECC crossing the SAC for 1.3 km (assuming the cable runs through the centre of the offshore ECC).

5.4 SCOPE AND METHODOLOGY

5.4.1 SCOPE OF THE ASSESSMENT

IMPACTS SCOPED IN FOR ASSESSMENT

5.4.2 The following impacts have been scoped into this assessment:

- Construction and Decommissioning:
  - Impact 1: Temporary habitat disturbance;
  - Impact 2: Temporary increase in suspended sediment and sediment deposition;
  - Impact 3: Direct and indirect seabed disturbances leading to the release of sediment contaminants; and
  - Impact 4: Increased risk of introduction or spread of Marine INNS.
- Operation and maintenance:
  - Impact 5: Permanent habitat loss/ alteraion;
  - Impact 6: Temporary habitat disturbance;
  - Impact 7: Colonisation of hard substrates;
  - Impact 8: Increased risk of introduction or spread of Marine INNS;
  - Impact 9: Changes in physical processes; and
  - Impact 10: EMF effects generated by inter-array and export cables during operational phase.

IMPACTS SCOPED OUT OF ASSESSMENT

5.4.3 On the basis of the baseline environment and the project description outlined in Volume 6, Part 2, Chapter 1: Offshore Project Description, a number of impacts have been scoped out in agreement with stakeholders and the Scoping Opinion (PINS, 2021), these include:

- Construction and Decommissioning:
  - Noise pollution on benthic ecology during foundation installation; and
  - Accidental pollution.
- Operation and maintenance:
  - Accidental pollution.

5.4.4 It is generally accepted that the particle motion component of noise is most relevant to benthic species. While there are few studies looking at reactions of benthic invertebrates and in particular polychaetes and infaunal bivalves, it is likely that particle motion will dissipate in close proximity to the noise source (in the order of metres). In addition, the noise will be temporary in nature and conditions will return to baseline following cessation of piling. It is proposed that this impact is therefore scoped out of the assessment – this aligns with advice from PINS and the MMO as set out above in Section 5.3.

5.4.5 The magnitude of an accidental spill will be limited by the size of chemical or oil inventory on construction vessels. In addition, released hydrocarbons will be subject to rapid dilution, weathering and dispersion and will be unlikely to persist in the marine environment. The likelihood of an incident will be reduced by the implementation of a PEMP (see Volume 9, Report 18). It is proposed that this impact is therefore scoped out of the assessment.

5.4.6 As outlined within the transboundary screening (Volume 6, Part 1, Annex 3.2) no potentially significant transboundary effects are predicted for benthic ecology receptors and therefore a transboundary effects assessment is not considered necessary in this chapter. Transboundary impacts for all stages of the VE development have been scoped out in agreement with stakeholders and the Scoping Opinion (PINS, 2021). No other potential impacts have been scoped out from further assessment in this ES chapter.

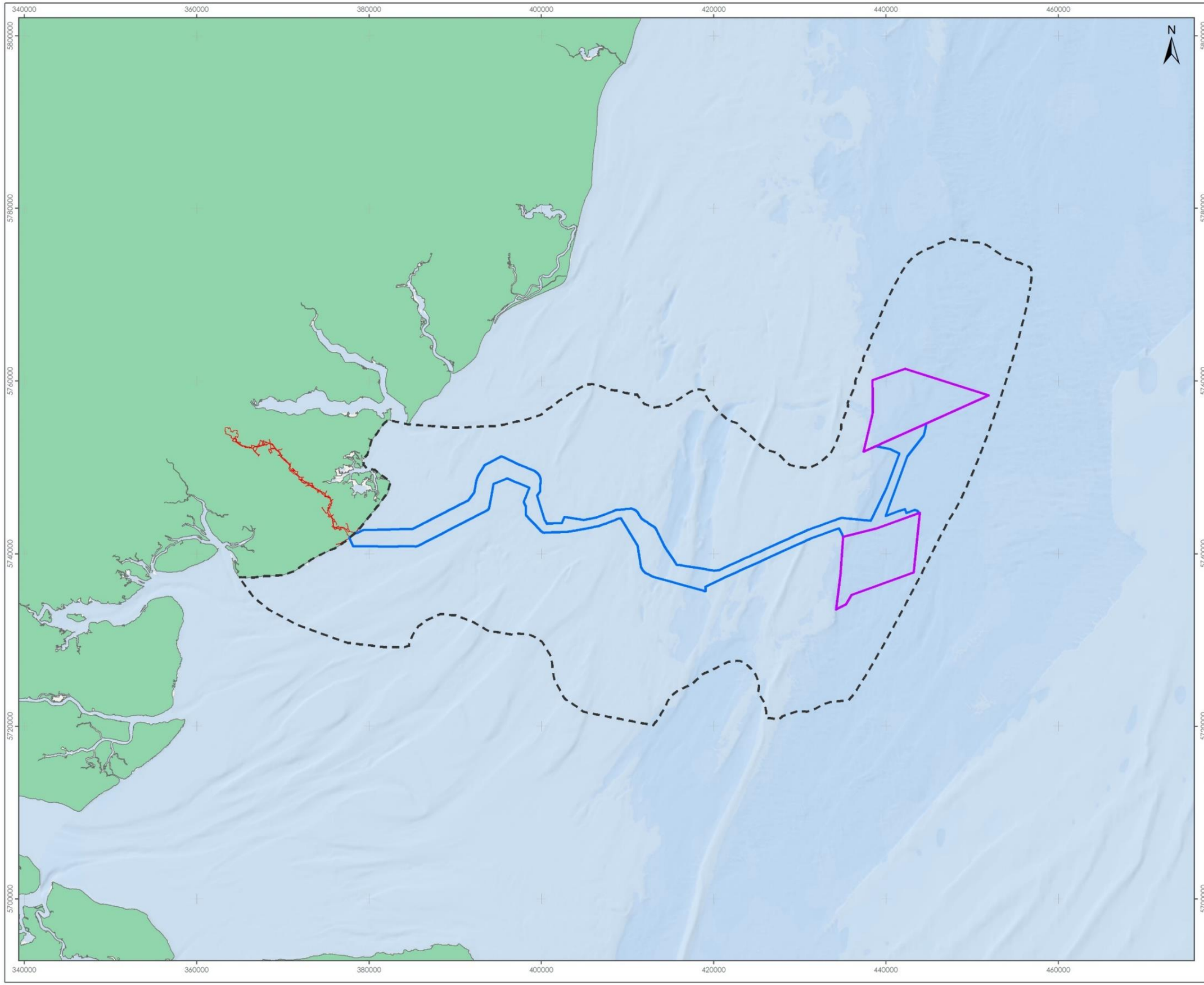
5.4.7 STUDY AREA

5.4.8 For the purposes of this report the VE benthic subtidal and intertidal study area (Figure 5.1) have been defined by the following:

- The VE project Order Limits is defined as the VE array areas along with the VE offshore ECC, where landfall lies at Holland-on-Sea and Frinton-on-Sea on the Essex coast (Figure 5.1). The Order Limits defines that area where direct impacts to benthic ecology features will be limited.
- The VE benthic subtidal study area is defined by a secondary Zone of Influence (ZoI), which has been defined based on the expected maximum distance that water from within the VE array areas and offshore ECC might be transported on a single mean spring tide, in the flood and/or ebb direction. The area conservatively indicates the likely spatial extent over which measurable plume effects arising at anytime from anywhere within the Order Limits might be experienced. The maximum distance of the secondary ZoI from the Order Limits is 22.5 km and the minimum distance is 0.85 km (Figure 5.1).
- This area defines the maximum distance suspended sediments disturbed by development activities might have an impact on benthic habitats, although the majority of suspended sediment is expected to be deposited much closer to the disturbance activity.
- The VE benthic intertidal ecology study area is defined by the intertidal habitats up to the MHWS mark within the VE offshore ECC.

5.4.9 Habitats landward of MHWS have been considered in Volume 6, Part 3: Chapter 4: Onshore Biodiversity and Nature Conservation.

5.4.10 The study area for the CEA is defined by the wider benthic ecology study area (secondary ZOI), to incorporate the maximum distance suspended sediments will travel in one tidal cycle and therefore the indirect impacts on benthic subtidal ecology arising from VE that could interact cumulatively with impacts from other plans or projects.



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits
- Benthic Ecology Study Area

0 2,500 5,000 10,000
Meters

Data Sources:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Five Estuaries Benthic Subtidal and Intertidal Study Area and ZoI

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.1

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:400,000	A3	WGS84	UTM31N

FIVE ESTUARIES
OFFSHORE WIND FARM

5.5 ASSESSMENT CRITERIA AND ASSIGNMENT OF SIGNIFICANCE

5.5.1 This assessment is consistent with the EIA methodology presented in Volume 6, Part 1, Chapter 3: EIA methodology. Potential impacts have been considered in terms of permanent or temporary, and adverse or beneficial.

5.5.2 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 sensitivity of receptors and the magnitude of potential impacts.

5.5.3 The magnitude of potential impacts is defined by a series of factors, including the spatial extent of any interaction, the likelihood, frequency and duration of a potential impact. The definitions of magnitude used in the assessment are defined in Table 5.3. Where an effect could reasonably be assigned more than one level of magnitude, professional judgement has been used to determine which rating is applicable.

Table 5.3: Impact magnitude definitions.

Magnitude	Definition
High	Fundamental, permanent/irreversible changes, over the whole receptor, and/or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent/irreversible changes, over the majority of the receptor, and/or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness
Negligible	Discernible, temporary (for part of the Proposed Development duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

5.5.4 In line with the Chartered Institute of Ecology and Environmental Management (CIEEM) guidance (CIEEM 2018), the sensitivities of different biotopes have been classified by the Marine Life Information Network (MarLIN) on the MarESA four-point scale (high – medium – low – not sensitive) (MarLIN 2019). The scale takes account of the resistance and recoverability (resilience) of a species or biotope in response to a stressor. Specific benchmarks (duration and intensity) are defined for the different impacts for which sensitivity has been assessed (e.g. smothering, abrasion, habitat alteration etc.). Detailed information on the benchmarks used and for further information on the definition of resistance and resilience can be found on the MarLIN website[2].

5.5.5 The CIEEM guidance also considers the importance of ecological features. Ecological features can be important for a variety of reasons and may relate, for example, to the quality, rarity or extent of habitats/ species, and/ or the extent to which they are threatened throughout their range, or to their rate of decline.

5.5.6 For the purposes of this assessment, four sensitivity categories have been defined, each drawing on the four MarLIN MarESA categories[2] and the importance of the receptor. Sensitivity/ importance of the environment is defined in Table 5.4.

Table 5.4: Sensitivity/ importance of the environment.

Receptor sensitivity/ importance	Description/ reason
High	Equivalent to MarLIN MarESA sensitivity category 'High'. The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e. > 25 years or not at all (resilience is 'Very Low'); or The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e. > 10 or up to 25 years (resilience is 'Low').
Medium	Equivalent to MarLIN MarESA sensitivity category 'Medium'. The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium timescales, i.e. > 2 or up to ten years (resilience is 'Medium'); or The habitat or species is noted as exhibiting 'None' resistance (tolerance) to an external factor, whether that arises from natural

[2] https://www.marlin.ac.uk/sensitivity/sensitivity_rationale

Receptor sensitivity/ importance	Description/ reason
	events or human activities, and is expected to recover over < 2 years (resilience is 'High'); or The habitat or species is noted as exhibiting 'Medium' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e. > 2 years or up to 25 years or not at all (resilience is 'Medium', 'Low' or 'Very Low').
Low	Equivalent to MarLIN MarESA sensitivity category 'Low'. The habitat or species is noted as exhibiting 'Low' or 'Medium' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over < 2 years (resilience is 'High'); or The habitat or species is noted as exhibiting 'High' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e. > 2 years or up to 25 years or not at all (resilience is 'Medium', 'Low' or 'Very Low').
Negligible	Equivalent to MarLIN MarESA sensitivity category 'Not Sensitive'. The habitat or species is noted as exhibiting 'High' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over short timescales, i.e. < 2 years (resilience is 'High').

5.5.7 The matrix used for the determination of significance is shown in Table 5.5. The combination of the magnitude of the impact with the sensitivity of the receptor determines the assessment of significance of effect. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms. Any effect that has a significance of minor or negligible is not considered to be significant in EIA terms. An assessment of the significance of potential effects is described in Sections 5.11, 5.12 and 5.13.

Table 5.5: Matrix to determine effect significance.

Magnitude		Sensitivity: High	Sensitivity: Medium	Sensitivity: Low	Sensitivity: Negligible
Adverse	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
Neutral	Negligible	Minor	Minor	Negligible	Negligible
Beneficial	Low	Moderate	Minor	Minor	Negligible
	Medium	Major	Moderate	Minor	Negligible
	High	Major	Major	Moderate	Minor

Note: shaded cells are defined as significant with regards to the EIA Regulations 2017[3].

5.6 UNCERTAINTY AND TECHNICAL DIFFICULTIES ENCOUNTERED

5.6.1 Grab sampling and video surveys, while providing detailed information on the sediment types, infauna and epifauna present, cannot cover wide swaths of the seabed and consequently represent point samples that must be interpreted in combination with the geophysical datasets to produce benthic maps that provide comprehensive cover.

5.6.2 Classification of survey data into benthic habitats and the production of benthic habitat maps from the survey data, while highly useful for assessment purposes, has two main limitations:

- Difficulties in defining the precise extents of each biotope, even when using site specific geophysical survey data to characterize the seabed; and
- There is generally a transition from one biotope to another, rather than fixed limits and therefore, the boundaries of where one biotope ends and another starts often cannot be precisely defined.

5.6.3 However, whilst biotope transitions are common the baseline data is robust and can be used to effectively characterise the VE array areas and offshore ECC for the purpose of this assessment, whilst acknowledging this level of precision.

[3] The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

5.6.4 The benthic subtidal survey campaign was conducted in November 2021, whilst this is outside the optimal survey window, the subtidal species of relevance to this chapter are not likely to undergo significant annual die back which would ultimately change the final biotope definitions. In terms of *Sabellaria spinulosa* reef the sub-optimum time for surveying would be after the winter storms, where they are likely to suffer from some breakage (Limpenny *et al*. 2010). Therefore, the characterisation and assessment remain valid.

5.6.5 The project uses historical data to characterise the wider benthic ecology study area, providing a useful picture of temporal and spatial habitats for contextualisation. Whilst VE understand the limits of using historical data, it is useful to consult all available data which helps to contribute to the wider characterisation where site-specific data cannot be obtained i.e. it would be unrealistic to undertake site specific survey works across the wider benthic ecology study area and given the greatest risks to benthic ecology receptors are typically limited to within the VE array areas and offshore ECC a bigger survey effort would be disproportionate.

5.6.6 There are additional limitations inherent within the MarESA sensitivity assessments. These include the assessments not being site specific and consequently there may be differences in sensitivity within a species in different habitats. These limitations are included within the confidence score assigned to the MarESA assessment, for which the full details and rationale are provided on the MarLIN website, and in the assessment summaries.

5.6.7 The overall confidence in the evidence used for the MarESA sensitivity assessments is assessed for three categories: the quality of the evidence/ information used; the degree to which the evidence is applicable to the assessment; and the degree of concordance (agreement) between the available evidence. A 'low' confidence score can be applied for the different categories:

- For quality of the evidence – the assessment is based on expert judgement (i.e. insufficient scientific evidence or grey literature[4]);
- For applicability of the evidence – the assessment is based on proxies for the pressure (e.g. based on natural disturbance events rather than anthropogenic); and
- For the degree of concordance of the evidence – the available evidence does not agree on direction or magnitude of the impact or recoverability.

5.6.8 The confidence of the sensitivity assessment is based on the confidence of the assessments for the resilience and resistance of each habitat. If the confidence for the resilience or resistance assessment is 'low' then the corresponding confidence for the sensitivity assessment will also be low. This is of particular relevance to the quality of the evidence that is available.

[4] Grey literature is information produced on all levels of government, academia, business and industry in electronic and print formats not controlled by commercial publishing" i.e.. where publishing is not the primary activity of the producing body.

5.6.9 However, despite the above uncertainties, it should be noted that there is robust data available on the benthic communities present in the study area. The seabed in the area is well studied and surveyed, therefore, the sensitivities of the habitats present are understood. As such, the available evidence base is considered sufficiently robust to underpin the assessment presented here and an overall high confidence is placed in the baseline characterisation.

5.7 EXISTING ENVIRONMENT

5.7.1 METHODOLOGY TO INFORM THE BASELINE

5.7.2 Information on the benthic subtidal and intertidal communities within the VE ecology study area was collected through a detailed desktop review of existing literature and data sources, and site-specific surveys. These have provided coverage across large parts of the VE benthic and intertidal ecology study area, and wider region (Table 5.6 and Figure 5.2).

5.7.3 Site specific surveys for VE have been undertaken to provide an up-to-date characterisation of the habitats and species occurring within the study area. Both the subtidal and intertidal benthic surveys were conducted by Fugro Ltd. All survey methodologies were in line with the relevant guidance documentation (Cefas, 2002; Cefas *et al*., 2004; Davies *et al*., 2001; Ware and Kenny, 2011), and agreed with stakeholders during the benthic survey consultation in May 2021 (Table 5.2).

5.7.4 A full description of the site-specific survey methodologies and sample analysis is presented within Volume 6, Part 5, Annex 5.1: Main Array: Benthic Ecology Monitoring Report; Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report; and Volume 6, Part 5, Annex 2.4: Main Array and ECR - Environmental Features Report. Table 5.6 present details of the site-specific survey data collected.

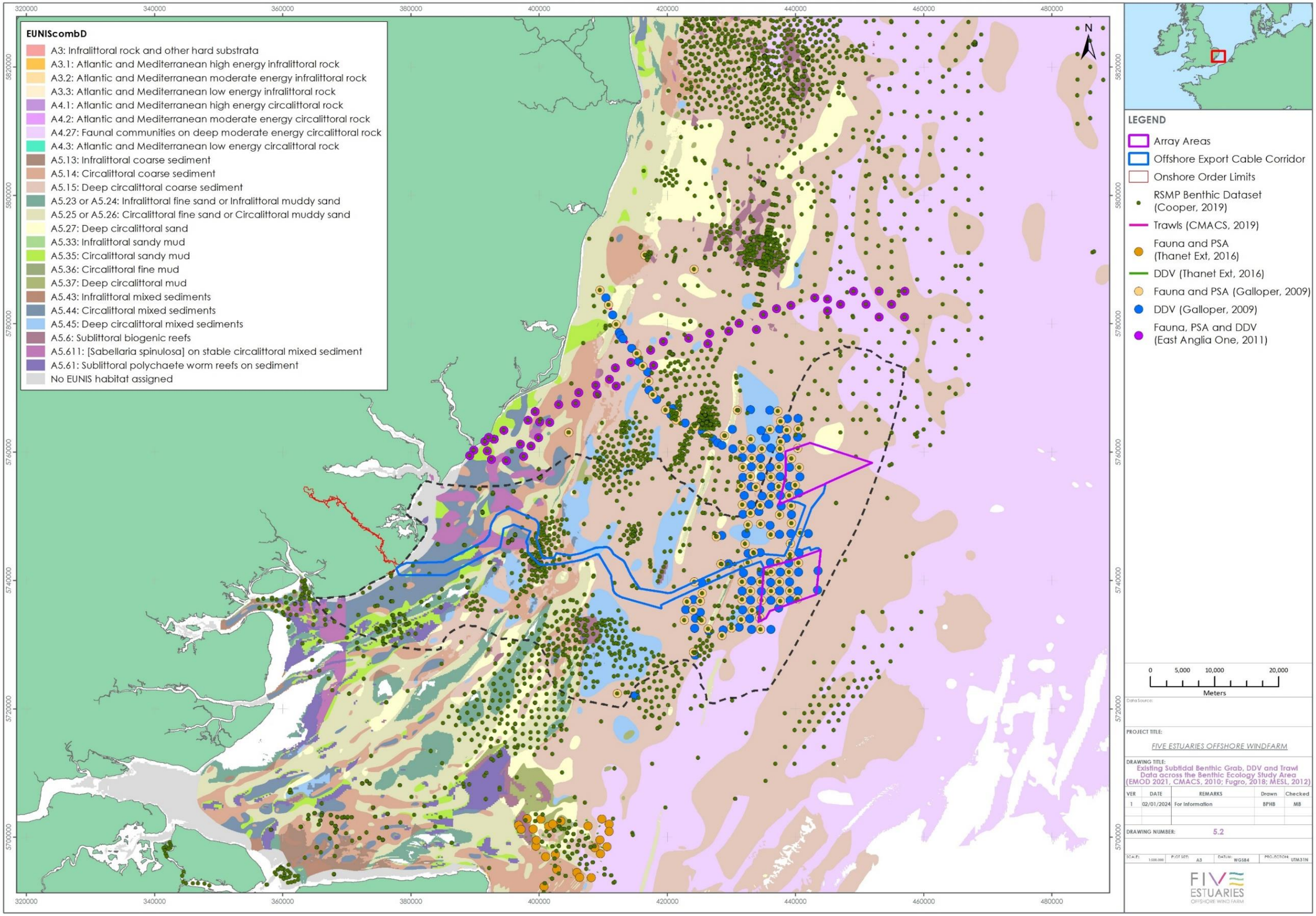
Table 5.6: Key sources of information for benthic, subtidal and intertidal ecology.

Source	Summary	Coverage of VE
VE Geophysical Survey, 2021 Volume 6, Part 5, Annex 2.4: Main Array & ECR - Environmental Features Report	Geophysical survey using single-beam and multi-beam echo sounders (SBES and MBES), side scan sonar (SSS), magnetometer and a sub-bottom profiler (SBP)	Full coverage of array areas and offshore ECC.
VE Benthic Characterisation Survey, 2021 Volume 6, Part 5, Annex 5.1: Main Array – Benthic Ecology Monitoring Report and Volume 6, Part 5, Annex 5.2: Export Cable Route and	Benthic sediment grab samples were collected with 0.1 m^2 mini-Hamon grab at locations within the array (17 stations) areas and offshore ECC (47 stations). All benthic grab samples were subject to infaunal species analysis and PSA. Chemical contaminants analysis with Day	Coverage of representative habitats within the array areas and offshore ECC (Figure 5.5).

Source	Summary	Coverage of VE
Intertidal Benthic Ecology Monitoring Report	Grab at 3 stations in array and 8 across the offshore ECC. DDV data was collected at all 14 target locations in potential conservation 'areas-of-focus' and 6 locations where there was hard substrate identified in geophysical data.	
VE Intertidal Survey, 2021 Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report	Phase I walkover survey carried out landward to mean low water springs (MLWS). Phase II sampling was conducted across 8 transects perpendicular to the shore, with a station located at High Water (HW), Middle Water (MW) and Low Water (LW) at each transect (24 stations).	Coverage of VE intertidal zone where landfall lies from where landfall lies at Holland-on-Sea and Frinton-on-Sea on the Essex coast (Figure 5.6).
Regional Seabed Monitoring Programme (RSMP) (Cooper and Barry, 2017) (data obtained from the One Benthic baseline tool[5])	The dataset comprises of 33,198 macrofaunal samples (83% with associated data on sediment particle size composition) covering large parts of the UK continental shelf. Data points for the VE benthic, subtidal and intertidal ecology study area were extracted.	Good coverage across the benthic ecology study area and wider region (Figure 5.2).
Biologically informed habitat map (Cooper *et al.*, 2019)	A biologically informed habitat map produced using all available RSMP data. Full details of the habitat map can be found here: - https://doi.org/10.1111/1365-2664.13381	Complete modelled coverage up to MHWS.
Galloper Offshore Wind Farm (OWF) site (Centre for Marine and Coastal Studies (CMACS), 2010), including pre- and post-construction surveys.	Beam trawl, benthic grab and DDV surveys were deployed to characterise the benthic infaunal and epifaunal communities. Samples collected for benthic faunal analysis, contaminant	Coverage within VE array areas (Figure 5.2).

[5] https://rconnect.cefas.co.uk/content/25/

Source	Summary	Coverage of VE
	and PSA were also undertaken for baseline characterisation.	
Environmental Statements from other OWF developments within the Outer Thames Strategic Area (Galloper, East Anglia One, Thanet Extension, Greater Gabbard and Gunfleet Sands OWF (CMACS, 2010; Marine Ecological Surveys Limited (MESL), 2012; Fugro, 2018; Greater Gabbard Offshore Wind Limited (GGOWL), 2005; RPS, 2007)	Characterisation and monitoring data for the existing OWF developments.	Site specific benthic, subtidal and intertidal surveys for wind farm developments across the Outer Thames estuary and off the coast of East Anglia (Figure 5.2).
EMODnet (2022)	EUNIS Level 4 model, detailing biological zone and substrate.	Complete modelled coverage up to MHWS.
The Outer Thames Estuary Regional Environmental Characterisation (Marine Aggregate Levy Sustainability Fund, 2009)	Provides characterisation of the marine and seabed conditions for the Outer Thames region.	Regional dataset and report covering the benthic, subtidal and intertidal ecology study area.
Information on species of conservation interest (JNCC, 2007)	Species specific data, of native species of conservation interest.	This data source provides species specific data. of native species of conservation interest.


EUNIScombD
A3: Infralittoral rock and other hard substrata
A3.1: Atlantic and Mediterranean high energy infralittoral rock
A3.2: Atlantic and Mediterranean moderate energy infralittoral rock
A3.3: Atlantic and Mediterranean low energy infralittoral rock
A4.1: Atlantic and Mediterranean high energy circalittoral rock
A4.2: Atlantic and Mediterranean moderate energy circalittoral rock
A4.27: Faunal communities on deep moderate energy circalittoral rock
A4.3: Atlantic and Mediterranean low energy circalittoral rock
A5.13: Infralittoral coarse sediment
A5.14: Circalittoral coarse sediment
A5.15: Deep circalittoral coarse sediment
A5.23 or A5.24: Infralittoral fine sand or Infralittoral muddy sand
A5.25 or A5.26: Circalittoral fine sand or Circalittoral muddy sand
A5.27: Deep circalittoral sand
A5.33: Infralittoral sandy mud
A5.35: Circalittoral sandy mud
A5.36: Circalittoral fine mud
A5.37: Deep circalittoral mud
A5.43: Infralittoral mixed sediments
A5.44: Circalittoral mixed sediments
A5.45: Deep circalittoral mixed sediments
A5.6: Sublittoral biogenic reefs
A5.611: [Sabellaria spinulosa] on stable circalittoral mixed sediment
A5.61: Sublittoral polychaete worm reefs on sediment
No EUNIS habitat assigned
320000
340000
360000
380000
400000
420000
440000
460000
480000
5820000
5800000
5780000
5760000
5740000
5720000
5700000
N
LEGEND
Array Areas
Offshore Export Cable Corridor
Onshore Order Limits
RSMP Benthic Dataset (Cooper, 2019)
Trawls (CMACS, 2019)
Fauna and PSA (Thanet Ext, 2016)
DDV (Thanet Ext, 2016)
Fauna and PSA (Galloper, 2009)
DDV (Galloper, 2009)
Fauna, PSA and DDV (East Anglia One, 2011)
0
5,000
10,000
20,000
Meters
Data Source:
PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM
DRAWING TITLE:
Existing Subtidal Benthic Grab, DDV and Trawl Data across the Benthic Ecology Study Area (EMOD 2021, CMACS, 2010; Fugro, 2018; MESL, 2012)
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WGS84
PROJECTION:
UTM31N
FIVE ESTUARIES
OFFSHORE WIND FARM

REGIONAL CONTEXT

5.7.5 The following sections provide the broad regional characterisation of the wider study area before focussing on the site-specific data. Detailed baseline descriptions, univariate and multivariate analyses are presented within the technical annexes that accompany this Chapter, including spatial representations and figures. The following section provides a summary of the detail within those reports and therefore must be read in conjunction with the following:

- Volume 6, Part 5, Annex 5.1: Main Array – Benthic Ecology Monitoring Report;
- Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report; and
- Volume 6, Part 5, Annex 2.4: Main Array and ECR - Environmental Features Report.

