




F I V E 
ESTUARIES
OFFSHORE WIND FARM

FIVE ESTUARIES
OFFSHORE WIND FARM
PRELIMINARY ENVIRONMENTAL
INFORMATION REPORT

VOLUME 2, CHAPTER 5: BENTHIC AND
INTERTIDAL ECOLOGY

Document Reference 004685495-01
Revision A
Date March 2023





Project	Five Estuaries Offshore Wind Farm
Sub-Project or Package	Preliminary Environmental Information Report
Document Title	Volume 2, Chapter 5: Benthic and Intertidal Ecology
Document Reference	004685495-01
Revision	A

COPYRIGHT © Five Estuaries Wind Farm Ltd

All pre-existing rights reserved.

This document is supplied on and subject to the terms and conditions of the Contractual Agreement relating to this work, under which this document has been supplied, in particular:

LIABILITY

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 for which it was contracted. Five Estuaries Wind Farm Ltd makes no warranty as to the accuracy or completeness of material supplied by the client or their agent.

Other than any liability on Five Estuaries Wind Farm Ltd detailed in the contracts between the parties for this work Five Estuaries Wind Farm Ltd shall have no liability for any loss, damage, injury, claim, expense, cost or other consequence arising as a result of use or reliance upon any information contained in or omitted from this document.

Any persons intending to use this document should satisfy themselves as to its applicability for their intended purpose.

The user of this document has the obligation to employ safe working practices for any activities referred to and to adopt specific practices appropriate to local conditions.

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Mar-23	Final for PEIR	GoBe	GoBe	VE OWFL



CONTENTS

5	Benthic and intertidal ecology	12
5.1	Introduction	12
5.2	Statutory and policy context.....	12
5.3	Consultation	25
5.4	Scope and Methodology	38
5.4.1	Scope of the assessment.....	38
5.4.5	Study area.....	39
5.5	Assessment criteria and assignment of significance.....	41
5.6	Uncertainty and technical difficulties encountered	44
5.7	Existing environment.....	46
5.7.1	Methodology to inform the baseline	46
5.7.70	The intertidal export cable corridor.....	65
5.10.4	Impact 1: Temporary habitat disturbance.....	90
5.10.31	Impact 2: Temporary increase in suspended sediment and sediment deposition 95	
5.10.63	Impact 3: Direct and indirect seabed disturbances leading to the release of sediment contaminants	108
5.10.70	Impact 4: Increased risk of introduction or spread of Marine Invasive Non- Native Species (INNS)	109
5.11	Environmental assessment: operational phase.....	110
5.11.1	Impact 5: Permanent habitat loss/ alteration	110
5.11.9	Impact 6: Temporary habitat disturbance.....	111
5.11.15	Impact 7: Colonisation of hard substrates.....	112
5.11.25	Impact 8: Increased risk of introduction or spread of Marine INNS	113
5.11.34	Impact 9: Changes in physical processes.....	114
5.11.42	Impact 10: EMF effects generated by inter-array and export cables during operational phase.....	115
5.12	Environmental assessment: cumulative effects	117
5.12.13	Cumulative Temporary habitat disturbance.....	127
5.12.27	Cumulative temporary increase in SSC and sediment deposition.....	129
5.12.36	Cumulative permanent habitat loss/ alteration	130
5.14	Transboundary	132
5.15	Summary of effects	132
5.16	Next steps.....	134
6	References.....	135



TABLES

Table 5.1: Legislation and policy context.....	13
Table 5.2: Summary of consultation relating to Benthic Subtidal and Intertidal ecology.....	26
Table 5.3: Impact magnitude definitions.....	41
Table 5.4: Sensitivity/ importance of the environment.....	42
Table 5.5: Matrix to determine effect significance.....	44
Table 5.6: Key sources of information for benthic, subtidal and intertidal ecology.....	46
Table 5.7: Biotopes found across the VE array areas (Fugro, 2022).....	58
Table 5.8: Biotopes found across the offshore ECC (Fugro, 2022).....	63
Table 5.9: Biotopes found across the intertidal ECC.....	67
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.....	70
Table 5.11: VERs within the VE benthic subtidal and intertidal ecology study area.....	74
Table 5.12: Maximum design scenario for the project alone.....	82
Table 5.13: Embedded mitigation relating to Benthic Ecology.....	88
Table 5.14: MarESA assessment for the benthic subtidal habitats for abrasion/ disturbance.....	91
Table 5.15: MarESA assessment for the intertidal habitats for abrasion/ disturbance.....	95
Table 5.16: MarESA assessment for the benthic subtidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering and siltation rate).....	99
Table 5.17: MarESA assessment for the benthic intertidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering and siltation rate).....	104
Table 5.18: Description of Tiers of other developments considered for cumulative effect assessment.....	118
Table 5.19: Projects considered within the benthic and intertidal ecology cumulative effect assessment.....	119
Table 5.20: Cumulative MDS.....	125
Table 5.21: Summary of effects for benthic and intertidal ecology.....	132

FIGURES

Figure 5.1: VE benthic subtidal and intertidal study area- and-Zol.....	40
Figure 5.2: The location of existing subtidal benthic grab, DDV and trawl data across the VE benthic ecology study area (CMACS, 2010; Fugro, 2018; MESL, 2012; Cooper, 2017; and EMODnet, 2022).....	49
Figure 5.3: Potential Annex I habitats across the VE benthic, subtidal and intertidal ecology study area and wider region (CMACS, 2010; JNCC, 2019, 2021; MESL, 201.....	54
Figure 5.4: Spatial distribution of EUNIS biotope complexes identified through single point grab sampling and side scan sonar data following the Five Estuaries Offshore Site Investigation (Fugro, 2022).....	56
Figure 5.5: EUNIS biotopes identified from site specific surveys across VE (Fugro, 2022).....	59
Figure 5.6: Habitat types identified within the VE intertidal ECC during the baseline surveys.....	68
Figure 5.7: National conservation designations of relevance to benthic subtidal and intertidal ecology within the area of potential direct and indirect impact of V.....	72



Figure 5.8: Projects screened into the CEA for benthic subtidal and intertidal ecology fall within the benthic ecology study area.....123



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 Estuaries array area to the proposed substation areas, within which the export cables will be located.