SEDIMENT CHARACTERISTICS

5.7.6 The seabed sediments that characterise the VE benthic ecology study area are typical of the Southern North Sea, where large areas of similar well-sorted medium or fine sands have been recorded offshore (Tappin *et al*. 2011; Cefas 2019). Nearshore heterogeneous distribution of sediments ranging from sand and mixed sediments to muddy sand sediments are characteristic of the wider area (Defra 2019; Forewind 2013; Premier Oil 2018).

5.7.7 Broadscale regional habitat mapping to EUNIS Level 4, detailing biological zone and substrate (EUSeaMap, 2022), indicates that the dominant habitats across the array areas are predominantly circalittoral coarse sediments. This is also true for the offshore ECC further offshore, which then becomes more variable with circalittoral mixed sediments, circalittoral fine sand or circalittoral muddy sand and circalittoral sands as you follow the offshore ECC back to landfall (Figure 5.2).

5.7.8 The spatial patterns evident in sediment composition are likely due to regional hydrodynamics, with proportions of mud associated with the input from the local fluvial sources, differences in depositional and erosion regimes. London clay is also found regionally, with fine-grained deep-water marine clayey silts, silty clays and clays, produce the thick (commonly >100 m) sequences of the London Clay Formation (MALSF, 2009). Well sorted mobile sand are likely to be associated with the tidally aligned sandbanks, notably the Inner Gabbard, Greater Gabbard, Galloper and North Falls (MALSF, 2009).

SEDIMENT CHEMISTRY

5.7.9 During the baseline characterisation survey at Galloper OWF (CMACS, 2010), the organic content for most of the stations ranged between 0.50 and 2.95%, levels that can reasonably be expected from areas dominated by ‘sandy gravel’ and ‘gravelly sand’, with low organic content typically associated with coarser sediments.

5.7.10 The baseline characterisation at Galloper OWF also tested surface sediments for a range of contaminants. The results revealed that there were elevated levels of arsenic in all samples. For the most part, contaminants that will have an anthropogenic source (i.e. organic compounds and heavy metals) were found to be at low levels (CMACS, 2010). Similar results were recorded at the Greater Gabbard and London Array OWF, with the only contaminant found at significant levels being arsenic (GGOWL, 2005). Arsenic is known to occur at high levels in seabed sediments in several parts of the North Sea, including a wide area of the outer Thames Estuary (Whalley *et al*., 1999), which has been attributed to historical disposal of arsenical wastes.

5.7.11 The site-specific VE sediment contaminant data have been collected and analysed for the site and are presented in paragraphs 5.7.29 *et seq*. for the array areas and 5.7.50 *et seq*. for the offshore ECC.

SEABED HABITAT AND COMMUNITIES

5.7.12 The benthic habitats of the southern North Sea are generally defined by the substrata of the seabed. Mobile sand dominated habitats are generally considered to be species poor and are characterised by robust species such as annelid worms and fast burrowing bivalves (Barne *et al*., 1998, Jones *et al*., 2004). Epibenthic flora and fauna normally occur on mixed substrata with significant coarse components, where a range of microhabitats allow colonisation by a wide array of species (Jones *et al*., 2004).

5.7.13 The MALSF Regional Environmental Classification work (MALSF, 2009) found four broad groups of benthic infauna across the region, dominated at the high level by sublittoral coarse sediment and sublittoral sands and muddy sand habitat complexes (Connor *et al*., 2004).

5.7.14 The biological-based seabed map utilises a comprehensive dataset of macrofaunal data (33,198 samples from 777 surveys) and used these data to produce a baseline assessment for UK shelf waters (Cooper *et al*. 2019). This large dataset was created by integrating empirical data acquired from both governmental and non-governmental sector (e.g., marine aggregates, offshore wind, oil and gas) monitoring efforts and is a useful resource. The model demonstrates that the macrofaunal assemblages across the VE array areas and offshore ECC were characterised bythe following groupings: -

- C1a - was characterised by members of the polychaete families Spionidae, Terebellidae, Serpulidae, Syllidae, Capitellidae, Cirratulidae, Lumbrineridae, Sabellariidae, Nemertea, Glyceridae and the nematode family Nemertea. This group is recorded across the array areas and likely to be located on a variety of sandy substrates.
- C1b, was characterised by a similar assemblage to C1a but included the amphipod family *Ampeliscidae* and members of the polychaete families *Phyllodocidae, Polynoidae, Scalibregmatidae* and *Pholoidae*. This group is recorded across the array areas and likely to be located on a variety of sandy substrates.
- D2a, represented a faunal assemblage that was characterised by members of the polychaete families *Spionidae, Glyceridae, Terebellidae, Capitellidae, Phyllodocidae* and the nematode family *Nemertea.* This group is recorded across the array areas and likely to be located on a variety of sandy substrates.

- D2c - represented a faunal assemblage that was characterised by polychaetes including members of the families *Nephtyidae, Spionidae* and *Opheliidae*. All of which are typically found in sands and muddy sands. This faunal cluster is widespread across the array areas and offshore ECC.

5.7.15 The results of the benthic characterisation surveys across the adjacent Galloper OWF site, which included grab, DDV and trawl data identified that the infaunal communities across the site were relatively species poor, with the most taxa reported in any one grab sample totalling 63 (CMACS, 2010). The most abundant faunal group in the grab survey were annelid worms. The most abundant taxa included the keel worm *Spirobranchus triqueter*, the Ross worm *Sabellaria spinulosa* and the white furrow shell *Abra alba* (CMACS, 2010). Sessile epifauna recorded were dominated by echinoderms and crustaceans typical of sands and muddy sand sediments, such as the brittlestars *Ophiura ophiura*, *Ophiura albida,* the sea potato *Echinocardium cordatum* and decapods including the shrimp *Crangon allmani* and the prawn *Pandalus brevirostris* (CMACS, 2010).

5.7.16 The results of the surveys across the Galloper OWF site identified a number of biotopes, these included:

- *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (EUNIS 2022 code: MC3212);
- Polychaete-rich deep Venus community in offshore circalittoral mixed sediment (EUNIS 2022 code: MD4211);
- *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (EUNIS 2022 code: MB5233);
- *Spirobranchus triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (EUNIS 2022 code: MC3211);
- *Spisula subtruncata* and *Nephtys hombergii* in Atlantic infralittoral muddy sand (EUNIS 2022 code: MB5238); and
- Sabellaria spinulosa on stable Atlantic circalittoral mixed sediment (EUNIS 2022 code: MC2211)

5.7.17 The biotope communities identified above are typical of the faunal assemblages previously described for the southern North Sea. This is supported by benthic surveys undertaken at Greater Gabbard OWF which described the benthic communities from across much of the surveyed area to be dominated largely by the biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (EUNIS 2022 code: MC3212) (GGOWL, 2005).

5.7.18 Results from the site-specific surveys undertaken at the London Array site, the south of the Galloper OWF and Greater Gabbard OWF identified that the benthic community were also similar to that described above, with the main biotopes also being '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (EUNIS 2022 code: MC3212) (CMACS, 2005).

5.7.19 Biotopes identified within this desktop assessment of the wider benthic ecology study area have been included within the Valued Ecological Receptors (VER) table (Table 5.11).

5.7.20 Annex I habitats are defined under the Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora; more commonly referred to as the EC Habitats Directive (1992) as amended. Under this Directive, which has been transposed into UK legislation through the Conservation of Habitats and Species Regulations 2017, species and habitats that fall into specific categories are eligible for legal protection from activities that have the potential to damage them. Annex I habitats are protected through a network for SACs that aims to establish a network of important high-quality conservation sites that will make a significant contribution to conserving the habitats listed in Annex I.

5.7.21 Non-designated Annex I 'reef' (biogenic and geogenic) and Annex I 'sandbanks slightly covered by seawater all the time' have been recorded across the VE benthic and intertidal ecology study area within historic data (CMACS, 2010; JNCC, 2019, 2021; MESL, 2012), as demonstrated in Figure 5.3. The offshore ECC crosses the northern top of the M&LS SAC which is designated for 'sandbanks slightly covered by seawater all the time'.

5.7.22 The only biotope of potential conservation importance that was recorded through a review of historic surveys was the *S. spinulosa* dominated biotope. *S. spinulosa* is prevalent in the southern North Sea, with reefs more commonly found in association with more stable sedimentary deposits (Pearce, 2014). *S. spinulosa* reef can be extremely ephemeral in nature and has been recorded 'disappearing' in areas where a seemingly stable habitat has previously been established, such as Saturn Reef in the southern North Sea (Pearce, 2014).

5.7.23 Dense aggregations of the *S. spinulosa* have previously been found in the deeper, polychaete dominated areas, on mixed sediments across the Outer Thames Estuary (MALSF, 2009). The only *S. spinulosa* reefs recorded during the MALSF REC surveys were to the south of Greater Gabbard and Galloper OWF, in the vicinity of Long Sand Head (MALSF, 2009).

5.7.24 Interpretation of side-scan sonar survey data to summarise major seabed features for the Greater Gabbard OWF found no indications of extensive reef-like structures and suggested most of the area away from the Gabbard and Galloper sandbanks to be generally thin layers of sand and gravel over clay (GGOWL, 2005). During the benthic characterisation at Galloper OWF, *S. spinulosa* was commonly recorded, however, there was only a single station (located outside of the Galloper OWF boundary) where *S. spinulosa* dominated in possible reef form.

5.7.25 *S. spinulosa* has been found in sufficient abundance to warrant the classification of a separate biotope at several other wind farms in the region including Scroby Sands (Worsfold and Dyer, 2005), Thanet (MESL, 2005), Thanet Extension (Fugro, 2018) and East Anglia One (MESL, 2012). At Thanet OWF where development microsited around areas of *S. spinulosa* reef, post-construction surveys noted a positive growth of reef features which was attributed to the reduction in destructive bottom fishing activities as a result of the presence of the OWF and associated cable infrastructure (Pearce *et al*., 2014).

340000 360000 380000 400000 420000 440000 460000

5800000 5780000 5760000 5740000 5720000 5700000

N

LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits
- Benthic Ecology Study Area
- Annex I Sandbanks
- Reefs (BGS)

Galloper EIA *S. spinulosa* assessment (2009)

- Extensive
- Present
- Abundant Patches

EA ONE EIA *S. spinulosa* assessment (2009)

- Potential Low Quality Reef
- Potential Low-Medium Quality Reef

Annex I Reefs by Subtype (JNCC 2021)

- Bedrock
- Bedrock / Mixed
- Biogenic
- Stony

0 2,500 5,000 10,000

Meters

Data Source:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Potential Annex I Habitats across the Benthic, Subtidal and Intertidal Ecology Study Area and Wider Region (CMACS, 2010; JNCC, 2019, 2021; MESL, 2012)

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.5

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:450,000	A3	WGS84	UTM31N

FIVE ESTUARIES
OFFSHORE WIND FARM

SEDIMENT CHARACTERISTICS

5.7.26 Spatial distribution of EUNIS biotope complexes identified through single point grab sampling and side scan sonar (SSS) data are presented in Figure 5.4. It can be seen from the assessment of this data that the northern array is dominated by deep circalittoral coarse sediment to the east of the array and deep circalittoral mixed sediment to the west of the array. The array areas corridor presents a similar characterisation of these two sediment complexes. One of the DDV stations (FE1_01) also recorded firm clay with round burrows of piddocks within the northern array, as identified in Figure 5.5. The southern array is dominated by deep circalittoral sand with more heterogenous sediments (coarse and mixed) either side of the sand.

5.7.27 PSA of the sediments sampled across the VE study area determined that sediment type varied spatially throughout the array areas; sediments in the northern array were heterogeneous with increased gravel and fines in the west of the northern array, whereas sediments across the southern array were more homogenous with coarse sand. The coarsest sediment in the array areas corridor was most likely derived from older gravelly formations that were submerged due to rising sea levels (DTI, 2002).

5.7.28 London clay formations are found at or close to the surface in much of the Array Areas, deepening in areas where it has been incised by the Pleistocene channels or absent where eroded, exposing the Harwich formation (Fugro, 2022).

360000 380000 400000 420000 440000

5780000 5760000 5740000 5720000

N

LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits

EUNIS Biotopes (Fugro 22), Sediment:

- MC1251 -Piddocks with sparse associated fauna in very soft chalk or clay w A5.44
- A5 Sublittoral sediment
- A5.1 Sublittoral coarse sediment / A5.4 Sublittoral mixed sediments
- A5.13 - Infralittoal coarse sediment
- MC32 - Circalittoral coarse sediment
- MD3 - Deep circalittoral coarse sediment
- MC5 - Circalittoral muddy sand
- MD5 - Deep circalittoral sand
- A5.4 - Sublittoral mixed sediments
- A5.43 Infralittoral mixed sediments
- MC4 - Circalittoral mixed sediments
- A5.45 - Deep circalittoral mixed sediments

0 2,500 5,000 10,000

Meters

Data Source:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

EUNIS Biotope Complexes identified through single point Grab Sampling and Side Scan Sonar Data across the RLB (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.3

SCALE: 1:300,000	PLOT SIZE: A3	DATUM: WGS84	PROJECTION: UTM31N

FIVE ESTUARIES OFFSHORE WIND FARM

SEDIMENT CHEMISTRY

5.7.29 As presented in Volume 6, Part 5, Annex 5.1: Main Array - Benthic Ecology Monitoring Report the following contaminants were recorded as below the Level of Detection:

- Total hydrocarbon content (THC);
- Polycyclic aromatic hydrocarbons (PAHs);
- Polychlorinated biphenyls (PCBs);
- Polybrominated Diphenyl Ethers (PBDE)
- Organotins (including dibutyltin (DBT) and tributyltin (TBT)); and
- Organochlorine pesticides (OCPs)

5.7.30 All metals analysed were below CAL1. In addition, all metal concentrations in sediment samples across the VE array areas were below the Canadian sediment quality guidelines for all metals except arsenic, the concentration of which was above the Canadian TEL at all stations. The arsenic concentrations recorded in this study remained below CAL2 (8.7 mg/kg to 18.8 mg/kg) and were within the range of < 0.15 mg/kg to 135 mg/kg reported for the southern North Sea (Whalley *et al*., 1999).

5.7.31 Concentrations of PBDE across the array areas were below both the Background Assessment Concentrations (BAC) and Federal Environmental Quality Guidelines (FEQG) with the exception of BDE-209, which exceeded the BAC but remained below the FEQG for all samples. The main component of commercial decabromodiphenyl ether products, BDE-209 is historically measured at the highest of all the PDBE congeners within the sediments of the Southern North Sea (Bersuder *et al*., 2018).

5.7.32 Further details of sediment contamination is provided in Volume 6, Part 2, Chapter 2: Marine Water and Sediment Quality and Volume 6, Part 5, Annex 5.1: Main Array - Benthic Ecology Monitoring Report.

SEABED HABITAT AND COMMUNITIES

5.7.33 Across the array areas, a total of 1,208 individuals representing 141 taxa were recorded from the 17 macrofaunal samples acquired. Benthic subtidal community structure and composition were generally dominated by Annelida, that comprised most of the enumerated taxa composition (56.0 %), followed by Arthropoda (22.7 %), Mollusca (14.2 %) and Echinodermata (3.5 %). Other phyla comprised 3.5% of the taxa composition and were represented by Cnidaria (non-burrowing anemones of the order Actiniaria), *Phoronis*, Ascidiacea and Nemertea. The macrobenthic communities recorded in this study are indicative of coarse sediment habitats subject to a degree of surface sediment disturbance, as indicated by the polychaete composition, notably *Hesionura elongate* and species of *Glycera* (Künitzer *et al*., 1992; Heip and Craeymeersch, 1995) and the occurrence of crustaceans such as *Ampelisca spinipes* (Tillin, 2019).

5.7.34 Univariate indices indicated diverse communities in the northern array and array areas corridor and a moderate diversity in the southern array. The faunal community structure and composition reflected the sediment diversity and associated hydrodynamics, with macrofaunal richness and abundance higher at stations featuring coarse sediment, notably stations along the array areas corridor. Multivariate indices indicated a relatively heterogenous benthos reflecting the varying coarseness of the seabed sediment in a high energy environment.

5.7.35 There was a clear spatial distribution in the habitat types present within the array areas which is reflected by sediment character. By combining and considering collectively the macrofaunal data, DDV data, PSA data and geophysical data, two biotope complexes and two biotopes within the array areas were identified (Figure 5.5 and Table 5.7).

5.7.36 The biotope 'Sparse fauna in Atlantic infralittoral mobile clean sand' (MD5231) was recorded at two sites in the southern array. Faunal richness and abundance were low and represented by the polychaete *Nephtys cirosa* and the isopod *Eurydice pulchra* and were typical of clean sands with moderate exposure to wave or tidal action.

5.7.37 'Polychaete-rich deep Venus community in offshore mixed sediments' (MD4211) is the only biotope representative of the biotope complex 'Faunal communities in Atlantic offshore circalittoral mixed sediment' (MD421). This biotope was recorded throughout both array areas. The sediments across stations allocated to 'Polychaete-rich deep Venus community in offshore circalittoral mixed sediment' (MD4211) were heterogenous with varying proportions of mud and gravel, recorded to the west of the northern array, along the array areas corridor and north-west and south-east of the southern array. Given the heterogeneity of the sediments, the infaunal communities were also variable, with overall higher faunal richness and diversity, taxa including polychaetes such as *Pholoe baltica, G. lapidum, L. cingulata*, *Notomastus, Spirobranchus lamarcki and Scalibregma inflatum.* Mollusca were represented by bivalves such as *Spisula elliptica, Kurtiella bidentata, Abra alba, Diplodonta rotundata,* and the chiton *Leptochiton asellus*. Other characterizing epifauna species within MD421 included echinoderms *O. albida, Amphipholis squamata*, and *E. pusillus* and bryozoans, hydroids and sponges.

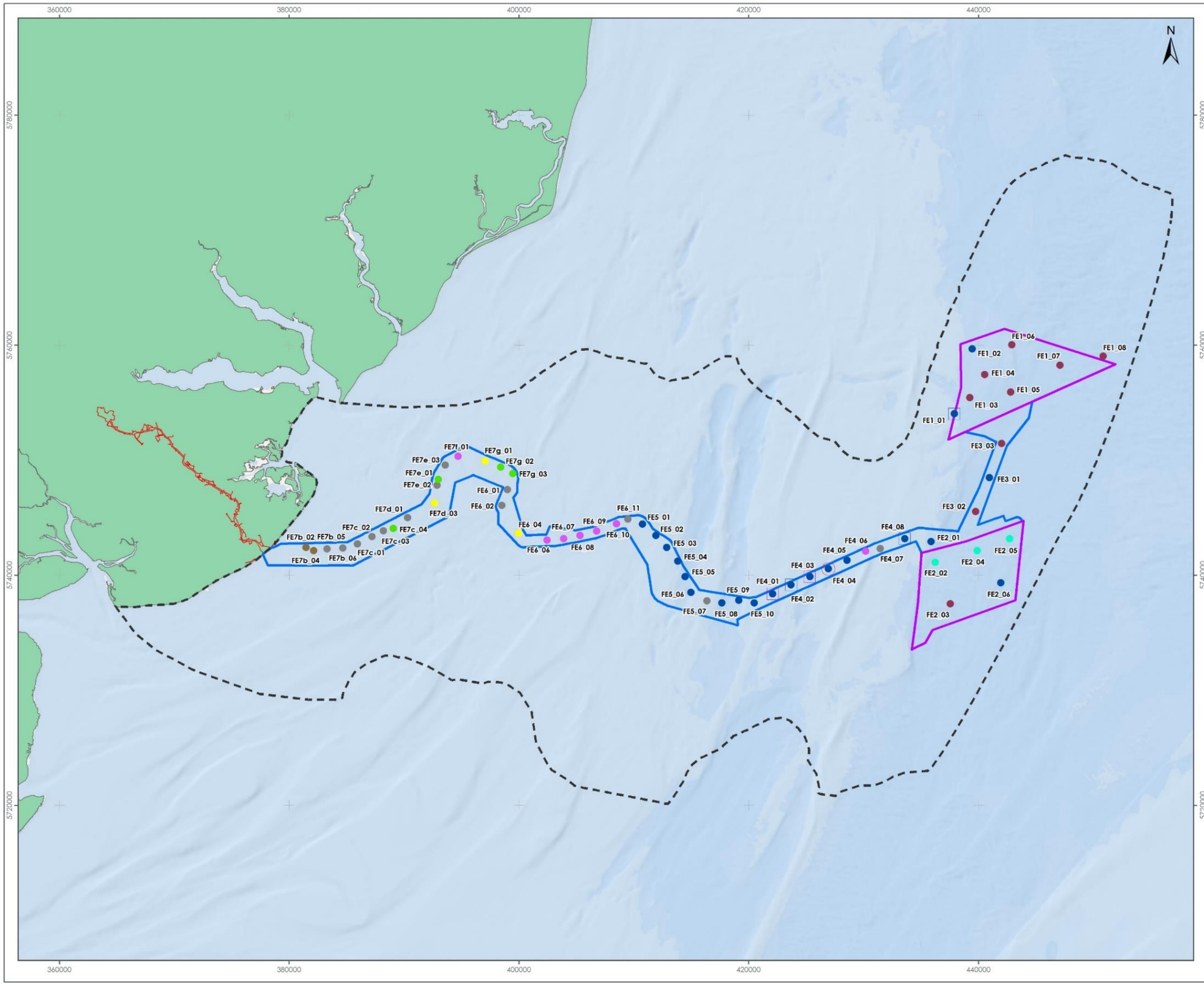
5.7.38 Much of seabed throughout the array areas were characterised by circalittoral coarse sediments which supported the biotope '*Glycera lapidum* in impoverished infralittoral mobile gravel and sand' (MB3235). The MB3235 biotope is an impoverished, transitional community that is subject to sediment disturbance from wave action, which develops into stable communities in more settled conditions, so there may be seasonal or spatial variability in this community (EEA, 2019). MB3235 stations featured poorly sorted gravelly sand and infauna characterised by polychaetes including *G. lapidum* and *Glycera alba*. Habitats containing this biotope are typically subject to sediment disturbance from wave action, which prevents the establishment of a more stable community.

5.7.39 One site within the array area within the coarse sand and gravels supported the biotope *Sabellaria spinulosa* on stable circalittoral mixed sediment' (MC2211). The community was characterised by the tube dwelling polychaete *S, spinulosa*, with a relatively diverse infaunal community of polychaetes, amphipods and bivalves.

5.7.40 A single station was classified as the biotope 'Piddocks with sparse associated fauna in sublittoral very soft chalk or clay' (MC1251) due to the sediment comprising of areas of firm clay with round burrows of piddocks recorded by the DDV.

Table 5.7: Biotopes found across the VE array areas (Fugro, 2022).

EUNIS Code (2022) / (2007 equivalent)	Biotope Name
Array Areas	
MD5 / A5.27	Offshore circalittoral sand
MB5231 / A5.231	Sparse fauna in Atlantic infralittoral mobile clean sand
MD4211 / A5.451	Polychaete-rich deep Venus community in offshore circalittoral mixed sediment
MC1251 / A4.231	Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay
MB3235 / A5.135	*Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand
MC2211 / A5.611	*Sabellaria spinulosa* on stable circalittoral mixed sediment



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits
- Benthic Ecology Study Area

EUNIS Biotype Classification:

- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)
- Circalittoral coarse sediment (A5.14)
- Circalittoral mixed sediment (MC4)
- Circalittoral muddy sand (MC5)
- Deep circalittoral coarse sediment (A5.15)
- Deep circalittoral sand (A5.27)
- *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (MB3235)
- Polychaete-rich deep Venus community in offshore mixed sediments (MD4211)

Sensitive Habitats:

- Peat and clay exposures with piddocks
- Peat and clay exposures with piddocks with stony reef
- Stony Reef

0 2,500 5,000 10,000
Meters

Data Source:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
EUNIS Biotopes and Seabed Sediment Features across Five Estuaries (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.4

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:300,000	A3	WGS84	UTM31N

FIVE ESTUARIES
OFFSHORE WIND FARM

5.7.41 Individuals of the tube building worm *S. spinulosa* were identified within the benthic grab samples at four stations within the array areas although these were not recorded in numbers that would constitute reef (Gubbay, 2007). Detailed review of the SSS and multibeam bathymetry datasets acquired within the VE (Fugro, 2022a) found no evidence of the distinctive signatures which would typically be associated with the presence of biogenic reefs.

5.7.42 Three discrete aggregations of cobble habitat were recorded in the northern array and scored as 'low' resemblance to Annex I habitat 'reef', as per the qualifying criteria set out in regulatory guidance (Irving, 2009 and Golding *et al*., 2020). Additional to setting out the reef qualifying criteria thresholds, this guidance also suggests that *"when determining whether an area of the seabed should be considered as Annex I stony reef, if a 'low' is scored in any of the four characteristics (composition, elevation, extent or biota), then a strong justification would be required for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive".* This suggests that the patches identified during this survey would not be considered as contributing to the National Site Network unless there is strong justification. Areas of heterogeneous coarse sediment inclusive of pebbles and cobbles are a component part of the mixed sediment seabed type that characterises this region of the North Sea.

5.7.43 The sediments observed throughout the survey area were identified as comprising of 'subtidal sands and gravels' which is a habitat of conservation importance in MCZs and a UK Biodiversity Action Plan (BAP) priority habitat. However, this habitat is the most widely distributed subtidal habitat in the UK (JNCC, 2019).

5.7.44 The biotope 'Piddocks with sparse associated fauna in sublittoral very soft chalk or clay' (MC1251) was observed in the northern array at one location (Figure 5.5) and is expected on account of the regional London clay formations (MALSF, 2009). Piddocks in clay are a UK BAP priority habitat.

5.7.45 The nationally scarce crab *Thia scutellata* was recorded in the southern array. Small numbers have been reported from Outer Thames Estuary (NBN, 2022). The most abundant known populations for this species are off the North Wales coast, where its preferred habitat has been reported as loose, well sorted medium sands into which it can burrow easily (Rees, 2001).

5.7.46 Other than those discussed above, there was no evidence of any Annex I habitats or Annex II species, OSPAR threatened and/ or declining species and habitats (OSPAR, 2021 and ICUN, 2022), or habitats and species listed under Section 41 of the NERC Act (2006), observed within the survey area.

OFFSHORE EXPORT CABLE CORRIDOR

SEDIMENT CHARACTERISTICS

5.7.47 Spatial distribution of EUNIS biotope complexes identified through single point grab sampling and side scan sonar data are presented in Figure 5.4. This data demonstrates that the majority of the offshore ECC is dominated by circalittoral mixed and circalittoral coarse sediments. Sediment descriptions using the Folk description (1954) categorised the seabed as predominantly muddy sandy gravel (14 stations), with seven stations described as sandy gravel and gravelly mud and gravelly muddy sand each typifying five stations.

5.7.48 The coarseness of the sediment declined towards the inshore region of the offshore ECC, where sediments became less heterogeneous. Sediments were predominantly sandy within the nearshore portion of the offshore ECC. The sediments recorded along the offshore ECC are typical of the southern North Sea, which is reported to comprise of a mix of sand and gravel (Jones *et al*., 2004).

5.7.49 London clay formations are found at or close to the surface within 2 m of the seafloor along most of the ECC, deepening in areas where it has been incised by the Pleistocene channels or absent where eroded, exposing the Harwich formation (Fugro, 2022). Areas of firm clay with round burrows of piddocks recorded at stations FE4_01, FE4_02 and FE4_03 (Figure 5.5). Rippled sand areas were also recorded due to sediment disturbance associated with hydrodynamics.

SEDIMENT CHEMISTRY

5.7.50 As presented in Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report the following contaminants were recorded as below CAL1:

- Total hydrocarbon content (THC);
- Polychlorinated biphenyls (PCBs);
- Organotins (including dibutyltin (DBT) and tributyltin (TBT));
- Organochlorine pesticides (OCPs); and
- Polybrominated Diphenyl Ethers (PBDE).

5.7.51 In general, concentrations of total PAHs were higher at stations along the nearshore section of the offshore ECC, however, all concentrations of individual PAHs were below their respective Canadian sediment quality guidelines. Station FE7b_02 exceeded CAL1 but remained below CAL2 for C1-naphthalenes and C2-naphthalenes. However, the PAH concentrations along the offshore ECC were below the marine sQGs and are therefore not considered to be detrimental to the marine environment.

5.7.52 Within the offshore ECC, the PBDE content in all sediment samples were below both the BAC and FEQG with the exception of BDE-209, which exceeded the BAC but remained below the FEQG for all samples. Station FE7E_02 exceeded the BAC for the congeners BDE-47 and BDE-99 but remained below the FEQG.

5.7.53 The following metals were recorded above CAL1, but less than CAL2, within the offshore ECC:

- Arsenic;

- Cadmium;
- Chromium; and
- Nickel.

5.7.54 These recorded concentrations are consistent with those within marine sediments in the Outer Thames and the wider North Sea. Further details of sediment contamination is provided in Volume 6, Part 2, Chapter 2: Marine Water and Sediment Quality and Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.

SEABED HABITAT AND COMMUNITIES

5.7.55 Across the offshore ECC the macrofaunal dataset comprised 262 taxa and 8402 individuals. Benthic subtidal community structure and composition were generally dominated by Annelida, which comprised most of the enumerated taxa composition (49.2 %), followed by Arthropoda (24.8 %), Mollusca (17.9 %) and Echinodermata (3.8 %). Other phyla comprised 4.2 % of the taxa composition (Table 5.19) and were represented by Cnidaria (*Cerianthus lloydii*, anemones of the family Edwardsiidae and non-burrowing anemones of the order Actiniaria), Sipuncula (*Golfingia elongata* and *Golfingia vulgaris*), Entoprocta (*Loxosoma annelidicola*), Enteropneusta, *Phoronis*, Ascidiacea, Nemertea and Platyhelminthes.

5.7.56 By combining and considering collectively the macrofaunal data, DDV data, PSA data and geophysical data collectively three biotope complexes and five biotopes were identified within the offshore ECC (Figure 5.5).

5.7.57 The biotope complex 'faunal communities of Atlantic circalittoral sand' (MC521) and the biotopes '*G. lapidum* in impoverished infralittoral mobile gravel and sand' (MB3235), and *A. alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC5214) classified infralittoral coarse and muddy sediment stations along the nearshore section of the ECC in water depths of < 20 m BSL.

5.7.58 The central section of the ECC featured predominantly coarse sediment classified as Atlantic offshore circalittoral coarse sediment (MD321). Further analysis of these communities determined that the biotope complex can be further defined as the biotope '*G. lapidum* in impoverished infralittoral mobile gravel and sand' (MB3235). The MB3235 biotope is an impoverished, transitional community that is subject to sediment disturbance from wave action, which develops into stable communities in more settled conditions, so there may be seasonal or spatial variability in this community (EEA, 2019). MB3235 stations featured poorly sorted gravelly sand and infauna characterised by polychaetes including *G. lapidum* and *Glycera alba*. Habitats containing this biotope are typically subject to sediment disturbance from wave action, which prevents the establishment of a more stable community.

5.7.59 The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC5214) was recorded at the two most inshore sites of the ECC. The sands and muds at these sites supported the bivalve molluscs *A. alba* and *N. Nitidosa* along with the polychaetes *Nephtys* spp., *Chaetozone* spp. And *Spiophanes bombyx*.

5.7.60 The majority of stations identified predominantly mixed sediments, mostly in the offshore and central ECC with these being defined within the biotope complex 'Faunal communities in Atlantic offshore circalittoral mixed sediment' (MD421). This biotope complex had the highest number of taxa and abundance, with annelids dominating. Sessile epifauna included soft corals (*Alcyonium digitatum*), bryozoans and hydroids. Characteristic mobile fauna reported from this habitat included starfish (*Asterias rubens*), sea urchins (*Psammechinus miliaris*) and brittlestars (*Ophiura albida* and *Ophiothrix fragilis*).

5.7.61 Classifications were further refined, with the biotope 'polychaete-rich deep Venus community in offshore mixed sediments' (MD4211) identified at 15 stations.

5.7.62 The seabed video and photography also recorded the presence of the biotope '*O.fragilis* and/ or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment' (MC4215) in the offshore eastern extents of the ECC, characterised by *O. fragilis*. As well as the biotope complex Atlantic infralittoral mixed sediment (MB42) along the nearshore sections of the offshore ECC, with identifiable fauna including *Flustra foliacea*, *Alcyonium digitatum* and turfs of hydrozoa/ bryozoa.

5.7.63 Areas of firm clay with round burrows of piddocks were recorded at three stations in the offshore area of the ECC from seabed video data and identified as the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251). This biotope included accompanying fauna including *A. rubens*, Paguridae and Ophiuroidea.

5.7.64 The biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (MC2211), was recorded at a single station in the offshore eastern extents of the ECC. This biotope was characterised by variable coverage of *S. spinulosa*, faunal turf (hydrozoa/ bryozoa), *P. miliaris, A. digitatum*, anemones (*Urticina Sp*. and Sagartiidae) and echinoderm *A. rubens.*

Table 5.8: Biotopes found across the offshore ECC (Fugro, 2022).

EUNIS Code (2022) / (2007 equivalent)	Biotope Name
Offshore ECC	
MB3235 / A5.135	*Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand
MC1251 / A4.231	Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay
MC2211 / A5.611	*Sabellaria spinulosa* on stable circalittoral mixed sediment
MC3212 / A5.142	*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel
MC4215 / A5.445	*Ophiothrix fragilis* and/ or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment
MC5214 / A5.261	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment

EUNIS Code (2022) / (2007 equivalent)	Biotope Name
MD4211 / A5.451	Polychaete-rich deep Venus community in offshore circalittoral mixed sediment
MC3 / A5.14	Circalittoral coarse sediment
MC4 / A5.44	Circalittoral mixed sediment
MD5 / A5.27	Offshore circalittoral sand

5.7.65 During site specific survey analysis, EUNIS habitats were classified to the lowest level possible. Where species data is less definite or ambiguous the level of classification is recorded to a higher level. Some of the habitats and biotopes identified through the Phase I habitat mapping could not be further redefined following analysis of the core samples, owing to the paucity of fauna. This was the case for several stations across the array areas and the offshore ECC, therefore they are only categorised by their physical properties.

FEATURES OF CONSERVATION INTEREST

5.7.66 Individuals of *S. spinulosa* were identified within the benthic grab samples at 23 stations within the offshore ECC although these were not recorded in numbers that would constitute biogenic reef (Gubbay, 2007). The highest abundance recorded was 155 individuals at a station in the eastern area of the offshore ECC. Aggregations of *S. spinulosa* were recorded at one station along the offshore section of the offshore ECC and three stations along the nearshore section. Owing to the presence of *S. spinulosa* aggregations, four transects were further assessed in relation to their 'reefiness' potential. All *S. spinulosa* aggregations were classified as 'Not a reef' in line with the criteria in Gubbay *et al*. (2007), Hendrick and Foster-Smith (2006) and Limpenny *et al*. (2010) and the methods in Jenkins *et al*. (2015).

5.7.67 Aggregation of cobbles at five stations along the offshore section of the ECC, were assessed for the potential to constitute Annex I habitat 'Reef', in line with criteria for the evaluation of stony reef. These discrete patches of stony habitat were scored as 'Not a reef' or 'Low resemblance' to stony reef, as per the qualifying criteria set out in regulatory guidance (Irving 2009, and Golding *et al*., 2020). Additional to setting out the reef qualifying criteria thresholds, this guidance also suggests that *"when determining whether an area of the seabed should be considered as Annex I stony reef, if a 'low' is scored in any of the four characteristics (composition, elevation, extent or biota), then a strong justification would be required for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive".* This suggests that the patches identified during this survey would not be considered as contributing to the national Marine Natura site network.

5.7.68 The biotope 'Piddocks with sparse associated fauna in sublittoral very soft chalk or clay' (MC1251) was observed at three locations across the offshore ECC (at stations further offshore) and is expected on account of the regional London clay formations (MALSF, 2009). Piddocks in clay are a UK BAP priority habitat.

5.7.69 Dense aggregations of brittlestars (*Ophiothrix fragilis*) were recorded at stations FE4_05 and FE5_09 associated with the mixed sediments, therefore these stations were classified as the biotope '*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment' (MC4215).

5.7.70 Anemones of the family Edwardsiidae, were recorded in three stations although at low abundance; of this family *Edwardsia timida* is a UK BAP priority species.

5.7.71 Other than those discussed above, there was no evidence of any other habitats of principal importance, species or other habitats listed as FOCI (Natural England and JNCC 2010); no other species or habitats listed under Section 41 of the NERC Act (2006); no additional species or habitats listed on the OSPAR (2008) list of threatened and/ or declining species and habitats were recovered in the samples; and no species on the International Union for Conservation of Nature (IUCN) Global Red List of threatened species (IUCN 2018).

NON-NATIVE SPECIES

5.7.72 The marine INNS, slipper limpets *Crepidula fornicata*, was recorded in two stations in the subtidal area, which has potential to cause likely significant effects to marine ecosystems without control measures in place.

5.7.73 The cryptogenic species recorded in the grab samples included the polychaetes *Aphelochaeta marioni* and the crustacean amphipod *Crassicorophium crassicorne*. Ascidians of the family *Didemnidae* were also recorded and may therefore include cryptogenic species such as *Diplosoma listerianum*.

THE INTERTIDAL EXPORT CABLE CORRIDOR

SEDIMENT CHARACTERISTICS

5.7.74 The foreshore of the offshore ECC comprises sand with varying proportion of gravel and hard substrate associated with sea defence structures, bedrock boulders and cobbles, with sediment coarseness and heterogeneity increasing further offshore (Figure 5.6). The sea defence structures included wooden groynes to the north-east of the survey area (near Frinton-on-Sea), concrete recurved and/ or stepped revetment sea walls and rock armour (across most of the survey area) and fishtail rock groynes to the south-west of the survey area (near Holland-on-Sea).

SEDIMENT CHEMISTRY

5.7.75 As presented in Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report, the following contaminants were recorded as below CAL1:

- Total hydrocarbon content (THC);
- Polycyclic aromatic hydrocarbons (PAHs);
- Polychlorinated biphenyls (PCBs);
- Organotins (including dibutyltin (DBT) and tributyltin (TBT));
- Organochlorine pesticides (OCPs); and
- All metals.

5.7.76 Within the intertidal, the PBDE content in all sediment samples were below both the BAC and FEQG with the exception of BDE-209, which exceeded the BAC but remained below the FEQG for all samples. Stations High Water and Low Water recorded a concentration of 0.2 μg/kg, and the Mid Water station returned 0.4 μg/kg.

5.7.77 Further details of sediment contamination is provided in Volume 6, Part 2, Chapter 2: Marine Water and Sediment Quality and Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.

HABITAT AND COMMUNITIES

5.7.78 The fauna colonising the hard substrata (associated with sea defence structures, bedrock boulders and cobbles) was similar across the intertidal survey area and included barnacles, limpets and the Pacific oyster. The flora was represented by seasonal green and red algae as well as perennial fucoid algae, which underpinned the biotope classification. A major biological influence on community structure is the presence of algae canopies, including ephemeral algal turfs of *Ulva* and *Porphyra*, which can increase biodiversity by supporting a variety of species that would otherwise not occur. Macroalgae such as *Fucus*, provide shelter from wave action, desiccation and heat and may act as substrate for the attachment of epifauna, as well as being a food source (Jones *et al*., 2000).

5.7.79 The biotope complex 'Littoral rock and other hard substrata' (MA1) was assigned to areas of bare substrate subject to scour from the adjacent sedimentary areas, and two areas of exposed clay on the lower shore.

5.7.80 The Phase II intertidal assessment identified that the intertidal macrofaunal sediment communities were characterised by low richness and diversity, with one station being abiotic, likely associated with the exposure of the survey area and the coarseness of the sediment. Thus, only taxa that are capable of withstanding the environmental stresses of long exposure are capable of living in such environment. Taxa recorded were represented mainly by Nematoda and Platyhelminthes. Annelida comprised oligochaetes and invertebrates that are typical of shallow estuarine and marine habitats, whereas crustaceans were represented by cumaceans and amphipods.

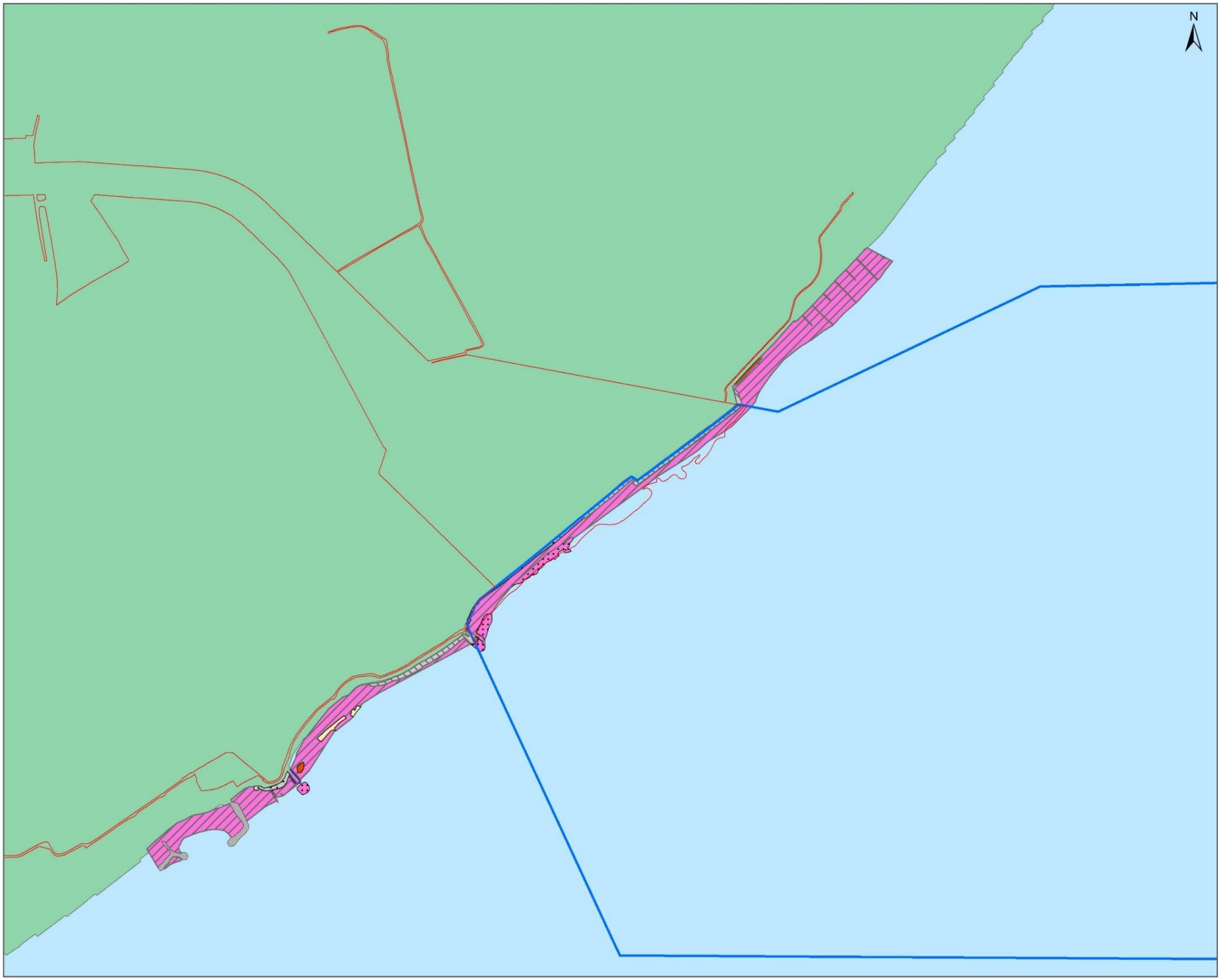
5.7.81 One habitat complex, one habitat, two biotope complexes, eight biotopes and one sub-biotope were identified across the intertidal survey area during the Phase I habitat mapping. The littoral sediment habitat complex littoral sand and muddy sand (MA5) was reported to account for the majority of the intertidal area within the offshore ECC.

5.7.82 Several smaller areas of other sediment habitats were recorded on the upper shore and strandline including '*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock' (B3.1132), '*Enteromorpha* spp. on freshwater-influenced and/ or unstable upper eulittoral rock' (MA123G), '*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock' (MA123H) and 'Fucus spiralis on full salinity exposed to moderately exposed upper eulittoral rock' (MA1242). As well as littoral sediment habitats including Littoral rock and other hard substrata (MA.1), '*Mytilus edulis* and/or barnacle communities on wave-exposed Atlantic littoral rock' (MA122), 'Seaweed communities on full salinity Atlantic littoral rock' (MA123), '*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock' (MA1223), '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (MA1243), '*Fucus serratus* on moderately exposed lower eulittoral rock' (MA1244), 'barren littoral shingle' (MA3211) and '*Lanice conchilega* in littoral sand' (MA5255).

5.7.83 Marine INNS species, barnacle *Austrominius modestus* and the Pacific oyster *Magallana gigas* were recorded on hard substrate in the intertidal survey area.

Table 5.9: Biotopes found across the intertidal ECC.

EUNIS Code (2022)	Biotope Name
MA1	Littoral rock
MA122	Mytilus edulis and/or barnacle communities on wave-exposed Atlantic littoral rock
MA123	Seaweed communities on full salinity Atlantic littoral rock
MA1242	*Fucus spiralis on exposed to moderately exposed upper eulittoral rock*
MA3211	Barren littoral shingle
MA1243	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
MA1244	*Fucus serratus* on moderately exposed lower eulittoral rock
MA5255	*Lanice conchilega* in littoral sand
MA123H	*Porphyra purpurea* or *Enteromorpha spp. on sand-scoured mid or lower eulittoral rock*
MA123G	*Enteromorpha spp.* on freshwater-influenced and/or unstable upper eulittoral rock
MA1223	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
MA12132	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock



LEGEND

- Offshore Export Cable Corridor
- Onshore Order Limits

Biotope

- Barren littoral shingle MA3211
- Fucus serratus on moderately exposed lower eulittoral rock (MA1244)
- Fucus serratus on moderately exposed lower eulittoral rock (MA1244)
- Fucus spiralis on full salinity exposed to moderately exposed littoral fringe rock (MA1242)
- Littoral rock & other hard substrata (MA1)
- Littoral sand & muddy sand (MA5255)
- Mussel and/or barnacle communities (MA122) & Lancice conchilega in littoral sand (A2.245)
- Robust fucoid and/or red seaweed communities (MA123)
- Zonation: MA1, MA123 and A1.452
- Zonation: A1.113, A1.452 and MA1242
- Zonation: A1.451 and MA1242
- Zonation: A1.452, MA1242 and B3.1132

0 125 250 500

Meters

Data Source:

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Spatial Distribution of Intertidal Habitats and Biotopes (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.6

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:10,000	A3	WGS84	UTM31N

FIVE ESTUARIES OFFSHORE WIND FARM

DESIGNATED SITES

5.7.84 The nature designations which have been included for consideration in the benthic and intertidal ecology assessment comprise sites within the National Site Network (i.e. SACs and SPAs) with benthic ecology features or designated sites including MCZs and SSSIs. This section identifies designated sites that have the potential to interact with VE and therefore fall within the benthic ecology study area (Figure 5.7).

5.7.85 The VE study area overlaps spatially with the M&LS SAC which is designated for Annex I Sandbanks. The sites that lie in the area of potential secondary impact of VE are identified in Table 5.10. Table 5.10 also summarises the qualifying features that relate to seabed habitats and benthic ecology and the distance from the closest part of VE. The location of designated sites is presented in Figure 5.7.

5.7.86 An assessment of direct impacts and indirect impacts (e.g. changes in suspended sediment concentrations (SSC) and/ or sediment deposition) as informed through the physical processes modelling presented in Volume6, Part 5, Annex 2.3: Physical Processes Technical Assessment has been undertaken on relevant benthic ecology features within sites that have the potential to be affected by VE. Those benthic ecology and seabed habitat features of designated sites within the secondary ZoI have been screened into the assessment.

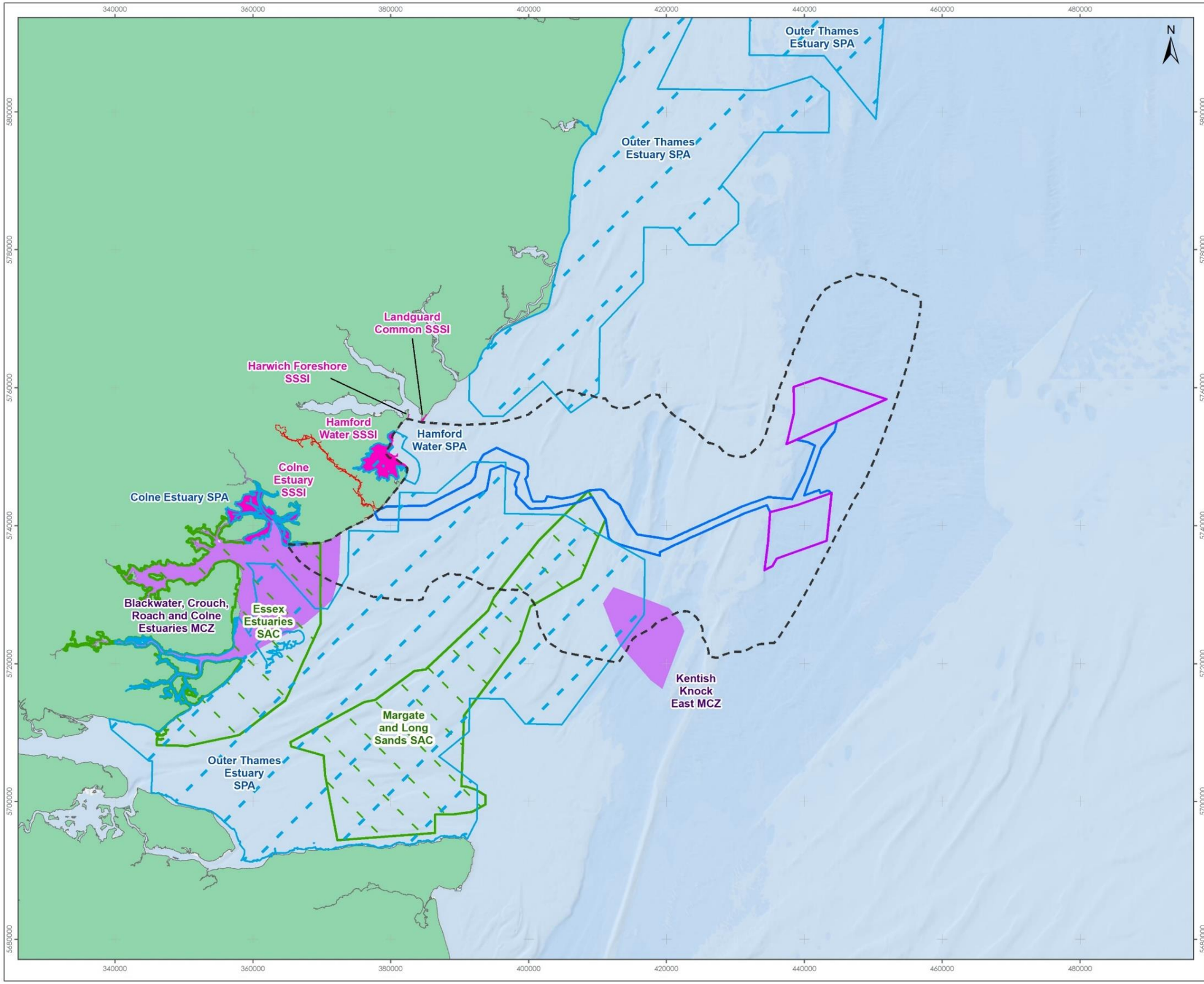
5.7.87 An assessment of the potential impacts on MCZs is provided in Volume 5, Report 6: MCZ Assessment. Several of the benthic ecological qualifying broadscale habitat features of the MCZs were found within the VE array areas and offshore ECC (although there is no spatial overlap with the MCZ sites) and have therefore been assessed for both direct and indirect impacts, as per the normal assessment. Where features of the MCZs were not found within array areas and offshore ECC, these features have only been assessed under the indirect impact assessment.

5.7.88 An assessment of the supporting habitats within the Outer Thames Estuary SPA has been detailed within Section 0 to 5.13. Where direct impacts are predicted to occur to supporting habitats these have been assessed through the direct assessment of biotopes that characterise the offshore ECC as these biotopes capture the supporting habitats identified within the SPA. Where indirect impacts are predicted to occur to SPA's this is discussed within the assessment. Supporting habitats identified in Table 5.10 are well represented by the biotopes presented and assessed within Section 5.11 to 5.13.

Table 5.10: National conservation designations of relevance to benthic subtidal and intertidal ecology within the area of potential direct and indirect impact of VE.

Site	Qualifying features	Distance from VE
Sites forming part of the National Site Network		
Margate and Long Sands SAC	Annex I habitat: > Sandbanks which are slightly covered by sea water all the time	0.11% of total SAC overlaps with the offshore ECC
Essex Estuaries SAC	Annex I habitat: > Estuaries > Mudflats and sandflats not covered by seawater at low tide > Salicornia and other annuals colonizing mud and sand > Spartina swards (*Spartinion maritimae*)	7.5 km away from the offshore ECC, and overlaps with the secondary ZoI
Outer Thames Estuary SPA	Annex I species of bird: Red-throated diver *Gavia stellata*, Common tern *Sterna hirundo*, Little tern *Sternula albifrons* The supporting habitats for these species include sublittoral coarse sediment, subtidal sand, subtidal mud, subtidal mixed sediment and circalittoral rock.	Direct overlap with the VE offshore ECC and indirect ZoI
Hamford Water SPA	This SPA is designated for a number of Annex I bird species and international important migratory species. The supporting habitats for these species include: Intertidal gravel and sand, intertidal mud and sand, Saltmash spp., and the estuarine fish communities.	3.1 km distance from the offshore ECC and is located within the VE indirect ZoI
Colne Estuary SPA	This SPA is designated for a number of Annex I bird species, including breeding and non-breeding birds. The supporting habitats for these species include estuarine mudflat communities.	9.4 km distance from the offshore ECC and is located within the VE indirect ZoI
National		
Kentish Knock East MCZ	> Subtidal sand > Subtidal coarse sediment > Subtidal mixed sediment	6.2 km distance from the offshore ECC
Blackwater, Crouch, Roach	> Intertidal mixed sediments > Native oyster (*Ostrea edulis*) beds	5.8 km distance from the offshore ECC

Site	Qualifying features	Distance from VE
and Colne Estuaries MCZ	> Native oyster (*Ostrea edulis*) > Clacton Cliffs and Foreshore	
Landguard Common SSSI	Sand and shingle spit consisting of a loose shingle foreshore backed by vegetated beach	10.0 km distance from the offshore ECC
Harwich Foreshore SSSI	Site contains designated exposures of Harwich Stone Bands, designated for the importance of its geology	11.9 km distance from the offshore ECC
Hamford Water SSSI	Large, shallow estuarine basin comprising tidal creeks, islands, intertidal mud, sand flats and saltmarshes	3.7 km distance from the offshore ECC
Colne Estuary SSSI	Branching estuary with mudflat communities	9.4 km distance from the offshore ECC



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits
- Benthic Ecology Study Area
- Sites of Special Scientific Interest
- Marine Conservation Zones
- Special Areas of Conservation
- Special Protection Areas

0 5,000 10,000 20,000
Meters

Data Source:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
Designated Sites overlapping the Study Area with relevance to Benthic and Intertidal Ecology

VER	DATE	REMARKS	Drawn	Checked
1	02/01/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.7

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:500,000	A3	WGS84	UTM31N

FIVE ESTUARIES
OFFSHORE WIND FARM

VALUED ECOLOGICAL RECEPTORS (VERS)

5.7.89 The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM 2016). The most straightforward context for assessing ecological value is to identify those species and habitats that have a specific biodiversity importance recognised through national legislation or through local, regional or national conservation plans (e.g. OSPAR, BAP habitats and species, habitats/ species of principal importance listed under the NERC Act 2006 and habitats/ species listed as features of MCZs). However, only a very small proportion of marine habitats and species are afforded protection under the existing legislative or policy framework and therefore evaluation must also assess value according to the functional role of the habitat or species. For example, some features may not have a specific conservation value in themselves but may be functionally linked to a feature of high conservation value.