Term	Definition
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. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of potentially significant effects.
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.
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Report to Inform Appropriate Assessment	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.



Term	Definition
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.
Substation search area	The search area in which the final OnSS construction compound footprint and the final OnSS will be located.
Substation zone	The area in which the final onshore substation (OnSS) footprint will be located. The footprint will be confirmed between PEIR and ES.
Subtidal	The region of shallow waters which are below the level of low tide.
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
BAP	Biodiversity Action Plan
BEIS	Business, Energy and Industrial Strategy
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
DDV	Drop-down Video
DECC	Department for Energy and Climate Change (now BEIS)
Defra	Department of Environmental Food and Rural Affairs
EA	Environment Agency
ECC	Export Cable Corridor
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
EUNIS	European Nature Information System
FOCI	Features of Conservation Interest
GBS	Gravity Base Structure
GES	Good Environmental Status
HDD	Horizontal Directional Drilling
HOCl	Habitat of Conservation Importance
HRA	Habitats Regulation Assessment



Term	Definition
INNS	Invasive Non-Native Species
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
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
MMO	Marine Management Organisation
MNCR	Marine Nature Conservation Review
MPCP	Marine Pollution Contingency Plan
MSFD	Marine Strategy Framework Directive
NERC	Natural Environment Research Council
NNR	National Nature Reserve
NPS	National Policy Statement
O&M	Operation and maintenance
OESEA	Offshore Energy Strategic Environmental Assessment
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PINS	Planning Inspectorate
PSA	Particle Size Analysis
RIAA	Report to Inform Appropriate Assessment
RLB	Red Line Boundary
RPSS	Route Planning and Site Selection



Term	Definition
RSMP	Regional Seabed Monitoring Programme
SAC	Special Area of Conservation
SBES	Single-beam Echo Sounder
SBP	Sub-bottom Profiler
SCIs	Sites of Community Importance
SoS	Secretary of State
SPA	Special Protection Area
SPP	Scour Protection Plan
SSC	Suspended Sediment Concentrations
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
UXO	Unexploded Ordinance
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 Preliminary Environmental Information Report (PEIR) chapters and annexes:
- > Volume 1, Chapter 4: Site Selection and Alternatives;
 - > Volume 2, Chapter 1: Offshore Project Description;
 - > Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes;
 - > Volume 2, Chapter 3: Marine Water and Sediment Quality;
 - > Volume 4, Annex 2.3: Physical Processes Technical Assessment;
 - > Volume 4, Annex 2.4: Main Array and ECR - Environmental Features Report;
 - > Volume 4, Annex 5.1: Main Array – Benthic Ecology Monitoring Report; and
 - > Volume 4, 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);
 - > The Conservation of Offshore Marine Habitats and Species Regulations 2017;
 - > Marine and Coastal Access Act 2009; and

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 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), 2011a);
- > The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3, DECC, 2011b);
- > Draft revised Overarching NPS EN-1 (Department for Business, Energy and Industrial Strategy (BEIS), 2021a));
- > Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (BEIS, 2021b); 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) (DECC, 2011a)	Paragraph 5.3.11 of NPS EN-1 states: <i>“Where a proposed development within or outside a Site of Special Scientific Interest (SSSI) is likely to have an adverse effect on an SSSI (alone or together with other developments) development consent should not normally be granted. If after mitigation an adverse effect is still likely then consent should only be given where the benefits (including need) for a development outweighs the impacts on the SSSI in question and also the wider SSSI network. The Secretary of State (SoS) should use requirements and/ or planning obligations to mitigate the harmful aspects of the development, and where possible, ensure the conservation of the site’s biodiversity or geological interest”.</i>	Through the Route Planning and Site Selection (RPSS) process, the guiding principles of site selection (using a proportional approach) included avoiding key sensitive features Volume 1, Chapter 4: Site Selection and Alternatives. There will be no direct impact to any subtidal or intertidal SSSI features as identified in Figure 5.7. Potential indirect impacts to neighbouring SSSI’s have been discussed within the assessment of indirect impacts, Section 5.10 and 5.11.
	Paragraph 5.3.12 of NPS EN-1 states:	The VE offshore ECC and array areas do not cross any MCZs. An MCZ assessment is presented within Volume 7,



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>“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 (MCAA) 2009”.</i></p>	<p>Report 7: 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 5.10 and 5.11.</p>
<p>National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (DECC, 2011b)</p>	<p>Paragraph 2.6.64 of NPS EN-3 states: <i>“The assessment of benthic and intertidal ecology should consider all stages of the lifespan of the proposed Offshore Wind Farm (OWF)”.</i></p>	<p>Consideration of the construction, operation and decommissioning phases of the scheme are set out in Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.6.65 of NPS EN-3 states: <i>“The consultation on the assessment methodologies should be undertaken at an early stage with the statutory consultees as appropriate”.</i></p>	<p>Consultation has been undertaken through the scoping process and is ongoing through the EIA Evidence Plan process as set out in Section 5.3</p>
	<p>Paragraph 2.6.66 of NPS EN-3 states: <i>“Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational OWFs should be referred to where appropriate”.</i></p>	<p>Relevant data collected as part of post-construction monitoring from other OWFs has informed the assessment of Section 5.10 and 5.11 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</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
		communities from certain impacts.
	Paragraph 2.6.67 of NPS-EN-3 states: <i>“The assessment of benthic and intertidal ecology should consider the potential for the scheme to have both positive and negative effects on marine ecology and biodiversity”.</i>	An assessment of both the positive and negative effects of VE is provided in Section 5.10 and 5.11 of this chapter.
	Paragraphs 2.6.113 and 2.6.81 of NPS EN-3 state: <i>“The assessment of benthic and intertidal ecology should consider the effects on the subtidal and intertidal environment from habitat loss due to foundations and seabed preparation, predicted scour, scour protection and altered sedimentary processes.”</i>	An assessment of the effects from all development phases on benthic and intertidal habitats and species in the vicinity of VE is provided in Section 5.10 and 5.11 of this chapter. These assessments included all likely effects from temporary and permanent habitat loss and the effects of changes in physical processes.
	Paragraphs 2.6.113 and 2.6.81 of NPS EN-3 state: <i>“The assessment of benthic and intertidal ecology should consider the effects on the benthic environment from extendible legs and anchors of construction vessels and habitat disturbance in the intertidal zone during cable installation and removal.”</i>	An assessment of the effects of benthic and intertidal disturbances throughout the whole of the development (Section 5.10 and 5.11), with specific reference to construction vessels and anchors and habitat disturbance within the intertidal zone in Table 5.12.
	Paragraphs 2.6.113 and 2.6.81 of NPS EN-3 state: <i>“The assessment of benthic and intertidal ecology should consider the effects of increased suspended sediment loads during construction on subtidal habitats and intertidal habitats.”</i>	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 5.10 and 5.11.



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p>Paragraphs 2.6.113 and 2.6.81 of NPS EN-3 state:</p> <p><i>“The assessment of benthic and intertidal ecology should consider the predicted rates for subtidal habitat recovery and intertidal habitat recovery.”</i></p>	<p>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 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.6.119 of NPS EN-3 states:</p> <p><i>“The construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints.</i></p> <p><i>Mitigation measures may include:</i></p> <ul style="list-style-type: none"> <i>> surveying and micrositing of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs;</i> <i>> burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and</i> <i>> the use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.”</i> 	<p>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.</p>
	<p>Paragraph 2.6.68 of NPS EN-3 states:</p> <p><i>“The SoS should consider the effects of a proposal on marine ecology and biodiversity taking into account all relevant information made available to it”.</i></p>	<p>Where relevant to benthic ecology this has been described and considered within the assessment for VE.</p>
	<p>Paragraph 2.6.69 of NPS EN-3 states:</p>	<p>Natura 2000 sites have been considered during the VE</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>“The designation of an area as Natura 2000 site does not necessarily restrict the construction or operation of OWFs in or near that area”.</i></p>	<p>assessment with potential effects on the relevant habitats described in Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.6.68 of NPS EN-3 states:</p> <p><i>“Mitigation may be possible in the form of a careful design of the development itself and the construction techniques employed”.</i></p>	<p>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 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.6.71 of NPS EN-3 states:</p> <p><i>“Ecological monitoring is likely to be appropriate during the construction and operational phases to identify the actual impact so that, where appropriate, adverse effects can then be mitigated and to ensure further useful information to be published relevant to future projects”.</i></p>	<p>A survey will be undertaken at pre-construction phases of the proposed development in order to determine the location, extent and composition of any habitats of principal importance (Section 41 of the 2006 Natural Environmental and Rural Communities (NERC) Act).</p>
	<p>Paragraphs 2.6.116 and 2.6.85 of NPS EN-3 state:</p> <p><i>“The SoS should be satisfied that activities have been designed taking into account sensitive benthic environmental aspects and intertidal habitats.”</i></p>	<p>Section 5.10 and 5.11 of this chapter present the assessment of the conservation status of intertidal and benthic receptors.</p>
	<p>Paragraphs 2.6.84 and 2.6.115 of NPS EN-3 state:</p> <p><i>“The conservation status of intertidal habitat and benthic habitat is of relevance to the SoS.”</i></p>	<p>Consideration of the potential impacts on sensitive benthic and intertidal habitats are set out in paragraphs Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.6.86 of NPS EN-3 states:</p> <p><i>“Where adverse effects are predicted, in coming to a</i></p>	<p>Section 5.10 and 5.11 of this chapter include the duration and reversibility of effects in the assessment of effects.</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>judgement, the SoS should consider the extent to which the effects are temporary or reversible, this includes the installation and decommissioning of cables.”</i></p>	
<p>Draft Overarching National Policy Statement for Energy NPS EN-1 (BEIS, 2021a)</p>	<p>Paragraph 5.4.11 of Draft NPS EN-1 states:</p> <p><i>“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 (MCAA) 2009”.</i></p>	<p>The VE offshore ECC and array areas do not cross any MCZs. An MCZ assessment is presented within Volume 7, Report 7: 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 5.10 and 5.11.</p>
<p>Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (BEIS, 2021b)</p>	<p>Paragraph 2.24.5 of Draft NPS EN-3 states:</p> <p><i>“The assessment of benthic and intertidal ecology should consider all stages of the lifespan of the proposed Offshore Wind Farm (OWF)”.</i></p>	<p>Consideration of the construction, operation and decommissioning phases of the scheme are set out in Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.24.6 of Draft NPS EN-3 states:</p> <p><i>“The consultation on the assessment methodologies should be undertaken at an early stage with the statutory consultees as appropriate”.</i></p>	<p>Consultation has been undertaken through the scoping process and is ongoing through the EIA Evidence Plan process as set out in Section 5.3</p>
	<p>Paragraph 2.24.7 of Draft NPS EN-3 states:</p> <p><i>“Any relevant data that has been collected as part of post-construction ecological monitoring</i></p>	<p>Relevant data collected as part of post-construction monitoring from other OWFs has informed the assessment of Section 5.10 and 5.11 of</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<i>from existing, operational OWFs should be referred to where appropriate”.</i>	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 2.24.8 of Draft NPS EN-3 states: <i>“The assessment of benthic and intertidal ecology should consider the potential for the scheme to have both positive and negative effects on marine ecology and biodiversity”.</i>	An assessment of both the positive and negative effects of VE is provided in Section 5.10 and 5.11 of this chapter.
	Paragraphs 2.30.2 and 2.27.3 of Draft NPS EN-3 state: <i>“The assessment of benthic and intertidal ecology should consider the effects on the subtidal and intertidal environment from habitat loss due to foundations and seabed preparation, predicted scour, scour protection and altered sedimentary processes.”</i>	An assessment of the effects from all development phases on benthic and intertidal habitats and species in the vicinity of VE is provided in Section 5.10 and 5.11 of this chapter. These assessments included all likely effects from temporary and permanent habitat loss and the effects of changes in physical processes.
	Paragraphs 2.30.2 and 2.27.3 of Draft NPS EN-3 state: <i>“The assessment of benthic and intertidal ecology should consider the effects on the benthic environment from extendible legs and anchors of construction vessels and habitat disturbance in the intertidal zone during cable installation and removal.”</i>	An assessment of the effects of benthic and intertidal disturbances throughout the whole of the development (Section 5.10 and 5.11), with specific reference to construction vessels and anchors and habitat disturbance within the intertidal zone in Table 5.12.
	Paragraphs 2.30.2 and 2.27.3 of Draft NPS EN-3 state:	Consideration of the specific effects of increased