5.7.90 Table 5.11 presents the VERs, their conservation status and importance within the VE benthic subtidal and intertidal ecology study area and the justification and regional importance of each receptor. Where VERs were found within the array areas and offshore ECC, they have been assessed within this chapter for direct and indirect impacts. VERs located within the secondary ZoI have been assessed for indirect impacts only (Section 5.11 and 5.12).

5.7.91 The current baseline description above provides an accurate reflection of the current state of the existing environment. Main offshore construction works are anticipated to commence in 2029, with some preliminary survey and clearance works potentially taking place prior to this. The expected operational life will be up to 40 years, and therefore there exists the potential for the baseline to evolve between the time of assessment and point of impact. Outside of short-term or seasonal fluctuations, changes to the baseline in relation to benthic ecology usually occurs over an extended period of time. Based on current information regarding reasonably foreseeable events, the baseline is not anticipated to have fundamentally changed from its current state at the point in time when impacts occur. The baseline environment for operational/ decommissioning impacts is expected to evolve as described in the next section, with the additional consideration that any changes during the construction phase will have altered the baseline environment to a degree as set out in this chapter.

Table 5.11: VERs within the VE benthic subtidal and intertidal ecology study area.

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within VE array areas and ECC (offshore and intertidal)	Importance within VE benthic subtidal and intertidal ecology study area and justification
Subtidal					
Impoverished mixed slightly gravelly sands	MB3235	None	Habitats of Principal importance and UK BAP (subtidal sands and gravels)	Located across parts of the offshore ECC (Figure 5.5)	Regional – although this habitat is representative of a nationally important marine habitat, the Southern North Sea is not a single key geographic area
Mixed sediments with high polychaete abundance and diversity with significant venerid bivalve component	MD4211, MC3212	None	Habitats of Principal importance and UK BAP (subtidal sands and gravels)	Located at numerous points across the array areas and offshore ECC (Figure 5.5)	Regional – although this habitat is representative of a nationally important marine habitat, the Southern North Sea is not a single key geographic area
Non-cohesive muddy sands or slightly shelly/gravelly muddy sand characterised by bivalves	MC5214, MB5238	None	N/A	Located within the nearshore portion of the offshore ECC (Figure 5.5)	Local – Habitat is not protected under any conservation legislation and are found widespread around much of the UK
Peat and clay exposure with piddocks	MC1251	None	Habitats of Principal importance and UK BAP (Littoral and sublittoral chalk)	Single station in the northern array and three stations in the offshore area of the	National – Habitats of Principal Importance protected under Section 41 of the NERC Act 2006

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within VE array areas and ECC (offshore and intertidal)	Importance within VE benthic subtidal and intertidal ecology study area and justification
			FOCI under the Nature Conservation part (Part 5) of the MCAA 2009	offshore ECC (Figure 5.5)	
Brittlestar dominated communities in mixed sediments	MC4215	None	Habitats of Principal importance and UK BAP	Brittles stars (*Ophiothrix fragilis* and/or *Ophiocomina nigra*) were recorded in high abundances in the DDV data at stations FE4_05 and FE5_09 along the offshore ECC (Figure 5.5)	Regional – although this habitat is representative of a nationally important marine habitat, the Southern North Sea is not a single key geographic area
Sabellaria spinulosa reef	MC2211	Within an SAC: Annex I Habitats Directive	OSPAR List of threatened and/or declining species for the Greater North Sea (OSPAR Region II) FOCI under the Nature Conservation part (Part 5) of the MCAA 2009	*S. spinulosa* individuals were recorded at four stations within the array areas and at 23 stations with the offshore ECC. No reef was recorded during site specific surveys (Fugro, 2022). *S. spinulosa*	*S. spiunlosa* habitat was not recorded in reef form therefore no national or international importance applied to this habitat within the offshore ECC or the array Indirect impacts to this habitat within in the wider study area have been

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within VE array areas and ECC (offshore and intertidal)	Importance within VE benthic subtidal and intertidal ecology study area and justification
			Habitats of Principal importance	reef has been predicted and recorded throughout the wider study area (Figure 5.3)	assessed (Section 5.11 to 5.13)
Unstable coarse sediment such as cobbles and slates, which are colonised by ephemeral species	MC3211	n/a	n/a	Not located within the VE array areas and ECC but recorded within wider study area	Local – Habitat is not protected under any conservation legislation and are found widespread around much of the UK
Intertidal					
Littoral rock with seaweed communities	MA123, MA1242, MA1244	n/a	n/a	Located across the intertidal portion of the offshore ECC (Figure 5.6)	Local – Habitat is not protected under any conservation legislation
Impoverished littoral shingle	MA3211	n/a	n/a	Located across the intertidal portion of the offshore ECC (Figure 5.6)	Local – Habitat is not protected under any conservation legislation
Littoral rock with mussel and barnacle communities	MA122	n/a	n/a	Located across the intertidal portion of the offshore ECC (Figure 5.6)	Local – Habitat is not protected under any conservation legislation

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within VE array areas and ECC (offshore and intertidal)	Importance within VE benthic subtidal and intertidal ecology study area and justification
Littoral sand dominated by *Lanice conchilega*	MA5255	n/a	n/a	Located across the intertidal portion of the offshore ECC (Figure 5.6)	Local – Habitat is not protected under any conservation legislation
Annex I habitat features of SACs					
Sandbanks which are slightly covered by sea water all the time	n/a	Annex I Habitats Directive	Annex I within an SAC UK BAP priority habitat	Direct overlap with 1.26 km^2 of the SAC (0.11% of the total SAC) (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Margate and Long Sand SAC)
Estuaries	n/a	Annex I Habitats Directive	Annex I within an SAC UK BAP priority habitat	No direct overlap with the SAC. Overlap with secondary ZoI (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)
Mudflats and sandflats not covered by seawater at low tide	n/a	Annex I Habitats Directive	Annex I within an SAC UK BAP priority habitat	No direct overlap with the SAC. Overlap with secondary ZoI (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)
Salicornia and other annuals colonizing mud and sand	n/a	Annex I Habitats Directive	Annex I within an SAC UK BAP priority habitat	No direct overlap with the SAC. Overlap with secondary ZoI (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)
Features of MCZs					

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within VE array areas and ECC (offshore and intertidal)	Importance within VE benthic subtidal and intertidal ecology study area and justification
Native oyster (*Ostrea edulis*) beds and Ostrea edulis	n/a	MCZ	Protected features within the Blackwater, Crouch, Roach and Colne Estuaries MCZ	No direct overlap with the MCZ. Overlap with secondary ZoI (Figure 5.7)	National – included as broadscale feature of Blackwater, Crouch, Roach and Colne Estuaries MCZ. *O. edulis* is appraised within Volume 6, Part 2, Chapter 6: Fish and Shellfish Ecology
Clacton Cliffs and Foreshore	n/a	MCZ	Protected features within the Blackwater, Crouch, Roach and Colne Estuaries MCZ	No direct overlap with the MCZ. Overlap with secondary ZoI (Figure 5.7)	National – included as broadscale feature of Blackwater, Crouch, Roach and Colne Estuaries MCZ
Subtidal sand	n/a	MCZ	Broadscale features of Kentish Knock East MCZ	Representative biotopes of these broadscale features occur within the VE array areas and offshore ECC but are not protected as part of the MCZ. Protected features of the MCZ fall within the secondary ZOI (Figure 5.7)	National – included as broadscale feature of Broadscale features of Kentish Knock East MCZ
Subtidal coarse sediment	n/a	MCZ			
Subtidal mixed sediment	n/a	MCZ			

EVOLUTION OF THE BASELINE

5.7.92 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that *"A description of the relevant aspects of the current state of the environment (baseline scenario) and 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 ES (EIA Regulations, Schedule 4, Paragraph 3). From the point of assessment, over the course of the development and operational lifetime of VE (operational lifetime anticipated to be approximately 40 years from first power), long-term trends mean that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that VE is not constructed, using available information and scientific knowledge of marine water quality. A description of the future baseline conditions has been produced (in the event of no development) and is described within this section.

5.7.93 Further to potential change associated with existing cycles and processes, it is necessary to take account of the 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 and intertidal habitats and communities in the mid to long term future (UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3) 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 (OESEA3 2016), with climatic process driving shifts in abundances and species composition of benthic communities (Marine Climate Change Impacts Partnership (MCCIP) 2015). Studies of the 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 the abundance of long-living sessile animals has decreased (Krönke 1995; Krönke 2011). Modelling sea surface temperature in relation to climate change in the UK has shown that the rate of temperature increase over the previous 50 years has been greater in waters off the east coast of the UK compared to the west and this is predicted to continue for the next 50 years (MCCIP 2013). Significant increases in seawater temperature, up to 0.24°C per decade, have also been reported across the majority of the North Sea (MCCIP 2020). In recent years, 2014 had the warmest temperatures across the Southern North Sea since the late 1970s and temperature anomalies remain above average (MCCIP 2020).

5.7.94 Furthermore, most literature to date focuses on specifically temperature, with regards to the effects of climate change on marine habitats. Climatic warming also causes deoxygenation within the water column. Over the past 50 years, oxygen content has decreased from 0.06-0.43% (Stramma *et al*. 2010) with a further 7% decrease predicted for the year 2100 (IPCC 2013). It was concluded from 26 years of monitoring a benthic community within the Firth of Clyde, UK that the benthic communities had been affected by the decreasing levels of oxygen. This finding agreed with other short-term studies (Breitburg et al. 2018; Levin *et al*. 2009). Specific changes included changes in morphology, burrow depth, bioturbation and feeding mode (Caswell *et al*. 2018).

5.7.95 As such, the baseline in the VE study area described above is a 'snapshot' of the present benthic ecosystem within a gradually yet continuously changing environment. Any changes that may occur during the construction, operation and decommissioning of VE should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment, and the changes that would be expected to occur naturally in the absence of VE.

5.8 KEY PARAMETERS FOR ASSESSMENT

5.8.1 This section identifies the MDS of relevance to the assessment of impacts on benthic ecology, defined by the project design envelope (Volume 6, Part 2, Chapter 1: Offshore Project Description). The method adopted is in accordance with the requirements of the Rochdale Envelope approach to environmental assessment as set out in the PINS Advice note nine: 'Using the Rochdale Envelope' (PINS, 2018), and as detailed in Volume 6, Part 1, Chapter 3: EIA methodology).

5.8.2 The MDSs assessed for benthic ecology features are described in Table 5.12. These scenarios will be taken forward to assess the realistic worst-case scenario for each of the identified potential impacts.

5.8.3 This section describes the MDS parameters on which the benthic ecology assessment has been based. These are the parameters which are judged to give rise to the maximum levels of effect for the assessment undertaken, as set out in Volume 6, Part 2, Chapter 1: Offshore Project Description. Should VE be constructed to different parameters within the design envelope, then impacts would not be any greater than those set out in the MDS presented in Table 5.12. The nature and extent of the environmental impacts arising during decommissioning is assumed (for the purposes of this assessment) to be similar to (or likely less) than that described for the equivalent activities during the construction phase and have therefore been presented based on the worst-case construction impacts.

Table 5.12: Maximum design scenario for the project alone.

Potential effect	Maximum design scenario assessed	Justification
Construction and Decommissioning		
Impact 1: Temporary habitat disturbance	**Total temporary habitat disturbance within Order Limits = 36,513,188 m²** **Array areas:** **Total temporary habitat disturbance within array areas = 21,771,734 m²** Foundation seabed preparation = 298,400 m² > Seabed preparation for 79 small Gravity Base Structure (GBS) (Wind Turbine Generator (WTG)) foundations for WTG = 284,400 m²; > Seabed preparation for 2 GBS foundations for Offshore Substation Platform (OSP) = 14,000 m²; and > Areas impacted by placement of gravel bed would be within the footprint of the seabed preparation and so are not considered to be additive. Jack-up vessels (JUV) and anchoring operations = 1,183,275m² > Seabed disturbance per jacking-up operation = 1,100 m² > 504 JUV operations (6 operations per WTG (70 WTGs), 2 jacking-up operations per accommodation vessels (2 vessels) and commissioning vessels (3 vessels)). > Total JUV impact area for WTG and OSP installation in the array = 554,400 m² > Anchor footprints for WTG and OSP installation (inclusive of topside installation) =379,080m² > Anchor footprints- array cable installation= 249,795m²	The subtidal temporary disturbance relates to seabed preparation for foundations and cables, jack up and anchoring operations, and cable installation. It should be noted that where boulder clearance overlaps with sandwave clearance, the boulder clearance footprint will be within the sandwave clearance footprint. The MDS for temporary habitat disturbance in the intertidal area from the HDD works is included.

Potential effect	Maximum design scenario assessed	Justification
	Cable seabed preparation and installation in the array areas = 20,290,059 m^2 > 100% of the inter-array cable route may require boulder clearance > Total area of seabed disturbed by boulder clearance for inter-array cables = 900,000 m^2 > 100% of the inter-array cable route may require pre-lay grapple run. > Total area of seabed disturbed by pre-lay grapple run is = 6,000,000 m^2 (as this area overlaps it has only been calculated once to form the total) > 75% of the inter-array cable route may require sandwave clearance > Total area of seabed disturbed by sandwave clearance of inter-array cable routes= 10,690,059 m^2 > Total area of seabed disturbed by burial of inter-array cables (total length 200 km length) = 3,600,000 m^2 **<u>Offshore ECC:</u>** **Total temporary habitat disturbance within Offshore ECC = 14,739,204 m^2** Cable seabed preparation and installation in the offshore ECC = 14,439,000 m^2 > 100% of the export cable route may require boulder clearance > Total area of seabed disturbed by boulder clearance for export cables = 879,750 m^2 > 100% of the export cable route may require pre-lay grapnel run > Total area of seabed disturbed by pre-lay grapple run is = 5,865,000 m^2 (as this area overlaps with boulder clearance it has only been calculated once to form the total)	

Potential effect	Maximum design scenario assessed	Justification
	> 50% of the export cable route may require sandwave clearance > Total area of seabed disturbed by sandwave clearance = 5,054,000 m^2 > Burial of export cables (total length 195.5 km length per cable) = 3,520,000 m^2 > The seabed footprint for cable jointing is within the design envelope for seabed preparation and cable installation. JUV and anchoring operations = 242,604 m^2 > Maximum area of habitat disturbance from anchoring footprints = 242,604 m^2 Seabed preparation for export cable vessel laydown areas = 57,600 m^2 > Seabed preparation for 8 vessel laydown areas resulting in disturbance of 57,600 m^2 of sediment. **Temporary intertidal habitat disturbance = 2,250 m^2** Temporary habitat disturbance from horizontal directional drilling (HDD) exit pit excavation within the intertidal (or shallow subtidal): > HDD pits will be in either the intertidal or below lowest astronomical tide; > Stage 1: Up to 3 HDD exit pits (10 m width x 75 m length x 2.0-2.5 m depth) excavated via backhoe dredge (or similar) with material side-cast for backfill; > Stage 2: Once the ducts are in place, the exit pits will likely be temporarily backfilled until ready for cable pull-through. The ducts will then need to be re-exposed to pull in the cable; and	

Potential effect	Maximum design scenario assessed	Justification
	> Any inter-tidal cable installation is captured within the MDS for the installation of export cables in the offshore ECC.	
Impact 2: Temporary increase in suspended sediment and sediment deposition	**Total sediment volume released on Order Limits = 42,960,742 m^3** **<u>Array areas</u>** **Total sediment volume suspended in array areas = 32,728,589 m^3** Seabed preparation for foundations = 1,193,600 m^3 > 79 small GBS (WTG) foundations = 1,137,600 m^3; > 2 GBS foundations for OSP = 56,000 m^3 Drill arisings from foundation installation = 563,223 m^3 > 79 small steel monopile WTG foundations = 536,080m^3 (assumes 50% of locations are drilled) > 2 OSP monopile foundations = 27,143 m^3 Cable trenching = 3,150,000 m^3 > Installation of 200 km of inter-array cables by mass flow excavator (MFE) resulting in the suspension of 3,150,000 m^3 of sediment Sandwave clearance for cable installation= 22,795,580 m^3 > Sandwave clearance for 150 km of array cables resulting in the suspension of 22,795,580 m^3 of sediment JUV and anchoring operations = 4,686,000 m^3 > JUV disturbance volumes for WTG and OSP installation in the array = 8,316,000m^3	The MDS for foundation installation results from the largest volume suspended from seabed preparation and presents the worst-case for WTG installation. For cable installation, the MDS results from the greatest volume from sandwave clearance and installation. This also assumes the largest number of cables and the greatest burial depth. The MDS for temporary habitat disturbance in the intertidal area from the HDD works is included. The maximum volume of bentonite which could be released as part of the landfall activities is considered. For this assessment, it is considered that the bentonite would not be captured and is released into the marine environment.

Potential effect	Maximum design scenario assessed	Justification
	> Anchor disturbance volumes WTG and OSP installation in array area = 1,516,320 m^3 > Anchor disturbance volumes for array cables= 374,693 m^3 **<u>Offshore ECC</u>** **Total sediment volume suspended in offshore ECC = 10,487,073 m^3** Sandwave clearance for cable installation = 6,988,922 m^3 > Sandwave clearance for 98 km of export cables resulting in the suspension of 6,968,922 m^3 of sediment. Seabed preparation for export cable vessel laydown areas = 57,600 m^3 > Seabed preparation for 8 vessel laydown areas resulting in suspension of 57,600 m^3 of sediment. Cable trenching = 3,079,125 m^3 > Installation of 196 km of export cables by mass flow excavator resulting in the suspension of 3,079,125 m^3 of sediment. JUV and anchoring operations = 363,906 m^3 > Anchor disturbance volumes in ECC (ECC installation) = 363,906 m^3 **Intertidal sediment volume = 17,520 m^3** > Three offshore HDD exit pits require excavation which will be side-cast onto the adjacent seabed. Backfilling of exit pits will recover a similar amount from the surrounding seabed, as required. It has not been confirmed whether exit pits will occur in the subtidal or intertidal. > Maximum volume of drilling fluid that is expected to be released from the	

Potential effect	Maximum design scenario assessed	Justification
	HDD into the intertidal/subtidal = 14,820 m^3 Indicative maximum volume of cuttings expected to be released from the HDD into the intertidal / subtidal = 2,700 m^3	
Impact 3: Direct and indirect seabed disturbances leading to the release of sediment contaminants	The MDS for seabed disturbance are presented in **Impact 2**	This scenario represents the maximum total seabed disturbance and therefore the maximum amount of contaminated sediment that may be released into the water column during construction activities.
Impact 4: Increased risk of introduction or spread of Marine INNS	The MDS for the total number of vessel return trips made during construction (or decommissioning) = 4,311 (based on 79 WTGs installed)	Maximum design scenario with regards to maximum number of vessel movements during construction activities in relation to the maximum number of WTG (79).
Operation and Maintenance		
Impact 5: Permanent habitat loss/ alteration	**Total habitat loss within Order Limits 3,415,083 m^2** **Array Areas** **Total habitat loss within array areas = 3,112,079 m^2** > Turbine total structure footprint including scour protection, based on 79 GBS (WTG-type) foundations = 1,313,537 m^2 > OSP total structure footprint including scour protection, based on two GBS monopile foundations = 81,656 m^2 > It is assumed that up to 20% of scour protection may be replaced over the lifetime of VE (Total scour area for all foundations = 1,395,286 m^2	The MDS is defined by the maximum area of seabed lost as a result of the placement of structures, scour protection, cable protection and cable crossings. The MDS also considers that scour protection is required for all foundations. Habitat loss from drilling and drill arisings is of a smaller magnitude than presence of project infrastructure. Additional justification for the mitigation strategy and cable protection within the M&LS SAC is

Potential effect	Maximum design scenario assessed	Justification
	> Maximum array cable rock berm protection = 321,600 m^2 **<u>Offshore ECC</u>** **Total habitat loss within offshore ECC = 303,004 m^2** > Total area of seabed covered by rock berm cable protection (10% of export cables) = 178,304 m^2 > Removable cable protection (if required) within the M&LS SAC = 5,400 m^2 (6 m width protection over 900 m)[6] > Total of 56 cable crossings associated with export cables. Footprint of crossing protection material (rock berms and mattresses) = 119,300 m^2	presented within Volume 9, Report 13: M&LS SAC Benthic Mitigation Plan.
Impact 6: Temporary habitat disturbance	**Total direct disturbance to seabed within Order Limits= 734,894m^2** **<u>Array areas</u>** **Total direct disturbance within array areas in Project lifetime: 589,052m^2** Major component replacement events for WTG's and platforms (jacking-up activities) > Seabed disturbance per jacking-up event = 1,100m^2 > Maximum number of major component replacement events for 'WTG's and platforms (jacking-up activities) during Project lifetime= 284 > Total seabed disturbance by jacking-up activities through Project lifetime = 312,400m^2 Array cable repairs > Total seabed disturbance for array cable repairs per event= 25,200 m^2 (8 array cable repairs in project lifetime)	Defined by the maximum number of jack-up vessel operations and the total cable replacement through life maintenance activities that could have an interaction with the seabed anticipated during operation.

[6] With a maximum height of 1.1m and a maximum volume of 5,400 m^3.

Potential effect	Maximum design scenario assessed	Justification
	> Additional seabed disturbance area to be considered for array cable repairs carried out by vessel utilising anchors per repair = 9,382m^2 (8 array cable repairs in project lifetime) > Total seabed disturbed by array cable repairs through Project lifetime = 276,652m^2 **<u>Offshore ECC</u>** **Total direct disturbance within Offshore ECC in Project lifetime = 145,842m^2** Export cable repairs > Seabed disturbance for export cable repairs per event= 10,000m^2 (9 export cable repairs in Project lifetime) > Additional seabed disturbance to be considered for export cable repairs carried out by vessel utilising anchors per repair= 6,205m^2 (9 export cable repairs in Project lifetime)	
Impact 7: Colonisation of hard substrates	**Total surface area of introduced hard substrate in the water column within the Order Limits = 3,651,745 m^2** **<u>Array areas</u>** Total area of introduced hard substrate at seabed level = 3,112,079 m^2 (see **Impact 5**) Total surface area of subsea portions of foundations in contact with the water column: 236,662 m^2 > 79 GBS (WTG-type) foundations, with a total surface area of 223,262 m^2 > OSP structure area, based on two GBS monopile foundations, assuming, with a total surface area of 13,400 m^2 **<u>Offshore ECC</u>** Total habitat loss within offshore ECC = 303,004 m^2	Maximum scenario for introduced hard substrate is as for the maximum scenario for loss of habitat.

Potential effect	Maximum design scenario assessed	Justification
	> Total area of seabed covered by rock berm cable protection (10% of export cables) = 178,304 m^2 > Removable cable protection (if required) within the M&LS SAC = 5,400 m^2 (6 m width protection over 900 m)[7] > Total of 56 cable crossings associated with export cables. Footprint of crossing protection material (rock berms and mattresses) = 119,300 m^2	
Impact 8: Increased risk of introduction or spread of Marine INNS	**Total surface area of introduced hard substrate in the water column of the array areas = 3,651,745 m^2 (see Impact 7)** Total of 1,776 annual round trips for all O&M vessels within Order Limits.	Maximum scenario for introduced hard substrate is as for the maximum scenario for loss of habitat. MDS with regards to maximum number of vessel movements during O&M activities.
Impact 9: Changes in physical processes	See MDS presented in Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes.	Full justification of the worst-case scenarios can be found within Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes.
Impact 10: EMF effects generated by inter-array and export cables during operational phase	**Inter-array cables** > Up to 200 km of inter-array cable, operating up to 132 kV > Inter-array cable depth = 0 – 3.5 m **Offshore export cables** > Up to 196 km of export cable, operating up to 275 Kv > Export cable depth = 0 – 3.5 m	The maximum adverse scenario is associated with the use of 79 WTGs as this results in the greatest length of inter-array cable and export cables as this results in the longest total length of cable.

[7] With a maximum height of 1.1m and a maximum volume of 5,400 m^3.

5.9 MITIGATION

5.9.1 The mitigation measures contained in Table 5.13 are mitigation measures or commitments that have been identified and adopted as part of the evolution of the project design of relevance to the topic, these include project design measures, compliance with elements of good practice and use of standard protocols.

Table 5.13: Mitigation relating to Benthic Ecology

Project phase	Mitigation measures
General	
Project design	The development boundary selection was made following a series of constraints analyses, with the array area and offshore ECC route selected to ensure the impacts on the environment and other marine users are minimised as far as reasonably practicable.
Pollution prevention	A PEMP (Volume 9, Report 18) is proposed to be produced to ensure that the potential for contaminant release is strictly controlled. The PEMP will include a MPCP and will also incorporate plans to cover accidental spills, potential contaminant release and include key emergency contact details (e.g., Environment Agency (EA), Natural England, Maritime Coastguard Agency (MCA) and the project site co-ordinator). The Outline PEMP (Volume 9, Report 18) will be secured as a condition in the deemed Marine Licence(s). Typical measures will include: > Storage of all chemicals in secure designated areas with impermeable bunding (generally to 110% of the volume); and > Double skinning of pipes and tanks containing hazardous materials. The purpose of these measures is to ensure that potential for contaminant release is strictly controlled and provides protection to marine life across all phases of the life of the wind farm.
Pollution prevention	The Applicant commits to the disposal of sewage and other waste in a manner which complies with all regulatory requirements, including but not limited to the IMO MARPOL requirements[8].
Construction	
Cable Specification and Installation Plan (CSIP)	Development of, and adherence to, a Cable Specification and Installation Plan (CSIP), relating to the offshore ECC, post consent. The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately

[8] https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx

Project phase	Mitigation measures
	designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will be conditioned in the deemed Marine Licence. An Outline CSIP has been provided as part of this DCO Application (Volume 9, Report 12).
Cable Burial Risk Assessment (CBRA)	A detailed CBRA to enable informed judgements regarding burial depth to optimise the chance of cables remaining buried whilst seeking to limit the amount of sediment disturbance to that which is necessary. An outline CBRA is provided within Volume 9, Report 9.
Operation	
Project design	Where burial depth cannot be achieved, cable armouring will be implemented (e.g. mattressing, rock placement etc). The suitability of installing rock or mattresses for cable protection will be investigated, based on (inter alia) the seabed current data at the location of interest, the assessed risk of impact damage and navigational water depth requirements.
Project design	In areas where there is potential for scour pits to develop around the foundations of structure, then scour protection will be implemented.
Decommissioning	
Decommissioning Programme	A Decommissioning Programme will be developed to cover the decommissioning phase as required under Chapter 3 of the Energy Act 2004. As the decommissioning phase will be a similar process to the construction phase but in reverse (i.e., increased project vessels on-site, partially deconstructed structures) the mitigation measure will be similar to those for the construction phase. The Decommissioning Programme will be secured as a condition in the deemed Marine Licence.

5.10 ADDITIONAL MITIGATION

5.10.1 The mitigation measures summarised in Table 5.14 are measures that have been proposed following the assessment of impacts on benthic ecology as detailed within Section 5.11 and 5.12. These additional mitigation measures have been applied to the project to reduce the environmental impact on benthic ecology receptors.