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>“The assessment of benthic and intertidal ecology should consider the effects of increased suspended sediment leads during construction on subtidal habitats and intertidal habitats.”</i></p>	<p>suspended sediment load and the associated sediment deposition on benthic and intertidal ecology are set out in Section 5.10 and 5.11.</p>
	<p>Paragraphs 2.30.2 and 2.27.3 of Draft NPS EN-3 state:</p> <p><i>“The assessment of benthic and intertidal ecology should consider the predicted rates for subtidal habitat recovery and intertidal habitat recovery.”</i></p>	<p>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 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.30.2 of Draft NPS EN-3 states:</p> <p><i>“The assessment of benthic and intertidal ecology should consider impacts on protected sites.”</i></p>	<p>Consideration of protected sites and the potential effects on the relevant habitats associated with the construction, operation and decommissioning are set out in Section 5.10 and 5.11.11 of this chapter. Reference to Natura 2000 sites and their features are also made in the Report to Inform Appropriate Assessment (RIAA).</p>
	<p>Paragraph 2.30.3 of Draft NPS EN-3 states:</p> <p><i>“The construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints.</i></p> <p><i>Mitigation measures may include:</i></p> <p><i>> surveying and micro-siting of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs;</i></p>	<p>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.</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p>> <i>burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and</i></p> <p>> <i>the use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.”</i></p>	
	<p>Paragraph 2.24.18 of Draft NPS EN-3 states:</p> <p><i>“The SoS should consider the effects of a proposal on marine ecology and biodiversity taking into account all relevant information made available to it”.</i></p>	<p>Where relevant to benthic ecology this has been described and considered within the assessment for VE.</p>
	<p>Paragraph 2.24.19 of Draft NPS EN-3 states:</p> <p><i>“The designation of an area as Natura 2000 site does not necessarily restrict the construction or operation of OWFs in or near that area”.</i></p>	<p>Natura 2000 sites have been considered during the VE assessment with potential effects on the relevant habitats described in Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.24.10 of Draft NPS EN-3 states:</p> <p><i>“Mitigation may be possible in the form of a careful design of the development itself and the construction techniques employed”.</i></p>	<p>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 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.24.11 of Draft NPS EN-3 states:</p> <p><i>“Ecological monitoring will be appropriate during the pre-construction, construction and operational phases to identify the actual impacts caused by the project and compare them to what was predicted in the EIA/ HRA. Should impacts be greater than</i></p>	<p>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</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>those predicted, an adaptive management process may need to be implemented and additional mitigation required, to ensure that so far as possible the effects are brought back within the range of those predicted. Monitoring should be of sufficient standard to inform future decision-making. Increasing the understanding of the efficacy of alternatives and mitigation will deliver greater certainty on developer requirements.”</i></p>	<p>of principal importance (Section 41 of the 2006 Natural Environmental and Rural Communities (NERC) Act).</p>
	<p>Paragraphs 2.24.19 and 2.30.5 of Draft NPS EN-3 state: <i>“The SoS should be satisfied that activities have been designed taking into account sensitive benthic environmental aspects and intertidal habitats.”</i></p>	<p>Section 5.10 and 5.11 of this chapter present the assessment of the conservation status of intertidal and benthic receptors.</p>
	<p>Paragraphs 2.27.6 and 2.30.5 of Draft NPS EN-3 state: <i>“The conservation status of intertidal habitat and benthic habitat is of relevance to the SoS.”</i></p>	<p>Consideration of the potential impacts on sensitive benthic and intertidal habitats are set out in paragraphs Section 5.10 and 5.11 of this chapter.</p>
	<p>Paragraph 2.35.12 of Draft NPS EN-3 states: <i>“Where adverse effects are predicted, in coming to a judgement, the SoS should consider the extent to which the effects are temporary or reversible, this includes the installation and decommissioning of cables.”</i></p>	<p>Section 5.10 and 5.11 of this chapter include the duration and reversibility of effects in the assessment of effects.</p>
	<p>Paragraph 2.26.6 of Draft NPS EN-3 states: <i>“The SoS should also consider any negative impacts from rock armouring on benthic habitats and</i></p>	<p>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</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>a balance between protection of various receptors must be made, with all mitigation and alternatives to rock armouring reviewed.”</i></p>	<p>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 5.10 and 5.11, in accordance with the cable design and specification as presented in Volume 2, Chapter 1: Offshore Project Description.</p>
<p>Marine Strategy Framework Directive (MSFD) (2008)</p>	<p>Descriptor 1 – Biological diversity: <i>“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.”</i></p>	<p>Consideration of the effects on biological diversity for VE alone and the Cumulative Effects Assessment (CEA) are set out in Section 5.12 of this chapter.</p>
	<p>Descriptor 2 – Non-indigenous species: <i>“Non-indigenous species introduced by human activity are at levels that do not adversely alter the ecosystems.”</i></p>	<p>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 5.10, 5.11 and 5.12 of this chapter.</p>
	<p>Descriptor 4 – Elements of marine food web: <i>“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.”</i></p>	<p>Consideration of the effects on benthic and intertidal ecology, inclusive of the interlinkages with interdependent ecological receptors described in other chapters and wider PEIR with inter-relationships are set out in Section 5.13 of this chapter.</p>
	<p>Descriptor 6 – Sea floor integrity: <i>“Seafloor integrity is at a level that ensures that the structure and</i></p>	<p>Consideration of the effects on benthic and intertidal ecology, inclusive of any risk to</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<p><i>functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.</i></p>	<p>ecological integrity, for VE alone and the CEA are set out in paragraphs Section 5.10, 5.11 and 5.12 of this chapter.</p>
	<p>Descriptor 7 – Alteration of hydrographical conditions: <i>“Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.”</i></p>	<p>Consideration of the potential for permanent alterations to hydrographical conditions that may be attributable to VE to adversely affect marine ecosystems is set out in Section 5.11 of this chapter.</p>
	<p>Descriptor 8 – Contaminants: <i>“Concentrations of contaminants are at levels not giving rise to pollution effects.”</i></p>	<p>Consideration of the effects of contaminants on benthic and intertidal habitats and species are set out in Section 5.10 and 5.11 of this chapter.</p>
	<p>Descriptor 10 – Marine litter: <i>“Properties and quantities of marine litter do not cause harm to the coastal and marine environment.”</i></p>	<p>A Project Environmental Management Plan (PEMP) will be produced post-consent and followed to cover the O&M phase of VE. 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).</p>
<p>East Inshore and East Offshore Marine Plans – ECO1</p>	<p><i>“Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation.”</i></p>	<p>Cumulative effects are considered within section 5.12.</p>
<p>East Inshore and East Offshore Marine Plans – MPA1</p>	<p><i>“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</i></p>	<p>Designated nature conservation sites within the VE study area have been described in section 5.7 and assessed in sections 5.10, 5.11, and 5.12.</p>