Table 5.14: Additional mitigation relating to Benthic Ecology

Description	Additional mitigation measures
General	
Removable cable protection within the M&LS SAC	As detailed within the Outline M&LS SAC Benthic Mitigation Plan (Volume 9, Report 13) additional mitigation is applied to cable protection within the M&LS SAC, this aims to reduce pressures on the sandbank features within this site. This mitigation plan has been developed in line with Natural England's mitigation hierarchy for designated sites. The mitigation that has been applied includes the following commitments: > Final cable routing will seek to take the shortest route through the M&LS SAC where possible, and considering the required separation to North Falls cables – this routing work will also consider the potential for successful cable burial with the objective of avoiding the need for cable protection; > Should burial not be achieved at the first attempt the burial hierarchy will followed in line with Section 5 of Volume 9, Report 13; > Rock dumping using loose rock will not be considered a feasible protection in the M&LS SAC; and > Should additional protection be required then mattresses or another form of protection that is equivalent (or less in terms of footprint or impact) and removable at decommissioning, will be used.
Sediment deposited back into the M&LS SAC	Any sediment removed from within the M&LS SAC will be deposited back within the SAC or within the same sediment cell. Following re-settlement of the deposited sediments, they will be immediately available again for transport at the naturally occurring rate and direction, controlled entirely by natural processes. As such, the sediment will have immediately re-joined the natural sedimentary environment within the local area and so by definition is not 'lost from the system' due to the dredging/spoil disposal process.

5.11 ENVIRONMENTAL ASSESSMENT: CONSTRUCTION AND DECOMMISSIONING PHASE

5.11.1 The effects of construction of VE have been assessed on benthic and intertidal ecology in the VE benthic ecology study area. The environmental impacts arising from construction of VE are listed in Table 5.12, along with the design envelope against which each construction phase impact has been assessed.

5.11.2 The nature and extent of the environmental impacts arising during decommissioning is assumed (for the purposes of this assessment) to be similar to that described for the equivalent activities during the construction phase and have therefore been assessed based on the worst-case construction impacts and presented in one section.

5.11.3 A description of the significance of effect upon benthic and intertidal receptors caused by each identified impact is also provided below.

5.11.4 The current project design includes an offshore ECC to shore to facilitate power export from the Array Areas to the national electricity grid. Under the Offshore Transmissions Network Review (OTNR) options, work to consider the potential for an offshore connection has been commenced but is not well advanced. An offshore connection is not a viable or deliverable alternative at this time. However, in order to allow the identification of impacts that be relevant were this to become an option, the assessment for each potential impact has been split into “Array Area Impacts” and “Offshore Export Cable Corridor Impacts.” Further details on the OTNR process are outlined in Volume 9, Report 29: Offshore Connection Scenario.

IMPACT 1: TEMPORARY HABITAT DISTURBANCE

ARRAY AREA IMPACTS

MAGNITUDE OF IMPACT

5.11.5 The total maximum area of temporary loss/ disturbance of subtidal habitat due to construction activities is described in Table 5.12. Approximately 21.7 km^2 is predicted to be temporarily lost/ disturbed within the VE array areas as a result of seabed preparations for foundations, jack-up barge operations and the installation and burial of inter-array cables (including associated anchor placements) and OSP installation. This equates to approximately 17% of the total seabed area within the VE array areas. It should be noted that the MDS presents a precautionary approach to temporary habitat disturbance because it counts both the total footprint of seabed clearance as well as cable burial across both the array areas.

5.11.6 This approach effectively counts the footprint of seabed habitat to be impacted by construction in the same area twice. However, this precautionary approach has been taken because there is some potential for recovery of habitats between the activities due to project timescales.

5.11.7 As described in Section 5.7, the benthic habitats comprise macrofaunal assemblages typical of the predominantly coarse and sandy sediments that characterise the array areas. The majority of benthic habitats that are predicted to receive a direct temporary habitat disturbance of this nature are common and widespread throughout the wider region and southern North Sea (as previously detailed). The temporary habitat disturbance during construction activities would therefore have an impact on a very limited footprint, particularly when compared to the overall extent of such habitats, and this loss is not expected to undermine regional ecosystem functioning or diminish biodiversity.

5.11.8 The impact on benthic habitats in the array areas is predicted to be of local spatial extent (i.e. restricted to discrete areas within the development area), short-term duration (as it is limited to the duration of construction activities), intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **low adverse**.

SENSITVITY OF THE RECEPTOR

5.11.9 The sensitivity of all biotopes that are known to characterise the VE array areas (Section 5.7) have been assessed according to the detailed MarESA sensitivity assessment (Table 5.15).

Table 5.15: MarESA assessment for the benthic subtidal habitats in the array areas for abrasion/ disturbance.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
G. lapidum in impoverished infralittoral mobile gravel and sand	MB3235	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)
Polychaete-rich deep Venus community in offshore mixed sediments	MD4211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)
Sabellaria spinulosa on stable circalittoral mixed sediment	MC2211	Medium (based on low resistance and medium resilience)	Confidence is low as the assessment is based on expert judgement
Piddocks with sparse associated fauna in	MC1251	Medium (based on medium resistance and	Confidence is low as the assessment is based on expert judgement

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
sublittoral very soft chalk or clay		very low resilience)	
Sparse fauna in Atlantic infralittoral mobile clean sand	MB5231	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)

5.11.10 As demonstrated in Table 5.15, the benthic communities identified within the array areas were determined as having low to medium sensitivity to an impact of this nature. These biotopes are typical of moderate energy environments and are therefore naturally subject to, and tolerant of, moderate levels of physical disturbance. The communities that predominantly characterise these biotopes include infaunal species such as polychaetes and bivalves. Such species can re-enter the substratum following a temporary habitat disturbance of this nature. The recovery of such communities is likely to occur as a result of larval dispersal and recruitment from surrounding unaffected areas, and recovery is likely to occur within one to ten years (based on the MarESA assessments).

5.11.11 Further evidence to support recovery is supported by research at North Sea aggregate extraction sites, where it was reported that the characteristic recovery time for typical sandy sediment communities may be two to three years, following cessation of dredging activity (Newell *et al*. 2004). This research indicated that following the initial suppression of diversity, abundance and biomass recovery of diversity to within 70 – 80% of that in non-dredged areas was achieved within 100 days; species' abundance also recovered within 175 days (Newell *et al*. 2004). It is important to acknowledge however, that the activities associated with aggregate extraction are different to those associated with OWF construction activities. (i.e. they involve the complete removal of sediment). Data collated from more analogous activities such as the burial of telecommunications cables, as well as the monitoring of OWFs, indicate that recovery is rapid with limited, if any, significant effects being discernible (Foden *et al*. 2011).

5.11.12 The biotope 'Sparse fauna in Atlantic infralittoral mobile clean sand' (MB5231) was recorded at two sites in the southern array area and is described as having a low sensitivity to a disturbance of this nature. This biotope is associated with mobile sands and are adapted to frequent disturbance. The community is characterised by low abundances and species able to withstand sediment disturbance such as amphipods, isopods and polychaetes.

5.11.13 Abrasion of coarser sediments is likely to disturb epifauna and may damage a proportion of those characterising epifaunal species. However, while opportunistic species are likely to recruit rapidly, some damaged characterising species may recover or recolonise, resulting in high resilience.

5.11.14 The biotope 'Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (MC1251)' was recorded at one location within the north array area (Section 5.7). This community is expected within the region due to the underlying London clay formation that is found regionally (MALSF, 2009). Due to their burrowing habitat piddocks are afforded some protection from surface abrasion, although where abrasion or disturbance impacts occur deeper than the surface, individuals inhabiting the chalk or clay are vulnerable to damage, although it is likely that denuded areas of exposed clay will be recolonised by piddocks once construction activities have ceased. However, where disturbance results in the removal of the clay habitat this substratum cannot recover through natural processes and recovery and the biotope will be lost. The resilience of this biotope is therefore assessed as very low and the MarESA assessment describes the sensitivity as 'medium' for abrasion and disturbance (Table 5.15).

5.11.15 The biotope '*S. spinulosa* on stable circalittoral mixed sediment' (MC2211) is descried as having 'medium' sensitivity to a disturbance of this nature. Whilst *S. spinulosa* reef itself was not observed from site-specific investigations, individuals were prevalent across the array areas and are known to occur throughout the wider region in both reef and encrusting forms (Section 5.7). As this species is fixed to the substratum, abrasion and disturbance is likely to lead to mortality. However, *S. spinulosa* is most frequently found in disturbed sediment conditions and is an r-strategist (a life strategy which allows a species to deal with the vicissitudes of climate and food supply by responding to suitable conditions with a high rate of reproduction; r-strategists are continually colonizing habitats of a temporary nature). *S. spinulosa* occurs in high densities on subtidal gravels that would be expected to be disturbed every year or perhaps once every few years due to storms. Areas where *S. spinulosa* had been lost due to winter storms appeared to recolonize up to a maximum thickness of 2.4 cm during the following summer (R. Holt, pers. comm. in Jones *et al*., 2000). Recoverability is therefore expected to be high for the species.

SIGNIFICANCE OF THE EFFECT

5.11.16 Overall, it is predicted that the impact of temporary habitat disturbance on benthic habitats in the array areas is considered to be of **low adverse** magnitude, and the sensitivity of receptors affected is considered to be worst-case **medium**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

5.11.17 The MarESA assessments identify that the confidence for the sensitivity of the specified habitats to abrasion/ disturbance of the surface is high for half of the biotopes assessed within Table 5.15. The low confidence associated with MC1251, and MC2211 biotopes is associated with the resistance measure, although evidence suggests high confidence associated with the resilience measure. Since the evidence agrees in terms of direction and magnitude of the impact the assessment is considered conservative and robust, particularly with the associated research and evidence provided.

OFFSHORE EXPORT CABLE CORRIDOR IMPACTS

MAGNITDUE OF IMPACT

5.11.18 Of the total area of temporary habitat loss described in Table 5.12, a maximum of approximately 14.7 km^2 will be disturbed within the subtidal areas of the offshore ECC as a result of seabed preparation, export cable installation, burial and jointing. This equates to approximately 9.7% of the total seabed area within the VE offshore ECC.

5.11.19 As described in Section 5.7, the benthic habitats that characterise the offshore ECC comprise macrofaunal assemblages associated with predominantly coarse and mixed sediment habitats, although some more sandy sediments and clay outcrops are also encountered. The majority of benthic habitats that are predicted to receive a direct temporary habitat disturbance of this nature, are common and widespread throughout the wider region and southern North Sea (as previously detailed). Consequently, the temporary habitat disturbance during construction activities would have an impact on a very limited footprint, particularly when compared to the overall extent of such habitats and this loss is not expected to undermine regional ecosystem functions or diminish biodiversity.

5.11.20 The impact on non-designated benthic habitats in the offshore ECC is predicted to be of local spatial extent, short-term duration, intermittent and with high reversibility with the impact predicted to affect the receptor directly. The magnitude is therefore, considered to be **low adverse**.

5.11.21 The offshore ECC overlaps with 1.26 km^2 of the M&LS SAC, which is designated for sandbank features. The maximum total area that is expected to be disturbed by sandwave clearance is 0.6 km^2 which equates to 0.09% of the total SAC. A detailed assessment on physical impact to the seabed where the Project overlaps with the SAC is presented within Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes. The magnitude of the predicted impact to designated areas of seabed is assessed as negligible because no sediment is being removed from the local sediment transport system, only redistributed (see additional mitigation to reduce impacts on features of the M&LS SAC in Table 5.14). The seabed in these areas has been shown to be dynamic and is assessed to have some capacity to recover from disturbance. Accordingly net rates of sediment transport to/ from the designated areas of the seabed will remain unaltered from the baseline.

5.11.22 A detailed analysis and discussion of sandwave clearance and recovery, including numerous examples of pre-dredge, post-dredge and partial recovery surveys of the Race Bank Offshore Wind Farm was produced as part of the Habitats Regulation Appraisal for the Hornsea Project Three Offshore Wind Farm (ABPmer, 2018a). Similar analysis was also undertaken for the Norfolk Vanguard and Norfolk Boreas Export Cable Route (ABPmer, 2018b). This information has been compiled into the final assessment of impact from sandwave clearance to the M&LS SAC and is presented within Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes.

5.11.23 The magnitude of impact to the physical properties of Annex I sandbanks resulting from levelling is considered low. This is because although direct impacts to the seabed will occur, the seabed is expected to recover in response to the occurrence of short-term seabed mobility (occurring during peak flood and ebb currents on spring tides in all locations) and observed natural migration of bedforms (lower rates of migration in the array area, higher in the offshore ECC) dependant on local patterns of net sediment transport).

5.11.24 The HDD exit pits (up to 3 no.) may be located within the intertidal zone or the shallow subtidal. The dimensions of the HDD exit pits will be up to 10 m wide, 75 m long and 2.5 m deep. Exit pits will be excavated or dredged to the required depth, and side-cast material for backfilling will be stored adjacent to the exit pit. Once the drilling operation has taken place, the ducts will be pulled through the drilled holes. The ducts are either constructed off-site, then sealed and floated to site by tugs, or will be constructed at the landfall compound and pulled over the beach on rollers. The ducts are then pulled back through the boreholes either by the HDD rig itself, or by separate winches.

5.11.25 Once the ducts are in place, the exit pits will likely be temporarily backfilled until ready for cable pull-through. Backfilling of the pits is required to prevent collapse and manage natural infill by sediment. Backfill methods may include the use of rock bags or concrete mattresses. Prior to cable installation, the ducts will then need to be re-exposed to pull in the cable using a MFE to remove any accumulated loose sediment and rock bags and/ or mattresses would be retrieved. Between the installation of the ducts and cable pulling operations may be up to two and a half years. Once installation is complete, the subtidal exit pits will be left to naturally backfill. Alternatively, intertidal exit pits will be filled to the natural beach level.

5.11.26 The duration of this impact to benthic features is therefore regarded as short-term duration (as it is limited to the duration of construction activities), intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly and whilst this is a nationally designated feature the magnitude is **low adverse** due to the limited extent.

SENSITIVITY OF THE RECEPTOR

5.11.27 The sensitivity of all biotopes that are known to characterise the offshore ECC array areas (Section 5.7) have been assessed according to the detailed MarESA sensitivity assessment (Table 5.16).

Table 5.16: MarESA assessment for the benthic subtidal habitats found in the offshore ECC for abrasion/ disturbance.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Piddocks with sparse associated fauna in sublittoral very soft chalk or clay	MC1251	Medium (based on medium resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement
Glycera lapidum in impoverished Atlantic infralittoral mobile gravel and sand	MB3235	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)
A. alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	MC5214	Low (based on medium resistance and high resilience)	Confidence is low as the assessment is based on expert judgement
Ophiothrix fragilis and/ or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	MC4215	Medium (based on low resistance and medium resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)
Polychaete-rich deep Venus community in offshore mixed sediments	MD4211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)
Sabellaria spinulosa on stable circalittoral mixed sediment	MC2211	Medium (based on low resistance and medium resilience)	Confidence is low as the assessment is based on expert judgement
Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel	MC3212	Low (based on high resistance and medium resilience)	Confidence is high as the assessment is based on peer reviewed papers (observational or experimental)

5.11.28 As demonstrated in Table 5.16, the communities identified across the offshore ECC were determined as having low to medium sensitivity to an impact of this nature. These biotopes are typical of high energy environments and are therefore naturally subject to, and tolerant of, high levels of physical disturbance. The communities that predominantly characterise these biotopes include infauna such as polychaetes and bivalves. Such species can re-enter the substratum following a temporary habitat disturbance of this nature. The recoverability of such communities is likely to occur as a result of larval dispersal and recruitment from surrounding unaffected areas, and recovery is likely to occur within one to ten years (based on the MarESA assessments).

5.11.29 The biotope *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment was described as having a medium sensitivity to a disturbance of this nature, as removal of the brittlestars would likely result in the biotope being lost or re-classified. Adults may migrate to recover from impacts with a small spatial footprint, however, brittlestars exhibit sporadic and unpredictable recruitment (Buchanan, 1964), despite having long-lived pelagic larvae with a high dispersal potential. As a result, sensitivity is described as having a medium sensitivity when a large proportion of the population is lost.

5.11.30 The biotope 'Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (MC1251)' was recorded within a portion of the offshore ECC. For further discussion on this biotope see 5.11.14.

5.11.31 Whilst *S. spinulosa* reef itself was not observed from site-specific investigations, individuals of this species were prevalent across the offshore ECC. For further discussion on *S. spinulosa* see 5.11.15.

5.11.32 The biotope '*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212) was recorded at two sites in the offshore ECC. This sedimentary biotope is characterised by circalittoral gravels, coarse to medium sands, and shell gravels, sometimes with a small amount of silt. The species that characterise the biotope are typically opportunist r-selected species that rapidly colonise disturbed habitats. For instance, it has been demonstrated generally that following severe disturbance, habitats are recolonised rapidly by opportunistic species (Pearson & Rosenberg, 1978), while specifically, it has been shown that within two years after hydraulic dredging of coarse sediments that abundances of opportunistic species are generally elevated relative to pre-dredging levels (Gilklinson *et al*., 2005). Consequently, it is evident that this the species present in this biotope are able to withstand disturbance of this type.

5.11.33 As shown in Figure 5.5, the site specific surveys identified that the sediments of the VE offshore ECC in the area coinciding with the M&LS SAC, are characterised by circalittoral coarse sediments, the biotope complex could not be classified further following analysis of the infaunal data, owing to the paucity of fauna. As detailed above, this habitat will naturally be exposed to high levels of physical disturbance and therefore are likely to be highly tolerant of an impact of this nature. A biotope that can be linked with an impoverished coarse sediment community and which was located across the offshore ECC is '*G. lapidum* in impoverished infralittoral mobile gravel and sand' (MB3235). As detailed in Table 5.16 this biotope has a low sensitivity to an impact of this nature.

5.11.34 As detailed within the SAC documentation[9] it states that the structure of these banks is dynamic and there have been significant movements of the bank edges over time, inhabiting fauna are therefore likely to be relatively tolerant to temporary habitat disturbances. The likely biotopes present within the Annex I habitat 'Sandbanks which are slightly covered by seawater all the time' are deemed to be of low vulnerability, medium to high recoverability and of national value. The sensitivity of the M&LS SAC is therefore regarded as medium as per the evidence provided.

5.11.35 As presented in Figure 5.7, there are no direct interactions with the Kentish Knock East MCZ and the Blackwater, Crouch, Roach and Colne Estuaries MCZ and therefore no assessment of direct impacts have been undertaken on these features.

5.11.36 The sensitivity of the majority of benthic subtidal features of the offshore ECC is therefore considered to be worst case medium, reflecting that the receptors have some ability to tolerate the potential impacts of temporary habitat disturbance and will potentially recover to an acceptable status over a 10-year period.

SIGNIFICANCE OF THE EFFECT

5.11.37 Overall, it is predicted that the impact of temporary habitat disturbance on benthic habitats in the offshore ECC areas will be of **low adverse** magnitude, and the sensitivity of receptors affected is considered to be worst-case **medium**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

5.11.38 The MarESA assessments identify that the confidence for the sensitivity of the specified habitats to abrasion/ disturbance of the surface is high for half of the biotopes assessed within Table 5.16. The low confidence associated with MC1251, MC5214 and MC2211 biotopes is associated with the resistance measure, however evidence suggests high confidence associated with the resilience measure. Since the evidence agrees in terms of direction and magnitude of the impact the assessment is considered conservative and robust, particularly with the associated research and evidence provided.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.11.39 Impacts will occur within the array area and offshore ECC and may bridge the two areas. The impacts will be localized with no significant additive spatial overlap.

INTERTIDAL AT LANDFALL

MAGNITDUE OF IMPACT

5.11.40 Temporary habitat disturbance is expected to occur within the intertidal area if HDD exit pits are located within this zone (it has not been confirmed if the exit pits will occur in the shallow subtidal or intertidal). Exit pits will be excavated or dredged to the required depth, and side-cast material for backfilling will be stored adjacent to the exit pit. Table 5.12 details the maximum temporary habitat disturbance for the intertidal area, in this scenario.

[9] https://sac.jncc.gov.uk/site/UK0030371

5.11.41 Access to the foreshore will be required for equipment and workers in relation to the HDD exit pits, however any impact to support beach operations is regarded as temporary.

5.11.42 As detailed within the VER table (Table 5.11) none of the biotopes that characterise the landfall location across the intertidal zone are rare or geographically restricted. The area of impact therefore represents a very small footprint compared to their overall extent. The magnitude of the impact has been assessed as **low adverse** on the basis that the impact is of temporary duration, reversible, and highly localised.

SENSITIVITY OF THE RECEPTOR

5.11.43 The sensitivity of all intertidal sedimentary biotopes (Section 5.7) have been assessed according to the detailed MarESA sensitivity assessments (Table 5.17). It should be noted that whilst hard substrates were found across the intertidal zone, they were only found in discreet locations associated with sea defence structures and will therefore not be subject to excavation associated with the HDD works. The associated hard substrate biotopes have therefore not been assessed within this section.

Table 5.17: MarESA assessment for the intertidal habitats for abrasion/ disturbance.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Barren littoral shingle	MA3211	Not sensitive (based on high resistance and high resilience).	Confidence is high as the assessment is based on published literature.
Lanice conchilega in littoral sand	MA5255	Not sensitive (based on high resistance and high resilience).	Confidence is high as the assessment is based on published literature.

5.11.44 The habitats directly affected by the temporary habitat disturbance are considered to be not sensitive to a disturbance of this nature, based on the high resistance and high reliance of the associated fauna, or lack thereof.

5.11.45 Outcrops of clay were also recorded within the intertidal ECC, as detailed within Section 5.7. An assessment of clay with piddock communities has been presented in Table 5.15. However, no bore holes were found within the intertidal outcrops. The lack of the piddock community within this feature therefore results in the sensitivity assessment regarded as low.

SIGNIFICANCE OF THE EFFECT

5.11.46 The magnitude of the impact has been assessed as **low adverse**. Overall, owing to the widespread distribution of the intertidal habitats and communities across the wider region (and southern North Sea), the impoverished nature of the sediments and their ability to withstand proposed levels of abrasion and disturbance, the sensitivity of the intertidal biotopes have been assessed as **low**, resulting in a **minor adverse** significance, which is not significant in EIA terms.

5.11.47 The MarESA assessments identify that the confidence for the sensitivity of the specified habitats to abrasion and disturbance of the surface is high for all the assessed intertidal habitats (Table 5.17). As such, the assessment of the significance of effects as not significant is considered to be robust.

IMPACT 2: TEMPORARY INCREASE IN SUSPENDED SEDIMENT AND SEDIMENT DEPOSITION

ARRAY AREA IMPACTS

MAGNITUDE OF IMPACT

5.11.48 In the array areas temporary localised increases in SSC and associated sediment deposition and smothering are expected from foundation and cable installation works and seabed preparation works (including sandwave clearance). This assessment should be read in conjunction with Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 6, Part 5, Annex 2.2: Physical Processes Model Design and Validation which provides the detailed offshore physical environment assessment (including project specific spreadsheet modelling of sediment plumes).

5.11.49 Background surface SSCs across the array areas are known to vary seasonally, with summer SSC ranging from 1-3 mg/l in the arrays, increasing to 10-20 mg/l during winter months. Higher SSCs are anticipated during spring tides and storm conditions, with greatest concentrations close to the seabed (Volume 6, Part 5, Annex 2.1: Physical Processes Baseline Technical Report).

5.11.50 Seabed preparation for foundations, sandwave clearance for cable installation, cable trenching, drilling for foundations and spoil disposal are all predicted to result in sediment plumes and localised increases in SSC. Table 5.12 presents the MDS associated with increases in SSC and deposition. Site-specific modelling of sediment plumes and deposition from seabed preparation and installation activities has been undertaken to quantify the potential footprint of the plumes, their longevity and the concentration of SSC as well as the subsequent deposition of plume material on the seabed.

5.11.51 In summary, sediment plumes caused by seabed preparation and construction activities are expected to be restricted to within a single tidal excursion from the point of release, which is captured by the benthic ecology study area (Figure 5.1). Sediment plumes are expected to quickly dissipate after cessation of the construction activities, due to settling and wider dispersion with the concentrations reducing quickly over time to background levels (i.e., within a couple of tidal cycles). Sediment deposition will consist primarily of coarser sediments deposited close to the source (a few hundred meters), with a small proportion of silt deposition (reducing exponentially from source).

5.11.52 As described within Section 5.7 above, PSA of the sediments sampled across the VE study area determined that sediment type varied spatially throughout the array areas; sediments in the northern array were heterogeneous with increased gravel and fines in the west of the northern array, whereas sediments across the southern array were more homogenous with coarse sand prevalent. Figure 4.3 within Volume 6, Part 5, Annex 5.1: Main Array - Benthic Ecology Monitoring Report presents the spatial variations of percentage of sand, gravel and fines within the array areas.

5.11.53 Figure 2 within Volume 6, Part 5, Annex 2.3: Physical Processes Technical Assessment, provides a useful schematic summarising the spatial extent of the impact zones associated with SSC and deposition in relation to VE. The figure details that the results of modelling can be summarised broadly in terms of three main zones of effect, based on the distance from the activity causing sediment disturbance:

- 0 to 50 m – zone of highest SSC increase and greatest likely thickness of deposition. All gravel sized sediment likely deposited in this zone, also a large proportion of sands that are not resuspended high into the water column, and also most or all dredge spoil in the active phase. Plume dimensions and SSC, and deposit extent and thickness, are primarily controlled by the volume of sediment released and the manner in which the deposit settles;
  - At the time of active disturbance - very high SSC increase (tens to hundreds of thousands of mg/l) lasting for the duration of active disturbance plus up to 30 minutes following end of disturbance; sands and gravels may deposit in local thicknesses of tens of centimetres to several metres; fine sediment is unlikely to deposit in measurable thickness
  - More than one hour after the end of active disturbance - no change to SSC; no measurable ongoing deposition.
- 50 to 500 m – zone of measurable SSC increase and measurable but lesser thickness of deposition. Mainly sands that are released or resuspended higher in the water column and resettling to the seabed whilst being advected by ambient tidal currents. Plume dimensions and SSC, and deposit extent and thickness, are primarily controlled by the volume of sediment released, the height of resuspension or release above the seabed, and the ambient current speed and direction at the time;
  - at the time of active disturbance - high SSC increase (hundreds to low thousands of mg/l) lasting for the duration of active disturbance plus up to 30 minutes following end of disturbance; sands and gravels may deposit in local thicknesses of up to tens of centimetres; fine sediment is unlikely to deposit in measurable thickness.
  - more than one hour after end of active disturbance - no change to SSC; no measurable ongoing deposition.
- 500 m to the tidal excursion buffer distance – zone of lesser but measurable SSC increase and no measurable thickness of deposition. Mainly fines that are maintained in suspension for more than one tidal cycle and are advected by ambient tidal currents. Plume dimensions and SSC are primarily controlled by the volume of sediment released, the patterns of current speed and direction at the place and time of release and where the plume moves to over the following 24 hours.
  - at the time of active disturbance - low to intermediate SSC increase (tens to low hundreds of mg/l) as a result of any remaining fines in suspension, only within a narrow plume (tens to a few hundreds of metres wide), SSC decreasing rapidly by dispersion to ambient values within one day after the end of active disturbance; fine sediment is unlikely to deposit in measurable thickness.

- one to six hours after end of active disturbance - decreasing to low SSC increase (tens of mg/l); fine sediment is unlikely to deposit in measurable thickness.
- six to 24 hours after end of active disturbance - decreasing gradually through dispersion to background SSC (no measurable local increase); fine sediment is unlikely to deposit in measurable thickness. No measurable change from baseline SSC after 24 to 48 hours following cessation of activities.

- Beyond the tidal excursion buffer distance or anywhere not tidally aligned to the active sediment disturbance activity - there is no expected impact or change to SSC nor a measurable sediment deposition.

5.11.54 Further information on sediment plume distances and modelling are provided in Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 6, Part 5, Annex 2.1: Physical Processes Baseline Technical Report.

5.11.55 Taking the above into consideration, it can be concluded that there will be a quick dissipation of the sediment plume and local nature (0-50 m) of deposition impacts where smothering effects on benthic habitats and features might be observed. The impact of increased SSC and smothering from sediment deposition from construction activities is expected to be short-term, intermittent and of localised extent and reversible. The magnitude of the impact is therefore considered to be **low adverse**.

SENSITIVITY OF THE RECEPTOR

5.11.56 The communities and habitats in the array areas are typical of the wider southern North Sea where relatively high levels of SSC occur naturally. Consequently, communities are exposed to and tolerant of variations in SSC and some degree of sediment deposition.

5.11.57 The contemporary MarESA assessments use annual mean values to determine the sensitivity of habitats to SSCs. As a result of the short-term nature of the construction phase of the proposed project the benchmarks will not be breached, as elevations in SSC created by the construction works will not reach a sufficient scale or magnitude to significantly alter the annual mean values. Consequently, for the purposes of this assessment, reference has been made to the previous MarLIN sensitivity benchmark for short-term acute increases in SSC (i.e. an arbitrary change of 100 mg/l for 1 month) together with that for short-term acute changes in turbidity (i.e. a change in two categories of the water clarity scale for a period of one month).

5.11.58 The sensitivity of the biotopes with reference to both the contemporary MarESA benchmarks for deposition and SSC, and the now superseded short-term MarLIN benchmarks for elevated SSCs and turbidity is summarised in Table 5.18.

Table 5.18: MarESA assessment for the benthic subtidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering and siltation rate).

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Glycera lapidum in impoverished infralittoral mobile gravel and sand	MB3235	> Not sensitive to longer term changes in SSC; > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm).	Confidence in the quality of the evidence is high for the assessments.
Piddocks with sparse associated fauna in sublittoral very soft chalk or clay	MC1251	> Not sensitive to longer term changes in SSC; > Medium sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 - 30 cm).	Confidence is low as the assessment is based on expert judgement. Confidence in the quality of the evidence is medium for the smothering assessments as they are based upon published literature.
A. alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	MC5214	> Low sensitivity to changes in SSC; > Not sensitive to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm).	Confidence is low for the SSC assessment as assessment is based on expert judgement. Confidence is low to medium for smothering and siltation. Confidence in the quality of the evidence is high for the smothering assessments, although the applicability and

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
			agreement between the evidence is low to medium.
Ophiothrix fragilis and/ or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	MC4215	> Not sensitive to longer term changes in SSC; > Medium sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 - 30 cm).	Confidence in the quality of the evidence is medium for all assessments.
Polychaete-rich deep Venus community in offshore mixed sediments	MD4211	> Low sensitivity to changes in SSC; > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm).	Confidence is high for the SSC assessment as assessment is based on peer reviewed papers or grey literature reports by established agencies on the feature. Confidence in the quality of the evidence is high for the smothering assessments, although the applicability and agreement between the evidence is low to medium.
Sabellaria spinulosa on stable circalittoral mixed sediment	MC2211	> Not sensitive to changes in SSC and turbidity; > Not sensitive to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm).	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	MC3212	> Low sensitivity to changes in SSC; > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm).	Confidence is high for the SSC assessment as assessment is based on peer reviewed papers or grey literature reports by established agencies on the feature. Confidence in the quality of the evidence is high for the smothering assessments, although the applicability and agreement between the evidence is low to medium.
Sparse fauna in Atlantic infralittoral mobile clean sand	MB5231	> Low sensitivity to changes in SSC; > Not sensitive to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 – 30 cm).	Confidence is high for the SSC assessment as assessment is based on peer reviewed papers or grey literature reports by established agencies on the feature. Confidence in the quality of the evidence is high for the smothering assessments, although the applicability and agreement between the evidence is low to medium.

5.11.59 The benthic habitats that characterise the array areas and wider benthic ecology study area are deemed to be a maximum of medium vulnerability to heavy smothering, a reasonable worst-case of medium recoverability and of regional to national value. The sensitivity of the receptors is therefore considered to be in the range from low to medium according to the EIA assessment values, however Table 5.18 demonstrates that lower levels of sensitivity are recorded for light smothering (which will be the spatially larger impact) and longer-term changes in SSC.

5.11.60 The MarESA sensitivity assessment defines *S. spinulosa* as being 'not sensitive' to increases in SSC and light deposition. *S. spinulosa* tube growth is dependent on the presence of suspended particles, hence increase in suspended sediment could facilitate tube construction and may result in increased populations. However, an increase in siltation may also clog feeding apparatus and heavy levels of deposition are recorded as 'medium', but recovery of this species is understood to be almost immediate when the population can recommence feeding and growing. Extrapolating from *Sabellaria alveolata* research reveals that it is probable that *S. spinulosa* can tolerate smothering by sediment for up to several weeks. Whilst feeding and growth will be curtailed during this period recovery of *S. spinulosa* would be almost immediate once the activity ceases (Tillin, 2010).

SIGNIFICANCE OF THE EFFECT

5.11.61 Increases in SSC and associated sediment deposition will represent a temporary and short-term intermittent impact, affecting a relatively small portion of the benthic habitats in the benthic ecology study area. Overall, the impact of increased SSC and deposition is considered to be **low adverse** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **medium**, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE EXPORT CABLE CORRIDOR IMPACTS

MAGNITDUE OF IMPACT

5.11.62 In the offshore ECC temporary localised increases in SSC and associated sediment deposition and smothering are expected from cable installation works (including HDD installation) and seabed preparation works (including sandwave clearance). This assessment should be read in conjunction with Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 6, Part 5, Annex 2.2: Physical Processes Model Design and Validation which provides the detailed offshore physical environment assessment (including project specific spreadsheet modelling of sediment plumes).

5.11.63 SSCs are higher within the offshore ECC compared to the array areas and reach a peak close to the coast at the landfall. During winter months, mean values exceed 100 mg/l although, as for the array areas, higher values are anticipated during spring tides and storm conditions, with the greatest concentrations encountered close to the seabed (Volume 6, Part 5, Annex 2.1: Physical Processes Baseline Technical Report).

5.11.64 Sandwave clearance for cable installation and cable trenching are all predicted to result in sediment plumes and localised increases in SSC. Table 5.12 presents the MDS associated with increases in SSC and deposition. Site-specific modelling of sediment plumes and deposition from seabed preparation and installation activities has been undertaken to quantify the potential footprint of the plumes, their longevity and the concentration of SSC as well as the subsequent deposition of plume material on the seabed.

5.11.65 In summary, sediment plumes caused by seabed preparation and construction activities are expected to be restricted to within a single tidal excursion from the point of release, which is captured by the benthic ecology study area (Figure 5.1). Sediment plumes are expected to quickly dissipate after cessation of the construction activities, due to settling and wider dispersion with the concentrations reducing quickly over time to background levels (i.e., within a couple of tidal cycles). Sediment deposition will consist primarily of coarser sediments deposited close to the source (a few hundred meters), with a small proportion of silt deposition (reducing exponentially from source).

5.11.66 As described within Section 5.7 above, PSA of the sediments sampled across the VE study area determined that sediment type varied spatially throughout the ECC with the majority of the corridor being dominated by circalittoral mixed and circalittoral coarse sediments. Figure 4.6 in Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report presents the spatial variations of percentage of sand, gravel and fines within the offshore ECC.

5.11.67 A summary of the spatial extent of the impact zones associated with SSC and deposition outlining the three main zones of effect are outlined above in 5.11.53. Based on this, it is considered that in relation to construction works in the offshore ECC, any sediment plume will disperse quickly with some smothering effects on benthic habitats and features potentially occurring within 50 m of construction activities. The impact of increased SSC and smothering from sediment deposition is expected to be short-term, intermittent and of localised extent and reversible. The magnitude of the impact is therefore considered to be **low adverse**.

5.11.68 The indirect impacts to the M&LS SAC are considered to be limited to the smothering and deposition impacts that are most likely to significantly disturb benthic communities (0-50 m), and whilst this will occur within the SAC where the offshore ECC overlaps (0.9% of the offshore ECC overlaps with the SAC), the magnitude of the impact is considered to be **low adverse** and the impact is expected to be localised.

5.11.69 The supporting habitats within the Outer Thames Estuary SPA (a range of mobile sediments, including several shallow sandbanks) are well represented by the biotopes presented and assessed within this section. Whilst the importance of this habitat is increased due to its designation status the limited footprint and impact to these habitats is regarded as **low adverse**.

5.11.70 No impacts to the designated Colne Estuary SPA, Hamford Water SPA, the Essex Estuaries SAC and the nationally designated Kentish Knock East MCZ and Blackwater Crouch, Roach, Colne Estuaries MCZ, Landguard Common SSSI, Harwich Foreshore SSSI, Hamford Water SSSI and Colne Estuary SSSI are expected due to their distance (Table 5.10) from construction activities, where SSC are not to be present in sufficient quantities to adversely impact benthic features and there will be no measurable thickness of deposition expected. The magnitude to these features is therefore assessed as negligible.

5.11.71 Release of bentonite (a non-toxic, natural clay mineral) during the trenchless installation technique for the HDD punch out may result in a single, large plume of sediment in suspension into the water column (this could be above or below the MHWS line depending of the final location of the exit pit). This will result in localised high levels of SSC within the nearshore, shallow waters. As presented in Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical processes, the majority of the plume will be advected in the direction of the ambient tidal currents. The direction of transport will depend on the state of the tide (flood or ebb) at the time of the release. It is expected that the plume would be dispersed to relatively low concentrations within hours of release and to background concentrations within a few tidal cycles. The drilling fluid typically consists of a low concentration bentonite – water mixture and it is expected that the bentonite will be diluted over time, without resulting in any notable settlement. The magnitude of the release of bentonite in the marine environment is assessed as negligible.

SENSITIVITY OF THE RECEPTOR

5.11.72 The communities and habitats identified across the offshore ECC are typical of the wider southern North Sea while all biotopes identified are acclimated to relatively high levels of SSC that occur naturally within this region and consequently, are subject to and able to tolerate variations in SSC and some degree of sediment deposition.

5.11.73 As discussed in 5.11.57, for the purposes of this assessment, reference has been made to the previous MarLIN sensitivity benchmark for short-term acute increases in SSC (i.e. an arbitrary change of 100 mg/l for 1 month) together with that for short-term acute changes in turbidity (i.e. a change in two categories of the water clarity scale for a period of one month).

5.11.74 The sensitivity of the biotopes with reference to both the contemporary MarESA benchmarks for deposition and SSC, and the now superseded short-term MarLIN benchmarks for elevated SSCs and turbidity is summarised in Table 5.17.

5.11.75 The benthic habitats that characterise the offshore ECC areas and wider benthic ecology study area are deemed to be a maximum of medium vulnerability to heavy smothering, a reasonable worst-case of medium recoverability and of regional to national value. The sensitivity of the receptors is therefore considered to be in the range from low to medium according to the EIA assessment values, however Table 5.17 demonstrates that lower levels of sensitivity are recorded for light smothering (which will be the spatially larger impact) and longer-term changes in SSC.

5.11.76 Whilst *S. spinulosa* reef itself was not observed from site-specific investigations, individuals of this species were prevalent across the offshore ECC. For further discussion on *S. spinulosa* see 5.11.60.

5.11.77 Given the national importance of some of the benthic features protected within the M&LS SAC and the supporting features of the Outer Thames Estuary SPA which overlap with the secondary ZoI for SSC and deposition, the overall sensitivity value of medium will be assessed, which is considered precautionary based on the limited extent of any predicted heavy smothering and deposition.

SIGNIFICANCE OF THE EFFECT

5.11.78 Increases in SSC and associated sediment deposition will represent a temporary and short-term intermittent impact, affecting a relatively small portion of the benthic habitats in the benthic ecology study area. Overall, the impact of increased SSC and deposition is considered to be **low adverse** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **medium**, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.11.79 Sediment plumes arising in the array area and offshore ECC have the potential to overlap with respect to both SSC and sediment deposition effects. If the activities causing sediment disturbance occur at the same time (to within a few minutes or hours at the most) and in locations that are closely aligned with respect to the ambient tidal currents so that a second plume is created within the footprint of effect of another plume, the effect on SSC is locally additive in the area of overlap. Plumes that overlap subsequently through lateral diffusion are not an additive effect on SSC and will not exceed the values quoted for individual plumes.

5.11.80 If activities causing sediment disturbance occur at any time in locations that are closely aligned with respect to direction of the ambient tidal currents, the total sediment thickness deposited is locally additive in the area of overlap. It is noted that measurable thicknesses of deposition are only expected within relatively small distances (tens of metres) from the site of the activity, extending in the direction of tidal current at the time of the work. Therefore, there is a very low likelihood of a large total area of overlapping measurable local thicknesses of deposition resulting from overlapping plume effects.

INTERTIDAL AT LANDFALL

MAGNITUDE OF IMPACT

5.11.81 Temporary increases in SSC and associated sediment deposition in the intertidal area are expected from the cable installation works and the release of drill cuttings and drilling mud from the HDD works. Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Process and Technical Report provides a full description of the physical assessment, with a summary of the maximum design scenarios associated with the impact detailed in Table 5.12.

5.11.82 There is a requirement to use drilling mud, such as bentonite (or another inert mud), in order to undertake HDD activities and make landfall. This in turn may result in the release of drilling mud within the intertidal area at the punch out points. Bentonite is a non-toxic, natural clay mineral (<63 µm particle diameter) and is included in the List of Notified Chemicals approved for use and discharge into the marine environment and is classified as a Group E substance under the Offshore Chemical Notification Scheme.

5.11.83 Substances in Group E are defined as the group least likely to cause environmental harm and are *"readily biodegradable and non-bioaccumulative".* This is further supported by bentonite being included on the OSPAR List of Substances Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment (PLONOR) [10].

5.11.84 The release of drilling fluid (a suspension of natural bentonite clay in water) into the coastal waters at the punch-out location may cause a sediment plume in the nearshore area.

5.11.85 Up to 3 HDD conduits might be required, with up to 4,940m^3 of drilling fluid potentially released per conduit (up to 14,820 m^3 total for all conduits). Lesser amounts are more likely, depending on the final drilling method, length and diameter required.

5.11.86 The drilling fluid typically consists of a low concentration bentonite – water mixture. Depending on the formation to be drilled through, the concentration is typically between 13 litres (30kg) and 35 litres (80kg) of dry bentonite clay per m³ of water (30,000 to 80,000mg/l).

5.11.87 The use of bentonite has limited potential to cause environmental impacts:

- it is a natural material, so has no chemical constituents;
- it is recyclable;
- it is on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR); and
- owing to the large diameter pipe and long length, the total volume of fluid used may be relatively large, but, owing to the low concentration, the total amount of bentonite used is limited.

5.11.88 As detailed within the Volume 6, Part 5, Annex 2.3: Physical Processes Technical Assessment, the magnitude of impact resulting from temporarily elevated levels of siltation in the would be negligible.

5.11.89 As detailed within the VER table (Table 5.11) none of the biotopes that characterise the landfall location across the intertidal zone are rare or geographically restricted. The impact is also temporally restricted. The magnitude of the impact has been assessed as **low adverse** on the basis that the impact is of temporary duration, reversible, and localised.

SENSITIVITY OF THE RECEPTOR

5.11.90 The intertidal habitats that characterise the VE landfall area have been assessed to have a low sensitivity to increases in SSC (both according to the MarESA and MarLIN benchmarks) and turbidity, medium sensitivity to light deposition (0-5 cm) and medium sensitivity to heavy deposition (5-30 cm) (Table 5.19). The sensitivity of the receptors is therefore considered to be in the range from low to medium according to the EIA assessment values, although Table 5.19 demonstrates that lower levels of sensitivity are recorded for most biotopes. The resilience of these habitats ranges from medium to high, with recovery anticipated in <2 years for some biotopes but up to 10 for others.

[10] https://www.cefas.co.uk/data-and-publications/ocns/downloads-and-useful-links/

Table 5.19: MarESA assessment for the benthic intertidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering and siltation rate).

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Verrucaria maura on very exposed to very sheltered upper littoral fringe rock	MA12132	> Not sensitive to increases in turbidity. > Medium sensitivity to changes in SSC. > No sensitivity assessment for smothering and siltation rate changes.	Confidence is low for the assessments as this are based on expert judgement.
Enteromorpha spp. on freshwater-influenced and/or unstable upper eulittoral rock	MA123G	> Not sensitive to longer term or to short-term changes in SSC; > Not sensitive to increases in turbidity; > Low sensitivity to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 - 30 cm).	Confidence in the quality of the evidence is high for the assessments as they are based upon published literature.
Porphyra purpurea and *Enteromorpha spp.* on sand-scoured mid or lower eulittoral rock	MA123H	> Not sensitive to longer term changes in SSC. > Low sensitivity to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 - 30 cm).	Confidence in the quality of the evidence is high for the assessments as they are based upon published literature.
Fucus spiralis on full salinity exposed to moderately	MA1242	> Medium sensitivity to changes in SSC. > Low sensitivity to light smothering (< 5 cm); and	Confidence is medium for the SSC assessment and low light smothering assessment as this is based on some peer

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
exposed upper eulittoral rock		> Medium sensitivity to heavy smothering (5 - 30 cm).	reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is high for the heavy smothering assessment as it is based on some peer reviewed papers.
Semibalanus balanoides on exposed to moderately exposed or vertical sheltered eulittoral rock	MA1223	> Low sensitivity to changes in SSC and > Medium sensitivity to light and heavy smothering.	Confidence is low for the SSC assessment as based on expert judgement. Confidence in the quality of the evidence is high for the smothering assessments as they are based upon published literature.
Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock	MA1243	> Medium sensitivity to changes in SSC; > Medium sensitivity to smothering (< 5 cm – 30 cm).	Confidence is medium for the SSC assessment as based on some peer reviewed papers but relies on expert judgment on feature. Confidence is high for the light smothering assessment as based on peer reviewed papers and medium for the heavy smothering as based on some peer reviewed papers but relies heavily on expert judgement.
Fucus serratus on moderately exposed lower eulittoral rock	MA1244	> Low sensitivity to short-term increases in SSC and turbidity, not	Confidence is medium as based on some peer reviewed papers, but all assessments are based

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
		sensitive to long term changes in SSC. > Low sensitivity to changes in light smothering (< 5 cm); and > High sensitivity to heavy smothering (5 - 30 cm).	on proxies for pressures and rely on expert judgment.
Barren littoral shingle	MA3211	> Not sensitive to longer term or to short-term changes in SSC; > Not sensitive to increases in turbidity; > Not sensitive to heavy smothering (< 5 cm – 30 cm).	Confidence in the quality of the evidence is high for the assessments as they are based upon published literature.
Lanice conchilega in littoral sand	MA5255	> Very low sensitivity to short-term increases in SSC and turbidity, not sensitive to long term changes in SSC. > Not sensitive to light smothering (< 5 cm) > Low sensitivity to heavy smothering (5 - 30 cm)	The confidence in the short-term SSC sensitivity assessments is medium as the assessment is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is high for the light the smothering assessment as this been derived from sources that specifically deal with sensitivity and recoverability of a species or biotope to a particular factor. Experimental work has

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
			been done investigating the effects of such a factor. Confidence is low for all remaining assessments as they are based on expect judgement.

5.11.91 The sensitivity of the receptors is considered to be in the range from low to medium except for the heavy smothering assessment (5 - 30 cm) on '*F. serratus* on moderately exposed lower eulittoral rock' (MA1244) which resulted in a high sensitivity as smothering could result in significant mortalities which could remain for many tidal cycles if in a sheltered area; thus, both resistance and resilience were assessed as low. However, it is unlikely that levels of heavy smothering will reach this biotope because sediment from HDD exit pits will be side-cast and therefore will not be suspended in the water column and result in heavy smothering (Table 5.12).

SIGNIFICANCE OF THE EFFECT

5.11.92 Overall, it is predicted that the sensitivity of the intertidal receptors located across the benthic ecology study area are at worst-case **medium** according to the detailed MarESA assessments and published literature. However, the MarESA assessments do not take into account the site-specific environmental conditions, and in considering these it is unlikely that the effects would be detectable above natural background variability. The impact of increased SSC and deposition is considered to be **low adverse** magnitude, and, according to the detailed MarESA assessments and published literature, the sensitivity of receptors affected is predicted to be at worst-case medium,. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

5.11.93 The MarESA assessment confidence scores were variable (Table 5.19), with low confidence scores due predominantly to low confidence for the resistance assessment and also to the applicability for the resilience assessment. The significance of effect has been assessed based on the lowest resistance score of low and a resilience score of low as part of the sensitivity assessments. Therefore, while the confidence score is low, the assessment is using the most conservative sensitivity. Furthermore, as discussed above, the intertidal area at landfall is a naturally energetic site within which there is evidence of naturally high sediment movement, particularly during storm surges and consequently, the communities will be adapted to SSC, turbidity and deposition events which are similar to the impacts of cable installation. As such, the assessment conclusion remains valid and robust.

IMPACT 3: DIRECT AND INDIRECT SEABED DISTURBANCES LEADING TO THE RELEASE OF SEDIMENT CONTAMINANTS

ARRAY AREAS IMPACTS

MAGNITUDE OF THE IMPACT

5.11.94 There is the potential for sediment bound contaminants, such as metals, hydrocarbons, and organic pollutants, to be released into the water column and lead to an effect on benthic ecology receptors, as a result of construction activities and associated sediment mobilisation.

5.11.95 Contaminant surveys in the array areas reported in Volume 6, Part 5, Annex 5.1: Main Array - Benthic Ecology Monitoring Report.

5.11.96 Following disturbance as a result of construction activities, the majority of resuspended sediments are expected to be deposited within the immediate vicinity of the works. 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.

5.11.97 Therefore, the magnitude of the impact is considered to be negligible, indicating that any release of sediment contamination is likely to be discernible over a very small area of the receptor, which does not threaten benthic subtidal ecology features, undermine regional ecosystem functions or diminish biodiversity.

SENSITIVITY OF THE RECEPTOR

5.11.98 The sensitivity of benthic species to toxic pollutants that may be disturbed is deemed to be worst-case high, which is considered precautionary and reflects the lack of evidence on individual receptors and biotopes. A sensitivity of high describes the habitat or species as exhibiting ‘none’ or ‘low’ resistance (tolerance) to an external factor and is expected to recover only over very extended timescales.

SIGNIFICANCE OF THE EFFECT

5.11.99 The impact of direct and indirect seabed disturbances leading to the release of sediment contaminants is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE EXPORT CABLE CORRIDOR IMPACTS

MAGNITUDE OF THE IMPACT

5.11.100 There is the potential for sediment bound contaminants, such as metals, hydrocarbons, and organic pollutants, to be released into the water column and lead to an effect on benthic ecology receptors, as a result of construction activities and associated sediment mobilisation.

5.11.101 Contaminant surveys in the offshore ECC reported in Volume 6, Part 5, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.

5.11.102 Following disturbance as a result of construction activities, the majority of resuspended sediments are expected to be deposited within the immediate vicinity of the works. 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.

5.11.103 Therefore, the magnitude of the impact is considered to be negligible, indicating that any release of sediment contamination is likely to be discernible over a very small area of the receptor, which does not threaten benthic subtidal ecology features, undermine regional ecosystem functions or diminish biodiversity.

SENSITIVITY OF THE RECEPTOR

5.11.104 As previously described in section 5.11.104, the sensitivity of benthic species to toxic pollutants that may be disturbed is deemed to be worst-case high, which is considered precautionary and reflects the lack of evidence on individual receptors and biotopes. A sensitivity of high describes the habitat or species as exhibiting 'none' or 'low' resistance (tolerance) to an external factor and is expected to recover only over very extended timescales.

SIGNIFICANCE OF THE EFFECT

5.11.105 The impact of direct and indirect seabed disturbances leading to the release of sediment contaminants is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.11.106 Impacts may potentially occur within the array area and offshore ECC and may bridge or transition between the two areas. The impacts will be localized with no additive spatial overlap.

IMPACT 4: INCREASED RISK OF INTRODUCTION OR SPREAD OF MARINE INVASIVE NON-NATIVE SPECIES (INNS)

ARRAY AREAS IMPACTS

MAGNITUDE OF THE IMPACT

5.11.107 There is a risk that through increased vessel movements during construction will contribute to the introduction or spread of Marine INNS through ballast water discharge (Eno *et al*., 1997). Table 5.12 identifies the number of round trips to port during the construction phase. Impacts associated with introduction of hard substrate is discussed within Impact 8. However, the movement of commercial vessels is common throughout the region (Volume 6, Part 2, Chapter 9: Shipping and Navigation) and this provides an existing and potentially more likely method of transport for Marine INNS species (due to the higher variety of ports and passage routes).

5.11.108 As detailed within Table 5.13, mitigation measures which include a PEMP with a biosecurity plan will ensure that the risk of potential introduction and spread of Marine INNS from increased vessel activity is minimised.

5.11.109 It should be noted that there is a wide-spread presence of Marine INNS across the southern North Sea. The Marine INNS *C. fornicata* has successfully established to an extent that it outcompetes indigenous species causing large scale habitat changes across coastal areas of the UK (EMU Limited, 2012). Moreover, the most problematic Marine INNS off the Suffolk coast are the Turkish crayfish (*Astacus leptodactylus*), Chinese mitten crab (*Eriocheir sinensis*), leathery sea squirt (*Styela clava*) and wireweed (*Sargassum muticum*). Demonstrating that the region is not a pristine environment in terms of the absence of Marine INNS (Dittel *et al*., 2009; Holdich *et al*., 2009; Macleod *et al*., 2016 and Nehls *et al*., 2006).

5.11.110 Mitigation measures, including a PEMP with a marine biosecurity plan (Table 5.13) will, however, ensure that the risk of potential introduction and spread of MINNS will be minimised as low as practicable.

5.11.111 Taking into consideration the mitigation (Table 5.13) the magnitude of the impact that construction activities will have to the introduction or spread of Marine INNS is considered to be negligible.

SENSITIVITY OF THE RECEPTOR

5.11.112 The sensitivity of benthic receptors within the benthic study area to an introduction or spread of Marine INNS is deemed to be at worse case 'high', given the lack of evidence for a potential impact of this nature. The sensitivity of nearby SAC and SPA features is also regarded as high given their protection status. Therefore, the sensitivity is considered to be high, reflecting that at worst-case benthic receptors have 'none' or 'low' resistance (tolerance) to an impact of this nature.

SIGNIFICANCE OF THE EFFECT

5.11.113 The impact of increased risk of introduction or spread of marine INNS is considered to have a **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE ECC IMPACTS

MAGNITUDE OF IMPACT

5.11.114 The overview of magnitude is the same as described for the array area in paragraph 5.11.107 *et seq*.

SENSITVITY OF THE RECEPTOR

5.11.115 The overview of sensitivity is the same as described for the array area in paragraph 5.11.112 *et seq*.

SIGNIFICANCE OF THE EFFECT

5.11.116 The impact of increased risk of introduction or spread of marine INNS is considered to have a **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.11.117 Impacts may potentially occur within the array area and offshore ECC and may bridge or marine INNS may move between the two areas. The impacts will be localized with no significant additive spatial overlap.

5.12 ENVIRONMENTAL ASSESSMENT: OPERATIONAL PHASE

IMPACT 5: PERMANENT HABITAT LOSS/ ALTERATION

ARRAY AREAS IMPACT

MAGNITUDE OF THE IMPACT

5.12.1 Within the array areas the presence of foundations and the associated scour protection, along with the cable protection measures used at inter-array cable crossings and areas where inter-array cable burial is not possible, will lead to a change from a sedimentary habitat to one characterised by hard substrate. This will be a permanent habitat loss (for the design life duration of VE) and a permanent change of habitat. It is assessed here as permanent habitat loss due to the potential shift in the baseline condition, although it is noted that this also has the potential to comprise beneficial effects, providing new habitats for different faunal assemblages to colonise, resulting in a likely increase in biodiversity and biomass.

5.12.2 Table 5.12 identifies the maximum design scenario for foundation, scour and cable protection footprint. The total habitat loss from these components equates to approximately 2.4% of the array areas. The magnitude of the impact that permanent habitat loss/ alteration will have on benthic ecology receptors is considered to be negligible. While the impact will be locally significant and comprise a permanent change in seabed habitat within the footprint of the structures and scour and cable protection, the footprint of the area affected is highly localised and the habitats and characterising biotopes are common and widespread throughout the wider region.