Legislation/ Policy	Key Provisions	Section Where Comment Addressed
	<i>agreed advice on an ecologically coherent network.”</i>	

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 the project 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
<p>January 2021 Benthic Survey Licensing Meeting with MMO, Cefas and Natural England</p>	<p>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.</p>	<p>The full description of the site-specific survey methodologies is presented within Volume 4, Annex 5.1: Main Array – Benthic Ecology Monitoring Report, Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report and Volume 4, 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.</p>
<p>February 2021 Marine Ecology & Processes Expert Topic Group (ETG)</p>	<p>It was requested that biotope codes should be converted to the EUNIS equivalent.</p>	<p>EUNIS biotopes have been recorded using the new 2022 biotope codes (EUNIS, 2022).</p>
<p>May 2021 Marine Ecology & Processes ETG</p>	<p>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.</p>	<p>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 4, Annex 5.1: Main Array: Benthic Ecology Monitoring Report, Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report and Volume 4, Annex 2.4: Main Array and ECR -</p>



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		Environmental Features Report.
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 1, 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 embedded 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 PEIR 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



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		of variable sources and dates to build a comprehensive picture. An appraisal of this validity is provided in Section 5.6.
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 5.11. 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. Site preparation activities have been fully appraised within Section 5.10.
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



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		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 pollution in relation to benthic ecology receptors.	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.
November 2021 MMO, Scoping Opinion	MMO raised concerns regarding the offshore cable route having a small overlap with the Margate and Long Sands 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 1, Chapter 4: Site selection and Alternatives. The conservation objectives for all designated sites will be referred to within VE Report to Inform Appropriate Assessment (RIAA) 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 Margate and Long Sand SAC. Furthermore, Section 5.10 and 5.11 provides a thorough assessment of the impacts to protected features.
November 2021	MMO agreed that impacts will generally be localised, though there	Cumulative impacts associated with MINNS



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
MMO, Scoping Opinion	may be potential for non-local, cumulative impacts if infrastructure from various projects acts as steppingstones for the spread of non-native species.	is addressed within Section 5.12.
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 5.10, 5.11 and 5.12 and potential transboundary effects is provided in Section 5.14.
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 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 4, Annex 5.1: Main Array - Benthic Ecology Monitoring Report, Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report and



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		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.
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 Report to Inform Appropriate Assessment.
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 Margate and Long Sands 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 5.10 and 5.11 and within the RIAA.