SENSITVITY OF THE RECEPTOR

5.12.3 The species and habitats identified during the characterisation study are typical of the wider region and southern North Sea (as previously discussed in Section 5.7). All biotopes identified within the array areas have been assessed according to the MarESA criteria as having no resistance to permanent habitat loss / change, with recovery assessed as very low as the change at the pressure benchmark is at worst case permanent. The sensitivity of subtidal receptors is therefore considered to be at worst-case high, taking into consideration the national value of the SAC according to the EIA assessment values.

SIGNIFICANCE OF THE EFFECT

5.12.4 For habitats within the array areas it is predicted that the sensitivity of the receptor is **high**, and the magnitude is **negligible**. As the habitats and characterising biotopes are not geographically restricted to the array areas and are widespread throughout the southern North Sea the loss of these habitats is assessed as barely discernible and the residual effect is considered to be of **minor adverse** significance, which is not significant in EIA terms.

OFFSHORE ECC IMPACTS

MAGNITUDE OF IMPACT

5.12.5 In the offshore ECC the presence of cable protection will lead to a change from a sedimentary habitat to one characterised by hard substrate. This will be a permanent habitat loss and a permanent change of habitat (for the design life duration of VE). It is assessed here as permanent habitat loss and a **potential adverse** effect (due to the potential shift in the baseline condition), although it is noted that this also has the potential to comprise beneficial effects, providing new habitats for different faunal assemblages to colonise, resulting in a likely increase in biodiversity and biomass.

5.12.6 Table 5.12 identifies the maximum design scenario for cable protection footprint which equates to approximately 0.2% of the offshore ECC corridor. The magnitude of the impact that permanent habitat loss/ alteration will have on benthic ecology receptors is considered to be negligible.

5.12.7 Where the offshore ECC crosses the M&LS SAC, any cable protection that might occur in this area is expected to be a greater magnitude of effect due to the conservation status of the benthic resources. On account of the conservation status, additional mitigation measures have been developed within the M&LS SAC (Table 5.14). The full details of this mitigation strategy are presented within the Outline M&LS SAC Benthic Mitigation Plan (Volume 9, Report 13). This mitigation plan has been developed in line with Natural England's mitigation hierarchy for designated sites. The mitigation that has been applied includes the following commitments:

- Final cable routing will seek to take the shortest route through the M&LS SAC where possible, and considering the required separation to North Falls cables – this routing work will also consider the potential for successful cable burial with the objective of avoiding the need for cable protection;
- Should burial not be achieved at the first attempt the burial hierarchy will followed in line with Section 5 of Volume 9, Report 13: M&LS SAC Benthic Mitigation Plan;
- Rock dumping using loose rock will not be considered a feasible protection in the M&LS SAC; and
- Should additional protection be required then mattresses or another form of protection that is equivalent (or less in terms of footprint or impact) and removable at decommissioning, will be used.

5.12.8 However, whilst this long-term loss of habitat might occur within the SAC where the offshore ECC overlaps, as detailed within Table 5.12, the MDS for removable cable protection is 5,400 m^2, and a maximum volume of 5,400 m^3, which relates to 0.0008% of the SAC. Furthermore, once the cable protection is removed it is expected that the sandbank would recover very quickly. The magnitude of the impact is therefore considered to be low after the implementation of additional mitigation, and the impact is expected to be localised.

5.12.9 No permanent habitat loss will occur in the intertidal area of the offshore ECC as no cable protection will be used in this area.

SENSITVITY OF THE RECEPTOR

5.12.10 The species and habitats identified during the characterisation study are typical of the wider region and southern North Sea (as previously discussed in Section 5.7). All biotopes identified within the offshore ECC have been assessed according to the MarESA criteria as having no resistance to permanent habitat loss / change, with recovery assessed as very low as the change at the pressure benchmark is at worst case permanent. The sensitivity of subtidal receptors is therefore considered to be at worst-case high, taking into consideration the national value of the SAC according to the EIA assessment values.

SIGNIFICANCE OF THE EFFECT

5.12.11 Overall, for habitats within the offshore ECC that are out with the M&LS SAC it is predicted that the sensitivity of the receptor is **high**, and the magnitude is **negligible**. As the habitats and characterising biotopes are not geographically restricted to array areas and offshore ECC and are widespread throughout the southern North Sea the loss of these habitats is assessed as barely discernible and the residual effect is considered to be of **minor adverse** significance, which is not significant in EIA terms.

5.12.12 Within the discreet location of the M&LS SAC the magnitude is regarded as **low** due to the implementation of additional mitigation (Table 5.14) and the limited impact on the sandbank features and the ability to remove cable protection after the lifetime of the project. The sensitivity of the receptor is deemed **moderate** because the sandbank is expected to recover after the removal of the pressure. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.13 Direct impacts from permanent habitat loss and alteration will occur within the array area and offshore ECC and may bridge between the two areas. The impacts will be within the direct footprint of the infrastructure with no additive spatial overlap.

IMPACT 6: TEMPORARY HABITAT DISTURBANCE

ARRAY AREAS

MAGNITUDE OF THE IMPACT

5.12.14 Temporary subtidal habitat loss will arise from the use of jack-up vessels for operational and maintenance activities as well as from inter-array cable maintenance and replacement. The total MDS is presented in Table 5.12, which is predicted to arise over the design life of VE equating to approximately 0.5% of the array areas.

5.12.15 Inter-array cable replacement works will require de-burial and re-burial of a cable or cable sections and along with cable preventative maintenance, including re-burial, will consequently result in increases in SSC and sediment deposition. However, the impacts from these works will be spread over the life span of operation and maintenance activities with only a limited number of activities occurring within any one year.

5.12.16 The magnitude of temporary habitat disturbance from jack-up vessels and inter-array cable maintenance activities relating to VE will have on benthic subtidal receptors is considered to be **low adverse**, indicating that the disturbance of habitat does not threaten the long-term viability of the benthic resource within the array areas.

SENSITVITY OF THE RECEPTOR

5.12.17 As detailed within paragraph 5.11.9 *et seq*., the habitats directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature, with the MarESA assessment also presented in detail. Paragraph 5.11.56 *et seq*., detail that the habitats indirectly affected by increased SSC and deposition have a worst-case medium sensitivity to the expected levels of SSC and deposition, with the MarESA assessment also presented in detail.

SIGNIFICANCE OF THE EFFECT

5.12.18 Overall, the impact of temporary habitat disturbance associated with the array areas is considered to be **low adverse** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **medium**, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.12.19 Temporary subtidal habitat loss will arise from the use of jack-up vessels for operational and maintenance activities as well as from array cable maintenance and replacement. The total MDS is presented in Table 5.12, which is predicted to arise over the design life of VE equating to approximately 0.09% of the offshore ECC.

5.12.20 Cable replacement works will require de-burial and re-burial of a cable or cable sections and along with cable preventative maintenance, including re-burial, will consequently result in increases in SSC and sediment deposition. However, the impacts from these works will be spread over the life span of operation and maintenance activities with only a limited number of activities occurring within any one year.

5.12.21 The magnitude of temporary habitat disturbance from cable maintenance activities is considered to be **low adverse**.

SENSITVITY OF THE RECEPTOR

5.12.22 The habitats within the offshore ECC directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature. Habitats indirectly affected by increased SSC and deposition have a worst-case medium sensitivity to the expected levels of SSC and deposition.

SIGNIFICANCE OF THE EFFECT

5.12.23 Overall, the impact of temporary habitat disturbance associated with the offshore ECC is considered to be **low adverse** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **medium**, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.24 Impacts will occur within the array area and offshore ECC and may bridge between the two areas. The impacts will be localized with no additive spatial overlap.

IMPACT 7: COLONISATION OF HARD SUBSTRATES

ARRAY AREAS

MAGNITUDE OF THE IMPACT

5.12.25 The introduction of hard substrate will change the type of available habitats within the array areas. However, the amount of introduced substrate is relatively small (Table 5.12), which accounts for approximately 2.4% of the total array areas.

5.12.26 Hard substrate habitats are not rare within the benthic ecology study area which is dominated by both sedimentary habitats, coarser sediments and rocky outcrops. The introduction of hard substrate, and associated increases in biodiversity, will alter sedimentary biotopes that characterise the area at the location of the introduction of the infrastructure and will be long term, lasting for the duration of the development. Any effects on benthic ecology, arising from the introduction of hard substrates will likely be localised to the proposed array areas where any such infrastructure are introduced.

5.12.27 The impact is therefore predicted to be of local spatial extent, long-term duration but reversable once the infrastructure is removed, although not all introduced hard substrate is likely to be removed, with cable and scour protection remaining *in-situ*. The magnitude of the impact is deemed to be negligible, as the habitats and characterising biotopes are not geographically restricted and are typically common and widespread throughout the wider region.

SENSITVITY OF THE RECEPTOR

5.12.28 The introduction of new hard substrate will represent a potential shift in the baseline condition within a small proportion of the array areas. Potential beneficial effects that may occur are associated with the likely increase in biodiversity and biomass, as has been observed at the Egmond an Zee Offshore Windfarm (Lindeboom *et al*. 2011). Individual species with the potential to benefit from the introduction of hard substrate due to increased substrate for attachment are those which are typical of rocky habitats and intertidal environments.

5.12.29 The species potentially introduced may also have indirect and adverse effects through increased predation on, or competition with, neighbouring soft sediment species. However, such effects are difficult to predict. The increased biodiversity associated with the structures could provide benefits at higher trophic levels as the benthic organisms colonising the structures provide an additional food source. Studies at the Horns Rev Offshore Windfarm in Denmark provided evidence that OWF structures are used as successful nursery habitats for the edible crab *Cancer pagurus* (BioConsult, 2006). However, any direct benefits are only likely to occur on a very localised basis (i.e. near the infrastructure).

5.12.30 Given the presence of epifaunal species and colonising fauna and flora within discrete parts of the array areas (i.e. associated with coarser sediment habitats), it is predicted that colonisation of hard substrates by common species such as bryozoans and ascidians will occur.

5.12.31 The sediment biotopes likely to be affected are deemed to be of low vulnerability and of local to national value. Recoverability following removal of the infrastructure is expected to be high although not all introduced hard substrate is likely to be removed, with cable and scour protection assumed to be remaining in-situ. The sensitivity of these receptors is therefore, considered to be at worst case high, in areas where infrastructure is not removed.

SIGNIFICANCE OF THE EFFECT

5.12.32 While the impact will be locally significant and comprise a permanent change in seabed habitat within the footprint of the structures and scour and cable protection, the footprint of the area affected and any associated increases and/or changes in biodiversity will be highly localised. As the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats is assessed as barely discernible.

5.12.33 Overall, the impact from colonisation of hard substrates is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.12.34 The introduction of hard substrate in the form of cable protection will change the type of available habitats within the array areas and offshore ECC. However, the amount of introduced substrate is relatively small (Table 5.12) amounting to approximately 0.2% of the total offshore ECC.

5.12.35 The impact is therefore predicted to be of local spatial extent, long-term duration but reversable once the infrastructure is removed, although it is likely that cable protection will remain *in situ*. Despite this the magnitude of the impact is deemed to be negligible, as the habitats and characterising biotopes are not geographically restricted and are typically common and widespread throughout the wider region.

SENSITVITY OF THE RECEPTOR

5.12.36 Following the reasoning detailed in 5.12.28 *et seq.* the sensitivity of receptors in the offshore ECC is considered to be at worst case high in areas where infrastructure is not removed.

SIGNIFICANCE OF THE EFFECT

5.12.37 Although the impact will be locally significant where cable protection remains in place the footprint of the area will be highly localised. As the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats is assessed as barely discernible.

5.12.38 Overall, the impact from colonisation of hard substrates is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.39 Direct impacts from colonisation of hard substrates will occur within the array area and offshore ECC where hard substrate has been introduced and may bridge between the two areas. Whilst the biodiversity enhancement of epibenthic and encrusting flora and fauna will increase the impacts are predicted to be relatively localised with no significant additive spatial overlap.

IMPACT 8: INCREASED RISK OF INTRODUCTION OR SPREAD OF MARINE INNS

ARRAY AREAS

MAGNITUDE OF THE IMPACT

5.12.40 There is a risk that the introduction of hard substrate into a sedimentary habitat will enable the colonisation of the introduced substrate by invasive/ non-indigenous species that might otherwise not have had a suitable habitat for colonisation, thereby enabling their spread. This along with the movement of vessels in and out of the array areas and offshore ECC has the potential to impact upon benthic ecology and biodiversity locally and in the broader region.

5.12.41 Table 5.12 presents the MDS for new hard substrate habitat that will be introduced into the array areas and offshore ECC, which has the potential to provide new habitat for colonisation by marine INNS.

5.12.42 In addition, Table 5.12 details the round trips to port during the O&M phase and the round trips to port by operational and maintenance vessels, which will contribute to the risk of introduction or spread of MINNS through ballast water discharge.

5.12.43 Mitigation measures, including a PEMP with a marine biosecurity plan (Table 5.13) will, however, ensure that the risk of potential introduction and spread of MINNS will be minimized as low as practicable.

5.12.44 The impacts on biotopes and VER within the array areas and offshore ECC is predicted to be of low spatial extent (though the introduction of structures may serve as 'stepping stones' and extend the impact beyond a local scale, however based on current scientific knowledge it is not possible to predict whether such a spread will occur and to what extent and which species, if any, this may involve), long term permanent duration, continuous and irreversible. It is predicted that the impact will affect the receptors indirectly. The magnitude of this impact is therefore considered to be negligible.

SENSITVITY OF THE RECEPTOR

5.12.45 As described in paragraph 5.11.112 *et seq*., benthic biotopes sensitivity within the benthic study area to an introduction or spread of Marine INNS is deemed to be at worse case ‘high’ sensitivity to an impact of this nature, given the lack of evidence for a potential impact of this nature. The sensitivity of nearby SAC and SPA features is also regarded as high given their protection status. Therefore, the sensitivity is considered to be high, reflecting that at worst-case benthic receptors have ‘none’ or ‘low’ resistance (tolerance) to an impact of this nature.

SIGNIFICANCE OF THE EFFECT

5.12.46 Overall, the increased risk of introduction or spread of marine INNS is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OFFSHORE ECC IMPACTS

MAGNITUDE OF IMPACT

5.12.47 The overview of magnitude is the same as described for the array area in paragraph 5.12.40 *et seq*.

SENSITVITY OF THE RECEPTOR

5.12.48 The overview of sensitivity is the same as described for the array area in paragraph 5.12.45 *et seq*.

SIGNIFICANCE OF THE EFFECT

5.12.49 The impact of increased risk of introduction or spread of marine INNS is considered to have a **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **high**. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.50 Impacts may potentially occur within the array area and offshore ECC and may bridge or marine INNS may move between the two areas. The impacts will be localized with no significant additive spatial overlap.

IMPACT 9: CHANGES IN PHYSICAL PROCESSES

ARRAY AREAS

MAGNITUDE OF THE IMPACT

5.12.51 The presence of foundations, scour protection and cable protection material may introduce changes to the local hydrodynamic and wave regime, resulting in changes to the sediment transport pathways and associated effects on benthic ecology. Scour and increases in flow rates can change the characteristics of the sediment potentially making the habitat less suitable for some species.

5.12.52 The use of correctly designed scour protection at foundations and sufficiently buried cables (Table 5.13) will prevent scour occurring. Scour will therefore only occur if and where scour protection has not been applied.

5.12.53 The exact form of cable protection to be used will depend upon local ground conditions, hydrodynamic processes, and the selected cable protection contractor. Where cable protection is used, some scouring is predicted to occur throughout the operational phase at these features. The extent of this scouring is predicted to be local, occurring around the perimeter of rock berms.

5.12.54 Volume 6, Part 2, Chapter 2: Marine Geology, Oceanography and Physical Processes assessment has determined that the impacts on hydrodynamic and wave regimes will be not significant to coastal and physical processes and will therefore not result in any significant changes to sediment transport and consequently will not have any significant impacts on benthic ecology. The magnitude of this impact is therefore considered to be negligible.

SENSITVITY OF THE RECEPTOR

5.12.55 As detailed within paragraph 5.11.9 *et seq*., the habitats directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature, with the MarESA assessment also presented in detail. Paragraph 5.11.56 *et seq*., detail that the habitats indirectly affected by increased SSC and deposition have a worst-case medium sensitivity to the expected levels of SSC and deposition, with the MarESA assessment also presented in detail.

SIGNIFICANCE OF THE EFFECT

5.12.56 Overall, the impact in the array areas from changes to physical processes is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be at worst-case **medium**, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be **negligible**, which is not significant in EIA terms.

ARRAY AREAS

MAGNITUDE OF THE IMPACT

5.12.57 Following the discussion in 5.12.56 *et seq*., allied to the small area of cable protection planned, the magnitude of impact in relation to changes in physical processes in the offshore ECC is considered to be negligible.

SENSITVITY OF THE RECEPTOR

5.12.58 As detailed within paragraph 5.11.28 *et seq*., the habitats directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature, with the MarESA assessment also presented in detail. Paragraph 5.11.62 *et seq*., detail that the habitats indirectly affected by increased SSC and deposition have a worst-case medium sensitivity to the expected levels of SSC and deposition, with the MarESA assessment also presented in detail.

SIGNIFICANCE OF THE EFFECT

5.12.59 Overall, the impact in the offshore ECC from changes to physical processes is considered to be negligible magnitude, and the sensitivity of receptors affected is predicted to be at worst-case medium, according to the detailed MarESA assessments and published literature. The significance of the residual effect is therefore concluded to be negligible, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.60 Direct impacts on benthic ecology receptors from changes to physical processes may potentially occur within the array area and offshore ECC and may bridge or transition between the two areas. The impacts will be localised with no significant additive spatial overlap.

IMPACT 10: EMF EFFECTS GENERATED BY INTER-ARRAY AND EXPORT CABLES DURING OPERATIONAL PHASE

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.12.61 EMF are generated by the current that passes through an electric cable. It is known that EMF can be detected by fish and elasmobranchs, and it is thought that any benthic invertebrates can also detect EMF. Three types of fields are generated by underwater electric cables: electric fields (E-fields), magnetic fields (B-fields) and induced electric fields (iE-fields). Standard industry practice is for the cables used to have sufficient shielding to contain the E-fields generated and the cable system descriptions for the inter-array and export cables have abided by this (Volume 6, Part 2, Chapter 1: Offshore Project Description). Shielding and/or burial does not reduce the B-fields and it is these fields that allow the formation of iE-fields. As such, further reference here to EMF is limited to B-fields and associated iE-fields.

5.12.62 Impacts from changes in EMFs arising from cables, are not considered to result in a significant effect on benthic ecology and intertidal receptors. EMFs are likely to be generated by subsea cables and detectable above background levels in close proximity to the cables. Although burial does not mask EMFs it increases the distance between species that may be affected by EMFs and the source. As the cable will be buried or protected, as detailed within Table 5.13, any behavioural responses are likely to be mitigated.

5.12.63 It is considered unlikely that EMFs at the strength predicted around subsea cables will result in a significant behavioural response that will cause a change in benthic communities within the benthic ecology study area and that any potential adverse effects will be confined to a localised area surrounding the cables. Therefore, the magnitude of the impact considered to be negligible, indicating that any behavioural response of benthic fauna is likely to be discernible or barely discernible over a very small area, that does not threaten benthic subtidal ecology features, undermine regional ecosystem functions or diminish biodiversity.

SENSITVITY OF THE RECEPTOR

5.12.64 The MarESA sensitivity assessments do not consider there to be sufficient evidence to support assessments of impacts of EMF on benthic and intertidal habitats; therefore, a desktop study has been undertaken to describe the typical responses of benthic invertebrates. A detailed assessment on elasmobranch, fish and shellfish species is provided in the Volume 6, Part 2, Chapter 6: Fish and Shellfish Ecology.

5.12.65 Typically, the impacts of EMF on marine organisms have focused on electrically sensitive fish and elasmobranchs, with little research focusing on benthic invertebrates, with the few studies using invertebrates focusing on crustaceans (e.g. Woodruff *et al.*, 2012). Furthermore, many studies contradict each other or provide inconclusive results (Switzer and Meggitt, 2010), further reducing the available evidence.

5.12.66 However, evidence of sensing, responding to, or orienting to natural magnetic field cues has been shown for invertebrates including molluscs and arthropods (Boles and Lohmann, 2003; Lohman and Willows, 1987; Ugolini, 2006; Ugolini and Pezzani, 1995). A study by Scott *et al*. (2019) reported that edible crabs (*C. pagurus*) exposed to EMF in the laboratory at the strength predicted around subsea cables resulted in a clear attraction of the crabs to EMF and significantly reduced their time spent roaming. This suggests that the natural roaming behaviour, where individuals will actively seek food and/or mates has been overridden by an attraction to the source of the EMF. The EMF had no effect on stress-related parameters, such as respiration rate or activity level, but the results predict that in benthic areas where there is increased EMFs, there will be an increase in the abundance of *C. pagurus* present.

5.12.67 A laboratory study assessing the effects of environmentally realistic, low-frequency B-field exposure on the behaviour and physiology of the common ragworm (*Hediste diversicolor*) did not find any evidence of avoidance or attraction behaviours (Jakubowska *et al*., 2019). The polychaetes did, however, exhibit enhanced burrowing activity when exposed to the B-field, with plausible consequences for their metabolism; however, knowledge about the biological relevance of this response is currently absent (Jakubowska *et al*., 2019).

5.12.68 One recent study examined the difference in invertebrate communities along an energised and nearby unenergised surface laid cables and this identified that there were no functional differences between the communities on and around the cables up to three years after installation (Love *et al*., 2016). This study also identified that the EMF levels reduce to background levels generally within one metre of the cable. This supports evidence collected from Nysted Wind Farm at Rødsand, in Denmark, which while the study focused on fish the conclusions should be valid for mobile invertebrates, that determined that there was no change in the overall distribution that could be attributed to the presence of the cables (Hvidt *et al*., 2004).

5.12.69 For invertebrate receptor species, it is difficult to translate the patchwork of knowledge about individual-level EMF effects into assessments of biologically or ecologically significant impacts on populations (Boehlert and Gill, 2010). However, given the evidence presented, it is predicted that EMFs have no significant impact on mobile or sessile benthic invertebrates, including if the cable is surface laid.

5.12.70 The sensitivity of benthic receptors is therefore considered to be **low adverse**, reflecting that the receptor has a high resistance and ability to tolerate the impacts of EMF over the approximate lifetime of VE.

SIGNIFICANCE OF THE EFFECT

5.12.71 Overall, the impact from emf effects generated by inter-array and export cables during operational phase is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be **low**. The significance of the residual effect is therefore concluded to be **negligible**, which is not significant in EIA terms.

OFFSHORE ECC IMPACTS

MAGNITUDE OF IMPACT

5.12.72 The overview of magnitude is the same as described for the array area in paragraph 5.12.61 *et seq*.

SENSITVITY OF THE RECEPTOR

5.12.73 The overview of sensitivity is the same as described for the array area in paragraph 5.12.64 *et seq*.

SIGNIFICANCE OF THE EFFECT

5.12.74 The impact from EMF effects generated by inter-array and export cables during operational phase is considered to be **negligible** magnitude, and the sensitivity of receptors affected is predicted to be **low**. The significance of the residual effect is therefore concluded to be **negligible**, which is not significant in EIA terms.

OVERLAP BETWEEN ARRAY AREAS IMPACTS AND OFFSHORE ECC IMPACTS

5.12.75 Impacts may potentially occur within the array area and offshore ECC and may bridge or transition between the two areas. The impacts will be localised with no significant additive spatial overlap.

5.13 ENVIRONMENTAL ASSESSMENT: CUMULATIVE EFFECTS

5.13.1 This cumulative impact assessment for benthic and intertidal ecology has been undertaken in accordance with the methodology provided in Volume 6, Part 1, Annex 3.1: Cumulative Effects Assessment Methodology.

5.13.2 The projects and plans selected as relevant to the assessment of impacts to benthic and intertidal ecology are based upon an initial screening exercise undertaken on a long list. Each project, plan or activity has been considered and scoped in or out on the basis of effect–receptor pathway, data confidence and the temporal and spatial scales involved. For the purposes of assessing the impact of the VE on benthic and intertidal ecology in the region, the cumulative effect assessment technical note submitted through the EIA Evidence Plan and forming Volume 6, Part 1, Annex 3.1: Cumulative Effects Assessment Methodology of this ES screened in a number of projects and plans as presented in Table 5.21 and are illustrated in Figure 5.8.

5.13.3 For potential effects on benthic and intertidal ecology, planned projects were screened into the assessment based on a screening range that encapsulates the VE benthic subtidal study area as defined by the secondary ZoI, which has been defined based on the expected maximum distance that water from within the Order Limits might be transported on a single mean spring tide, in the flood and/or ebb direction (Section 5.4). This screening area therefore encompasses the extent of impacts to benthic and intertidal ecology associated with VE.

5.13.4 The operational projects included within Table 5.21 are included due to their completion/commissioning subsequent to the data collection process for VE and as such not included within the baseline characterisation. Operational aggregate licence areas identified in Table 5.21 are considered within this CEA as they are located within a distance of one spring tidal excursion ellipse from VE. Accordingly, it is necessary to consider the potential for cumulative changes in SSC and bed levels.

5.13.5 In line with PINS' advice, Table 5.20 provides criteria that may be used to indicate the certainty that can be applied to other existing development. The criteria are assigned in tiers which descend from Tier 1 (most certain) to Tier 3 (least certain) and reflect a diminishing degree of certainty which can be assigned to each development. Note that this table only includes the projects screened into the assessment for benthic and intertidal ecology based on the criteria outlined above.

Table 5.20: Description of Tiers of other developments considered for cumulative effect assessment.

Tiers	Development Stage
Tier 1	Projects under construction.
	Permitted applications, whether under the Planning Act 2008 or other regimes, but not yet implemented.
	Submitted applications, whether under the Planning Act 2008 or other regimes, but not yet determined.
Tier 2	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted.
	Projects under the Planning Act 2008 where a PEIR has been submitted for consultation.
Tier 3	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted.
	Identified in the relevant Development Plan (and emerging Development Plans with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited.
	Identified in other plans and programmes (as appropriate) which set the framework for future development consents/ approvals, where such development is reasonably likely to come forward.

5.13.6 Note that Table 5.21 only includes the projects screened into the assessment for benthic and intertidal ecology based on the criteria outlined above.