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
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 7, Report 7: 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 Red-throated diver are present within the area of search AoS.	An assessment of SPA designations with regards to the benthic habitats acting as supporting habitats for bird features has been included in Section 5.10 and 5.11.
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 5.11.
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	Volume 1, Chapter 4: Site selection and alternatives details all the known constraints in the



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
	<p>may not be feasible given all the other constraints, including Archaeology. Therefore, consideration of other constraints should be undertaken during the consenting phase.</p>	<p>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.</p>
<p>November 2021 Natural England, Scoping Opinion</p>	<p>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.</p>	<p>Cumulative ecosystem effects have been considered and SPA designations have been included within this assessment (Section 5.12).</p>
<p>November 2021 Natural England, Scoping Opinion</p>	<p>Natural England advised on the difficulties of using Horizontal Directional Drilling (HDD) under marsh areas due to the nature of the 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.</p>	<p>As detailed within Volume 3, Chapter 7: Archaeology and Cultural Heritage, geotechnical works have provided information to inform HDD feasibility.</p>
<p>November 2021 Essex County Council, Scoping Opinion</p>	<p>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.</p>	<p>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.</p>
<p>December 2021</p>	<p>Natural England expressed a concern regarding the time of year</p>	<p>This was discussed with the survey contractor</p>



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
Marine Ecology & Processes ETG	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.	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.
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 (VE OWFL) 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 4, Annex 5.1: Main Array - Benthic Ecology Monitoring Report and Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
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 5.11. The Cefas OneBenthic comprehensive dataset of macrofaunal data and baseline model (Cooper <i>et al.</i> 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 Margate and Long Sands SAC data.	Natural England has provided VE with Margate and Long Sands SAC data. This data will be used to inform the ES.
December 2022 Pre-PEIR Project Update with Natural England	Natural England had previously raised concerns regarding the scope of the benthic ecology subtidal survey. The following subjects were raised in a letter dated 05 October 2022:- <ul style="list-style-type: none"> > <u>Temporal limitations</u> > <u>Geophysical Data</u> > <u>Zol</u> > <u>Meiofauna</u> > <u>Sabellaria spinulosa</u> 	VE OWFL provided the following responses to concerns during the December consultation:- <u>Temporal limitations:</u> 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



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		<p>constraints have dictated sampling. As per the JNCC guidance '<i>Where this is necessary, the temporal disparity should be acknowledged in analysis and reporting</i>'.</p> <p><u>Geophysical Data:</u> VE OWFL provided evidence of the survey design overlaying the geophysical data and demonstrated the representative sample locations against this data.</p> <p><u>Zol:</u> Site specific samples were not located within the secondary Zol. 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 Zol.</p> <p><u>Meiofauna:</u> For characterisation surveys all guidance advise that a 1mm mesh sieve is sufficient for subtidal sediments (including sand from sandbanks). In VE OWFL's experience, 1mm mesh is always used apart for intertidal</p>



Date and consultation phase/ type	Consultation and key issues raised	Section where comment addressed
		<p>muddy sediments (using a handcore).</p> <p>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.</p> <p><u>Sabellaria spinulosa</u>: It is VE OWFL position that survey timing should not fundamentally disturb the assessment of reef features, particularly those that are longstanding and high quality (Annex 1) habitat.</p>



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/ alteration;
 - > 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 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 As outlined within the transboundary screening (Volume 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 PEIR chapter.