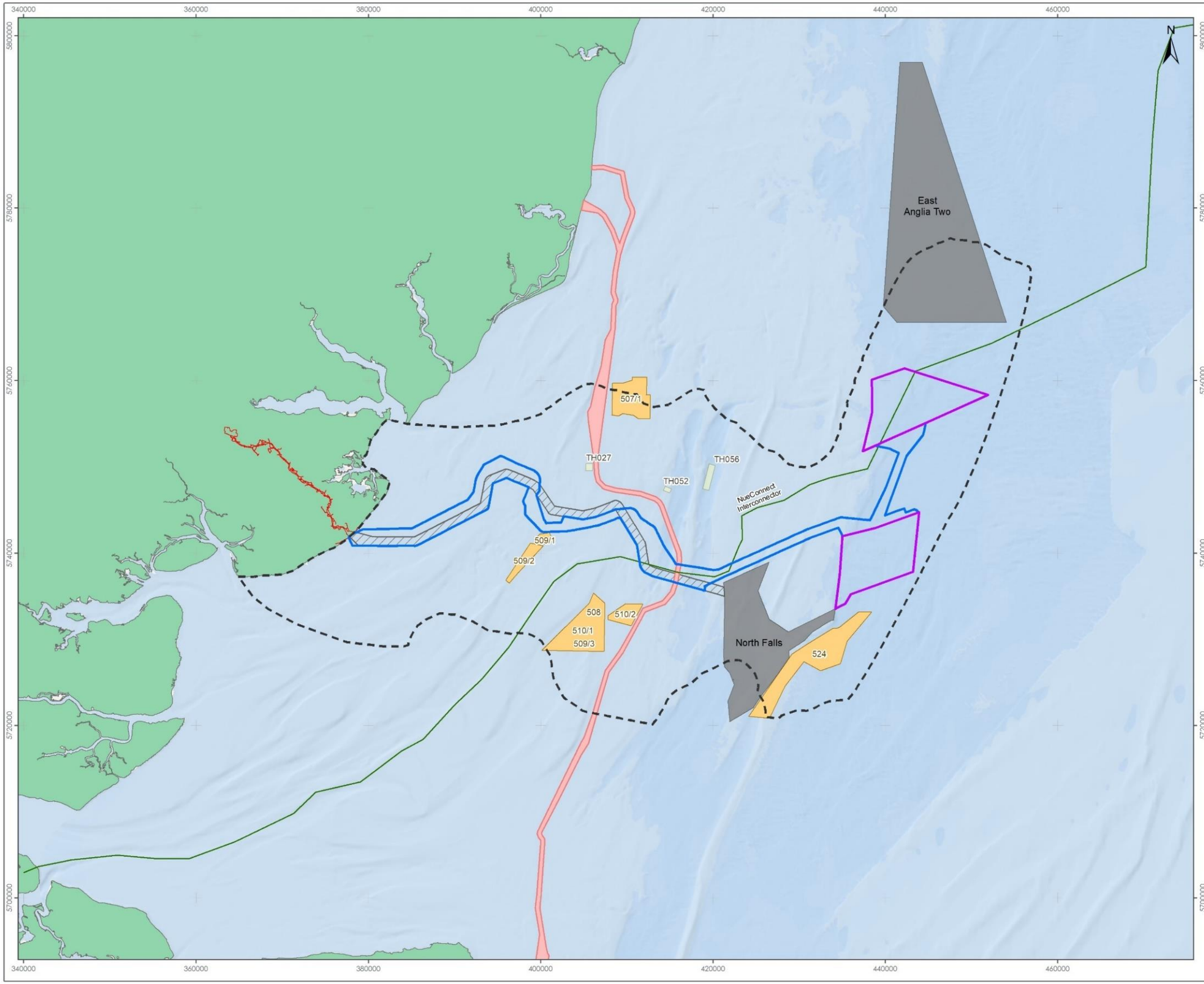
Table 5.21: Projects considered within the benthic and intertidal ecology cumulative effect assessment.

Development type	Project	Status	Data confidence assessment/ phase	Distance to Project (at nearest point)	Tier
Offshore Wind Farm	East Anglia TWO	Consented. The operational period will overlap with VE construction and operation.	High - Third party project details published in the public domain and confirmed as being 'accurate' by The Crown Estate	11.64 km from offshore ECC 5.33 km to array area	Tier 1
Offshore Wind Farm	North Falls	Pre-planning Application. If consent is granted the project will be constructed at the same time as VE and will be operational by 2030	High - Third party project details published in the public domain and confirmed as being 'accurate' by The Crown Estate	0 km from offshore ECC 0 km to array area	Tier 2
Aggregate Production Area	Tarmac Marine Ltd (509/1)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	0.10 km from offshore ECC 33.67 km to array area	Tier 1
Aggregate Production Area	Tarmac Marine Ltd (509/2)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	1.56 km from offshore ECC 34.54 km to array area	Tier 1
Aggregate Production Area	CEMEX UK Marine Ltd (510/2)	Operation	Medium - Third party project details published in the public domain and	3.46 km from offshore ECC	Tier 1

Development type	Project	Status	Data confidence assessment/ phase	Distance to Project (at nearest point)	Tier
			confirmed as being 'accurate'	22.39 km to array area	
Sea Disposal Site	Inner Gabbard (TH052)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	3.89 km from offshore ECC 20.6 km to array area	Tier 1
Sea Disposal Site	Harwich Haven (TH027)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	4.15 km from offshore ECC 29.99 km to array area	Tier 1
Aggregate Production Area	Tarmac Marine Ltd (509/3)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	5.83 km from offshore ECC 26.75 km to array area	Tier 1
Aggregate Production Area	CEMEX UK Marine Ltd (510/1)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	5.83 km from offshore ECC 26.75 km to array area	Tier 1
Aggregate Production Area	Britannia Aggregates Ltd (508)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	5.83 km from offshore ECC 26.75 km to array area	Tier 1

Development type	Project	Status	Data confidence assessment/ phase	Distance to Project (at nearest point)	Tier
Sea Disposal Site	Inner Gabbard East (TH056)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	7.15 km from offshore ECC 16.41 km to array area	Tier 1
Aggregate Production Area	DEME Building Materials Ltd (524)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	8.54 km from offshore ECC 1.70 km to array area	Tier 1
Aggregate Production Area	CEMEX UK Marine Ltd (507/1)	Operation	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	9.63 km from offshore ECC 24.99 km to array area	Tier 1
Interconnector	NeuConnect	Consented	Medium - Third party project details published in the public domain but not confirmed as being 'accurate'	Overlaps with array area Overlaps with the offshore ECC	Tier 1
Interconnector	Sea Link	Proposed	Medium - Third party project details published in the public domain but not confirmed as being 'accurate'	0 km from offshore ECC 18.42 km to array area	Tier 2
Interconnector	Nautilus Multi-Purpose Interconnector (MPI)	Proposed	Medium - Third party project details published in the public	Overlaps with array area	Tier 3

Development type	Project	Status	Data confidence assessment/ phase	Distance to Project (at nearest point)	Tier
			domain but not confirmed as being 'accurate'	Overlaps with the offshore ECC	
Interconnector	LionLink	Proposed	Medium - Third party project details published in the public domain but not confirmed as being 'accurate'	Overlaps with array area Overlaps with the offshore ECC	Tier 3



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Order Limits
- Benthic Ecology Study Area
- Aggregates Site
- Disposal Sites
- Offshore Wind Farm
- NorthFalls Indicative Offshore Export Cable Route Corridor
- Consented NueConnect Interconnector
- Proposed SeaLink Interconnector

0 2.5 5 10
Kilometers

Data Sources:
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

Projects and Plans Screened into the Cumulative Effect Assessment on Benthic Ecology

VER	DATE	REMARKS	Drawn	Checked
1	09/02/2024	For Information	BPHB	AdB

DRAWING NUMBER: 5.8

SCALE:	PLOT SIZE:	DATUM:	PROJECTION:
1:460,000	A3	WGS84	UTM31N

FIVE ESTUARIES
OFFSHORE WIND FARM

5.13.7 Certain impacts assessed for the project alone are not considered in the cumulative assessment due to:

- The highly localised nature of the impacts (i.e. they occur entirely within the VE offshore ECC and array areas only);
- Management measures in place for VE will also be in place on other projects reducing the risk of impacts occurring; and/ or
- Where the potential magnitude of the impact from VE alone has been assessed as negligible and there is overall no significance.

5.13.8 The impacts excluded from the CEA for the above reasons are:

- Construction & decommissioning phase:
  - Temporary habitat disturbance (intertidal);
  - Direct and indirect seabed disturbances leading to the release of sediment contaminants; and
  - Increased risk of introduction or spread of marine INNS.
- O&M phase:
  - Temporary habitat disturbance;
  - Colonisation of hard substrates;
  - Increased risk of introduction or spread of marine INNS;
  - Changes in physical processes; and
  - EMF effects generated by inter-array and export cables during operational phase.

5.13.9 The impacts that have been considered in the CEA are as follows:

- Construction phase:
  - Temporary habitat disturbance (subtidal); and
  - Temporary increase in suspended sediment and sediment deposition.
- O&M phase:
  - Permanent habitat loss/ alteration.

5.13.10 The cumulative MDS described in Table 5.22 have been selected as those having the potential to result in the greatest cumulative effect on an identified receptor group. The cumulative impacts presented and assessed in this section have been selected from the details provided in the project description for VE, as well as the information available on other projects and plans in order to inform a cumulative MDS. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the project design envelope to that assessed here, be taken forward in the final design scheme.

Table 5.22: Cumulative MDS.

Impact	Scenario	Justification
Cumulative temporary habitat disturbance	Tier 1: > O&M of OWF East Anglia Two; > Operation of aggregate production areas including Tarmac Marine Ltd (509/1, 509/2, 509/3), CEMEX UK Marine Ltd (510/2, 507/1), Britannia Aggregates Ltd (508) and DEME Building Materials Ltd (524) > Construction and O&M of NeuConnect Interconnector Tier 2: > Construction and O&M of OWF North Falls > Construction and O&M of Sea Link interconnector cable Tier 3: > Construction and O&M Nautilus MPI > Construction and O&M of LionLink interconnector cable	If these intermittent activities overlap temporally with either the construction or maintenance of VE, there is potential for cumulative temporary habitat disturbance
Cumulative temporary increase in SSC and sediment deposition	Tier 1: > Operation of aggregate production areas including Tarmac Marine Ltd (509/1, 509/2, 509/3), CEMEX UK Marine Ltd (510/2, 507/1), Britannia Aggregates Ltd (508) and DEME Building Materials Ltd (524) > Operation of sea disposal sites Inner Gabbard (TH052), Inner Gabbard	If these intermittent activities overlap temporally with either the construction or maintenance of VE, there is potential for cumulative SSC and sediment deposition to occur within the modelled plume footprints

Impact	Scenario	Justification
	East (TH056) and Harwich Haven (TH027) > Construction of NeuConnect Interconnector Tier 2: > Construction of OWF North Falls > Construction and O&M of Sea Link interconnector cable Tier 3: > Construction of Nautilus MPI > Construction of LionLink interconnector cable	
Cumulative permanent habitat loss/alteration	Tier 1: > O&M of OWF East Anglia Two > O&M of NeuConnect Interconnector Tier 2: > O&M of OWF North Falls > O&M of Sea Link interconnector cable Tier 3: > O&M Nautilus MPI > O&M LionLink interconnector cable	Maximum cumulative permanent habitat loss/change as a result of the presence of foundations, scour protection and cable protection is calculated within the benthic ecology study area. There is no exact indication where cable and scour protection will occur, therefore as a very precautionary measure this assessment will assume the total for each project will occur in the benthic ecology study area

5.13.11 It should be noted that operational projects, within the ZoI, such as Galloper and Greater Gabbard offshore wind farms form part of the environmental baseline as they were operational at the point when site-specific data was collected across the VE array areas and offshore ECC. Therefore, they have not been considered within this cumulative assessment.

5.13.12 A description of the significance of cumulative effects upon benthic and intertidal ecology arising from each identified impact is given below.

IMPACT 11: CUMULATIVE TEMPORARY HABITAT DISTURBANCE

5.13.13 There is potential for cumulative temporary habitat disturbance as a result of both the construction and maintenance activities associated with VE and the Tier 1, 2 and 3 project identified in Table 5.22. For the purposes of this assessment, this additive impact has been assessed from projects that fall within the benthic ecology study area, as defined in paragraphs 5.4.8 *et seq*.

5.13.14 The VE array areas and offshore ECC does not overlap with any of the aggregate sites. The impacts from both the construction and operation of VE and from aggregate extraction activities are predicted to be of local spatial extent, short-term, intermittent, and reversible. The same is true of the operation and maintenance activities associated with East Anglia Two, where any operation and maintenance associated with jack-up operations and inter-array cable maintenance activities would be restricted to within the footprint of the East Anglia Two array, which does not directly overlap with the VE array areas or offshore ECC (Figure 5.8).

5.13.15 The consented NeuConnect Interconnector is proposed to cross approximately 78 km of the VE benthic ecology study area. Construction is expected to occur in 2027, so there will be one year of construction overlap with VE construction. Operation and maintenance of NeuConnect Interconnector will also overlap with VE construction. The installation of the NeuConnect Interconnector and any subsequent operation and maintenance activities is expected to be short-term and localized to the site. Additionally, given the relatively limited overlap with the study area compared to the interconnector's overall GB extent (28%), no significant cumulative effects are predicted with the construction of VE.

5.13.16 The magnitude of impacts from the Tier 1 projects identified is therefore considered to be worst-case **low adverse**.

5.13.17 The EIA Scoping Report was submitted for the North Falls OWF project in July 2021 (North Falls Offshore Wind Farm Ltd, 2021). The Development Consent Order application and supporting environmental assessment and other documents is currently scheduled for submission in 2023. As North Falls is a Nationally Significant Infrastructure Project any grant of its DCO is anticipated in 2025. Construction would take place in the latter part of the decade, with a view to the project being operational by 2030. Whilst the project is still pre-application, the construction and operation and maintenance of this Tier 2 project has the potential to cause cumulative temporary habitat disturbance with VE construction.

5.13.18 There is no direct spatial overlap of North Falls OWF with the VE array areas, however the project overlaps with the offshore ECC and falls within the benthic ecology study area (Figure 5.8). There is no information in the public domain regarding the defined area for total temporary habitat disturbance, however based on OWFs of a similar size it is known that both the construction and operation and maintenance activities will be short-term, intermittent and localised to the site and therefore any cumulative impacts are expected to be minimal. Taking this into consideration, there are not predicted to be any significant cumulative impacts from the construction or operation of North Falls

5.13.19 The Tier 2 project Sea Link is a proposed offshore HVDC link between Suffolk and Kent, the purpose of which is to take the power brought in by East Anglia One North (EA1N), East Anglia Two (EA2), Nautilus, LionLink and Sizewell from Suffolk down to Kent to distribute within the Thames Valley where it is needed. There is currently limited detail on the project and therefore it is not possible to make a detailed assessment of the significance of effect, however it is predicted that any temporary habitat disturbance from the construction, operation and maintenance will be short term and localised to the site. It is not anticipated that any effects, once quantified, would result in a significant impact in EIA terms. The magnitude of impacts from this Tier 2 project is deemed at worst-case **low adverse**.

5.13.20 The Tier 3 project Nautilus Multi-Purpose Interconnector (MPI) is a proposed interconnector at the pre-scoping stage of consenting. The interconnector would be a subsea electricity cable that connects Great Britain to neighbouring energy markets in Belgium. This project forms part of the Offshore transmission network review (OTNR), which investigates the way that the offshore transmission network is designed and delivered, consistent with the ambition to deliver net zero emissions by 2050. There is currently limited detail on the project and therefore it is not possible to make a detailed assessment of the significance of effect, however it is predicted that any temporary habitat disturbance from the construction, operation and maintenance of Nautilus MPI is minimal, short term and localised to the site. Given the overlap of the interconnector with the VE benthic ecology study area (8.5%) compared to its overall extent (approximately 200 km), it is not anticipated that any effects, if consented, would result in a significant impact in EIA terms.

5.13.21 The Tier 3 project 'LionLink' is another proposed MPI project also at the pre-scoping stage of consenting. The project would deliver a new electricity link between Great Britain to the Netherlands. While limited information is available at this time, it is expected that *if* consented, LionLink and Nautilus MPI construction activities will overlap with VE construction.

5.13.22 Cumulative effects can also be considered in terms of duration of exposure from multiple projects which do not overlap but happen consecutively. As the effects from the projects will be short-lived, and due to the resilience of the biotopes to this type of impact (paragraph 5.10.9 *et seq.*), concurrent cumulative effects are not expected.

5.13.23 As detailed within paragraph 5.10.9 *et seq*., the habitats directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature, with the MarESA assessment also presented in detail.

5.13.24 Full discussions on the sensitivity of benthic ecology receptors in the VE array areas and offshore ECC are presented in paragraph 5.10.9 *et seq*., which conclude that benthic habitats have at worst-case medium sensitivity to an impact of this nature.

5.13.25 Overall, it is predicted that the cumulative impact of temporary habitat disturbance on benthic habitats is considered to be of **low adverse** magnitude, and the sensitivity of receptors affected is considered to be worst-case **medium**. The significance of the residual cumulative effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

IMPACT 12: CUMULATIVE TEMPORARY INCREASE IN SSC AND SEDIMENT DEPOSITION

5.13.26 There is potential for cumulative increases in SSC and associated sediment deposition as a result of construction activities associated with VE and the projects identified in Table 5.22. For the purposes of this assessment, this additive impact has been assessed from projects that fall within the benthic ecology study area (Figure 5.8), which is defined based on the expected maximum distance that water from within the VE array areas and offshore ECC might be transported on a single mean spring tide, in the flood and/or ebb direction. Table 5.22 identifies the projects that have the potential to contribute to cumulative temporary SSC's and deposition.

5.13.27 The SSC plumes generated during the construction (and operation) of VE are not predicted to reach the majority of the aggregate and disposal sites in any significant concentrations. As detailed in paragraph 5.11.48 *et seq*., the zone of measurable SSC increases and measurable deposition is within 500 m of the construction impact. Therefore, the only aggregate license area that will overlap in terms of potential significant impact is Tarmac Marine Ltd License Area 509/1. This site lies 100 m from the VE offshore ECC, however is still located outside the 0-50 m zone of highest SSC increase and greatest likely thickness of deposition (paragraph 5.11.48 *et seq*.). Furthermore, Tarmac Marine Ltd have confirmed that do not intend to take this site forward (personal communication, May 2021). Therefore, on account of the distance of the majority of these impacts from the zones of highest impact and the fact that they are intermittent in nature, the magnitude is expected to minor.

5.13.28 The consented NeuConnect Interconnector is proposed to cross approximately 78 km of the VE benthic ecology study area. Construction is expected to occur in 2027, so there will be one year of construction overlap with VE construction. Operation and maintenance of NeuConnect Interconnector will also overlap with VE construction. The installation of the NeuConnect Interconnector and any subsequent increases in SSC and sediment deposition that would have the potential to pose a significant smothering impact to benthic ecology receptors is expected to short-term and localised to the development area. Additionally given the relatively limited overlap with the study area compared to the interconnector's overall extent (28%), significant cumulative effects are not anticipated.

5.13.29 The magnitude of impacts from the Tier 1 projects identified is therefore considered to be worst-case **low adverse**.

5.13.30 Tier 2 project 'North Falls OWF' and 'Sea Link' Interconnector and the Tier 3 'Nautilus' and 'LionLink' MPIs are predicted to overlap their construction impacts, with VE construction, which is predicted to increase SSC and deposition within the wider benthic ecology study area. It is not known what volumes of sediment are likely to be displaced as the project hasn't submitted its environmental assessment. However, we do know that the projects will cause intermittent disturbances over the construction period and that spatial overlap resulting in a heavy level (5 - 30 cm) of deposition is unlikely (as this is only predicted to occur within 0 to 50 m of impact, based on the results presented in Volume 6, Part 5, Annex 2.3: Physical Processes Technical Assessment.

5.13.31 The cumulative impacts of increased SSC and sediment deposition is deemed to be **low adverse** magnitude, indicating that the potential is for localised disturbance that does not threaten the permanent viability of the resource.

5.13.32 Full discussion of the sensitivity of benthic ecology receptors to increased SSC and sediment deposition is discussed in 5.10.41 *et seq*., which conclude that the habitats that have the potential to be indirectly affected by increased SSC and deposition within the benthic ecology study area have a worst-case medium sensitivity to the expected levels of SSC and deposition.

5.13.33 It is predicted that the sensitivity of the receptors is worst-case **medium**, and the magnitude is **low adverse**. The short-term and/or localised nature of this impact and the tolerance and recoverability of the majority of the benthic receptors, the significance of the residual effect is deemed **minor adverse**, which is not significant in EIA terms.

IMPACT 13: CUMULATIVE PERMANENT HABITAT LOSS/ ALTERATION

5.13.34 Cumulative permanent habitat loss is predicted to occur because of the presence of VE infrastructure and projects identified in Table 5.22. The Tier 1 project East Anglia Two OWF and transmission asset is expected to contribute to long term habitat loss from the physical presence of foundations, scour and cable protection. East Anglia Two array area only overlap with the benthic ecology study area and the total long term habitat loss associated with the array assets is 1.91 km^2, the transmission assets do not overlap with the study area.

5.13.35 The NeuConnect Interconnector is anticipated to have cable protection associated with the route, where the target burial depth cannot be achieved. While the cumulative impact of permanent habitat loss will be locally significant and comprise a permanent change in seabed habitat within the footprint of the structures, the footprint of the area affected is highly localised. It is expected that the impacts are reversible following removal of any of the hard substrate, where this might occur however is less certain. As the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats is predicted to result in a slight alteration of the receptor that does not diminish regional ecosystem functions. The magnitude of loss for Tier 1 projects is therefore assessed as negligible.

5.13.36 It should be noted that as outlined in Chapter 3 of the NeuConnect Interconnector EIA (AECOM, 2019), under the licence application no cable protection will be added to the seabed within M&LS SAC as part of either the installation or maintenance phase of the GB Offshore Scheme[11].

5.13.37 The Tier 2 project North Falls OWF has the potential to create a cumulative permanent habitat loss/alteration with VE. Whilst there is currently limited detail on the area of loss, it is anticipated that as with the VE the magnitude for loss is likely to be negligible on account of the limited spatial extent of permanent infrastructure compared to the area of wider benthic resources. The magnitude of loss for Tier 2 projects is therefore assessed as negligible.

[11] Section located within UK EEZ of NeuConnect project which will provide first direct electricity link between UK and German energy networks.

5.13.38 The Tier 2 Project 'Sea Link' and Tier 3 projects 'Nautilus' and 'LionLink' MPIs are anticipated to have some cable protection associated with the route, however there is currently limited information on this. The footprint of any cable protection is expected to be limited in extent and highly localised. The magnitude of loss for Tier 3 projects is therefore currently assessed as **negligible**.

5.13.39 As previously discussed in impact paragraph 5.12.28, the sensitivity of benthic ecology receptors to permanent habitat loss/ change concludes that all benthic receptors have no resistance to permanent habitat loss/ change, with recovery assessed as very low as the change at the pressure benchmark is at worst-case permanent. The sensitivity of subtidal receptors is therefore considered to be at worst-case high according to the MarESA assessment values.

5.13.40 The maximum sensitivity of receptors in the area is therefore assessed as **high**, with a **negligible** magnitude of impact; this results in a **minor adverse** effect (in accordance with Table 5.5). Taking into consideration that habitats and characterising biotopes are common and widespread throughout the wider region and southern North Sea, the loss of these habitats is assessed as barely discernible, and the limited spatial loss is not predicted to diminish regional ecosystem functions and biodiversity. It is therefore concluded that the significance of effect from permanent habitat loss of VE cumulatively, with Tier 1, 2 and 3 projects is not significant in EIA terms.

5.14 CLIMATE CHANGE

5.14.1 Climate change has the potential to affect the extent, distribution and abundance of benthic and intertidal ecology receptors. This section assesses the following aspects:

- The effect of climate change on the local area in which the proposed development will take place; and
- The likely impacts of climate change and the project in-combination on the receiving environment.

5.14.2 The information provided in this section will be drawn upon and summarised in Volume 6, Part 4, Chapter 1: Climate change. As outlined in Volume 6, Part 4, Chapter 1: Climate Change, the operational phase of VE would enable the use of renewable electricity which would result in a positive greenhouse gas impact, resulting in a significant beneficial effect.

EFFECT OF CLIMATE CHANGE ON THE LOCAL ENVIRONMENT

5.14.3 The following effects of climate change have the potential to affect benthic and intertidal ecology receptors:

- Increase in seawater temperatures and/or pH levels. Increases in sea temperatures and acidification can lead to changes in the distribution of benthic ecology receptors, available habitat and alter the structure of ecosystems. Sudden changes to seawater temperature and PH levels can potentially lead to the loss of habitat and adverse pressure on native species composition or local extinction.
- Sea level rise and increases in storm surges and wave energy. Effects from sea level rise, especially during storms, have the potential to increase the pressures on intertidal habitat and native species composition or exacerbating local extinction.

- Greater wave energy. Greater wave energy can result in the loss of subtidal / intertidal habitat and result in adverse pressure on native species composition or local extinction.

EFFECT OF CLIMATE CHANGE AND THE PROJECT ON THE LOCAL ENVIRONMENT

5.14.4 The project is not predicted to contribute to the impacts of climate change in the local area to any significant extent.

5.15 INTER-RELATIONSHIPS

5.15.1 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 project (construction, O&M and decommissioning); to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages (e.g. subsea noise effects from piling, operational WTGs, vessels and decommissioning); and
- 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 ecology such as direct habitat loss or disturbance, sediment plumes, scour, JUVs use etc., may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short-term, temporary or transient effects, or incorporate longer term effects.

5.15.2 A description of the likely inter-related effects arising from VE on benthic and intertidal ecology is provided in Volume 6, Part 4, Chapter : Inter-Relationships, with a summary of assessed inter-relationships provided below.

5.15.3 Potential inter-relationships exist between benthic and intertidal ecology and:

- Fish and Shellfish - impacts to benthic ecology may affect the food resource of fish;
- Water quality - impacts on water quality may result in impacts on benthic ecology;
- Commercial fisheries - impacts on benthic ecology may impact on the catch of commercial fisheries; and
- Ornithology - impacts on benthic communities may impact bird populations dependent upon them as a food resource.

5.16 TRANSBOUNDARY

5.16.1 Transboundary effects arise when impacts from a development within one European Economic Area (EEA) states affects the environment of another EEA state(s). A screening of transboundary effects has been carried out and is presented in V1, A3.2: Transboundary Screening for the purposes of regulation 32 of the 2017 EIA Regulations. The screening exercise identified that there was no potential for significant transboundary effects to occur in relation to benthic and intertidal ecology.

5.17 SUMMARY OF EFFECTS

5.17.1 This chapter has assessed the potential effects on benthic and intertidal ecology receptors arising from VE. The range of potential impacts and associated effects considered has been informed by scoping responses, as well as reference to existing policy and guidance. The impacts considered include those brought about directly (e.g. by the presence of infrastructure at the seabed), as well as indirectly (e.g. the release of sediment contaminants from seabed disturbances). Potential impacts considered in this chapter, alongside any mitigation and residual effects are listed below in Table 5.23.

5.17.2 The impacts on relevant receptors from all stages of the project were assessed. The impacts assessed were found to either have either negligible or minor effects on benthic and intertidal receptors within the study area (i.e. not significant in EIA terms).

Table 5.23: Summary of effects for benthic and intertidal ecology

Description of Impact	Effect	Additional mitigation measures	Residual impact
Construction			
Impact 1: Temporary habitat disturbance	Subtidal: **Minor adverse** Intertidal: **Negligible**	No mitigation proposed In relation to SAC: See Table 5.14 - Sediment deposited back into the M&LS SAC	Subtidal: **Minor adverse** Intertidal: **Negligible** (not significant in EIA terms)
Impact 2: Temporary increase in suspended sediment and sediment deposition	Subtidal**: Minor adverse** Intertidal: **Minor adverse**	No mitigation proposed	Subtidal: **Minor adverse** Intertidal: **Minor adverse** (not significant in EIA terms)
Impact 3: Direct and indirect seabed disturbances leading to the release of sediment contaminants	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)
Impact 4: Increased risk of introduction or spread of Marine INNS	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)

Description of Impact	Effect	Additional mitigation measures	Residual impact
Operation and Maintenance			
Impact 5: permanent habitat loss/ alteration (outside SAC) Long-term habitat loss/ alteration within the M&LS SAC	**Minor adverse**	See Table 5.14 and the Outline M&LS SAC Benthic Mitigation Plan (Volume 9, Report 13)	**Minor adverse** (not significant in EIA terms)
Impact 6: Temporary habitat disturbance	**Negligible**	No mitigation proposed	**Negligible** (not significant in EIA terms)
Impact 7: Colonisation of hard substrates	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)
Impact 8: Increased risk of introduction or spread of Marine INNS	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)
Impact 9: Changes in physical processes	**Negligible**	No mitigation proposed	**Negligible** (not significant in EIA terms)
Impact 10: EMF effects generated by inter-array and export cables during operational phase	**Negligible**	No mitigation proposed	**Negligible** (not significant in EIA terms)
Cumulative effects			
Cumulative temporary habitat disturbance	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)
Cumulative temporary increase in SSC and sediment deposition	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)

Description of Impact	Effect	Additional mitigation measures	Residual impact
Cumulative permanent habitat loss/ alteration	**Minor adverse**	No mitigation proposed	**Minor adverse** (not significant in EIA terms)

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