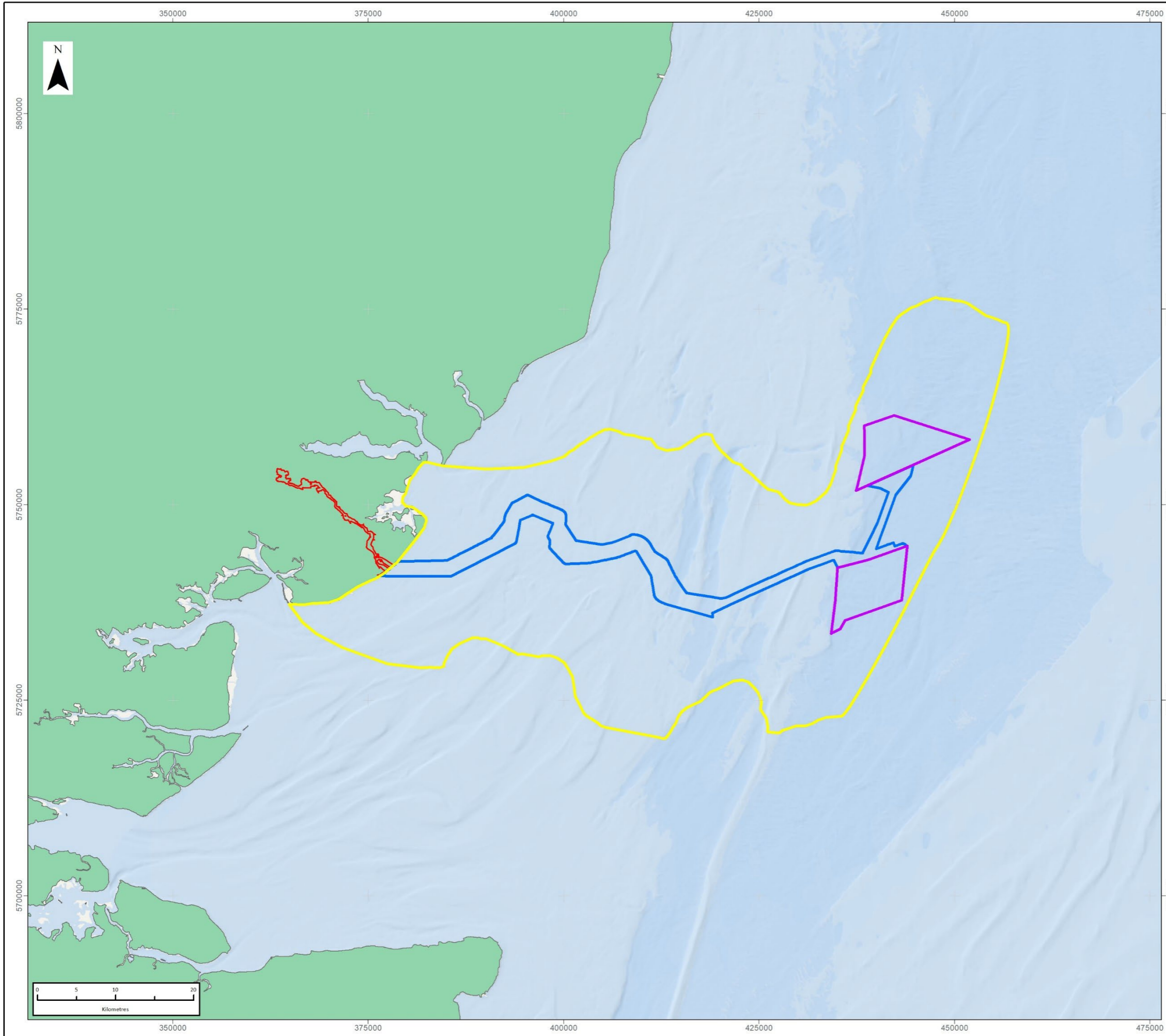
5.4.5 STUDY AREA

5.4.6 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 Red Line Boundary (RLB) 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 RLB 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 RLB might be experienced. The maximum distance of the secondary Zoi from the RLB 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.

5.4.7 Habitats landward of MHWS have been considered in Volume 3: Chapter 4: Onshore Biodiversity and Nature Conservation.

5.4.8 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 Red Line Boundary
- Benthic Ecology Study Area

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
VE benthic subtidal and intertidal study area and ZOI

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	KL

DRAWING NUMBER:
 5.1

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





5.5 ASSESSMENT CRITERIA AND ASSIGNMENT OF SIGNIFICANCE

- 5.5.1 This assessment is consistent with the EIA methodology presented in Volume 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 website².
- 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 categories² 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	<p>Equivalent to MarLIN MarESA sensitivity category 'High'.</p> <p>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</p> <p>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').</p>
Medium	<p>Equivalent to MarLIN MarESA sensitivity category 'Medium'.</p> <p>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</p> <p>The habitat or species is noted as exhibiting 'None' resistance (tolerance) to an external factor, whether that arises from natural</p>

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



Receptor sensitivity/ importance	Description/ reason
	<p>events or human activities, and is expected to recover over < 2 years (resilience is 'High'); or</p> <p>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').</p>
Low	<p>Equivalent to MarLIN MarESA sensitivity category 'Low'.</p> <p>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</p> <p>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').</p>
Negligible	<p>Equivalent to MarLIN MarESA sensitivity category 'Not Sensitive'.</p> <p>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').</p>

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 5.10, 5.11 and 5.12.



Table 5.5: Matrix to determine effect significance.

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

Note: shaded cells are defined as significant with regards to the EIA Regulations 2017³.

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 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.
- 5.6.5 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.
- 5.6.6 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 literature⁴);
 - > 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.
- 5.6.7 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.
- 5.6.8 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.

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.



5.7 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 4, Annex 5.1: Main Array – Benthic Ecology Monitoring Report, Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report and Volume 4, 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 4, 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 4, Annex 5.1: Main Array – Benthic Ecology Monitoring Report and Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report	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 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.	Coverage of representative habitats within the array areas and offshore ECC (Figure 5.5).

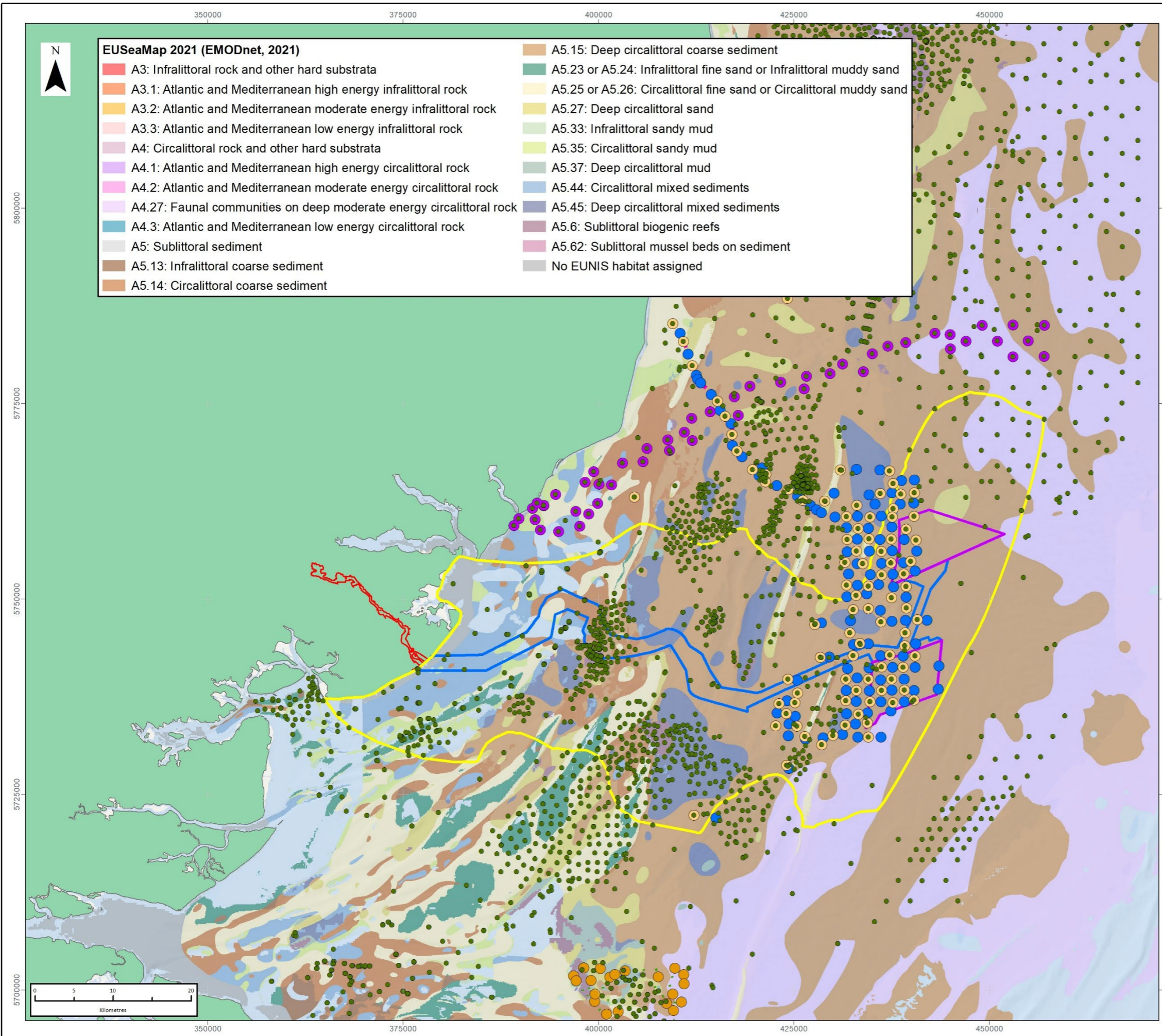


Source	Summary	Coverage of VE
<p>VE Intertidal Survey, 2021</p> <p>Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report</p>	<p>Phase I walkover survey carried out landward to mean low water springs (MLWS). Phase II sampling was conducted across 8 transects perpendicular to the shore, with a station located at High Water (HW), Middle Water (MW) and Low Water (LW) at each transect (24 stations).</p>	<p>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).</p>
<p>Regional Seabed Monitoring Programme (RSMP) (Cooper and Barry, 2017) (data obtained from the One Benthic baseline tool⁵)</p>	<p>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.</p>	<p>Good coverage across the benthic ecology study area and wider region (Figure 5.2).</p>
<p>Biologically informed habitat map (Cooper <i>et al.</i>, 2019)</p>	<p>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</p>	<p>Complete modelled coverage up to MHWS.</p>
<p>Galloper Offshore Wind Farm (OWF) site (Centre for Marine and Coastal Studies (CMACS), 2010), including pre- and post-construction surveys.</p>	<p>Beam trawl, benthic grab and DDV surveys were deployed to characterise the benthic infaunal and epifaunal communities. Samples collected for benthic faunal analysis, contaminant and PSA were also undertaken for baseline characterisation.</p>	<p>Coverage within VE array areas (Figure 5.2).</p>
<p>Environmental Statements from other OWF developments within the Outer Thames Strategic Area (Galloper, East Anglia One, Thanet Extension, Greater Gabbard and Gunfleet</p>	<p>Characterisation and monitoring data for the existing OWF developments.</p>	<p>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).</p>

⁵ <https://rconnect.cefas.co.uk/content/25/>



Source	Summary	Coverage of VE
Sands OWF (CMACS, 2010; Marine Ecological Surveys Limited (MESL), 2012; Fugro, 2018; Greater Gabbard Offshore Wind Limited (GGOWL), 2005; RPS, 2007))		
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.



EUSeaMap 2021 (EMODnet, 2021)

- | | |
|---|--|
| ■ A3: Infralittoral rock and other hard substrata | ■ A5.15: Deep circalittoral coarse sediment |
| ■ A3.1: Atlantic and Mediterranean high energy infralittoral rock | ■ A5.23 or A5.24: Infralittoral fine sand or Infralittoral muddy sand |
| ■ A3.2: Atlantic and Mediterranean moderate energy infralittoral rock | ■ A5.25 or A5.26: Circalittoral fine sand or Circalittoral muddy sand |
| ■ A3.3: Atlantic and Mediterranean low energy infralittoral rock | ■ A5.27: Deep circalittoral sand |
| ■ A4: Circalittoral rock and other hard substrata | ■ A5.33: Infralittoral sandy mud |
| ■ A4.1: Atlantic and Mediterranean high energy circalittoral rock | ■ A5.35: Circalittoral sandy mud |
| ■ A4.2: Atlantic and Mediterranean moderate energy circalittoral rock | ■ A5.37: Deep circalittoral mud |
| ■ A4.27: Faunal communities on deep moderate energy circalittoral rock | ■ A5.44: Circalittoral mixed sediments |
| ■ A4.3: Atlantic and Mediterranean low energy circalittoral rock | ■ A5.45: Deep circalittoral mixed sediments |
| ■ A5: Sublittoral sediment | ■ A5.6: Sublittoral biogenic reefs |
| ■ A5.13: Infralittoral coarse sediment | ■ A5.62: Sublittoral mussel beds on sediment |
| ■ A5.14: Circalittoral coarse sediment | ■ No EUNIS habitat assigned |



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Red Line Boundary
- Benthic Ecology Study Area
- RSMP Benthic Dataset (Cooper 2019)
- Trawls
- VE_PEIR_Fauna_PSA_2016_Thanet_Ext_XXXXXXXXX
 - Fauna and PSA
 - DDV
- VE_PEIR_Fauna_PSA_2009_Galloper_XXXXXXXXX
 - Fauna and PSA
 - DDV
- East Anglia One EIA (2011):
 - Fauna, PSA and DDV

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
existing subtidal benthic grab, DDV and trawl data across the VE benthic ecology study area (EMOD 2021, CMACS, 2010; Fugro, 2018; MESL, 2012).

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	AdB

DRAWING NUMBER:
5.2

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





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 4, Annex 5.1: Main Array – Benthic Ecology Monitoring Report;
 - > Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report; and
 - > Volume 4, 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 5.7.48 *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 by the following groupings: -
- > C1a - was characterised by the polychaetes *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 the polychaetes *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 the polychaetes *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.

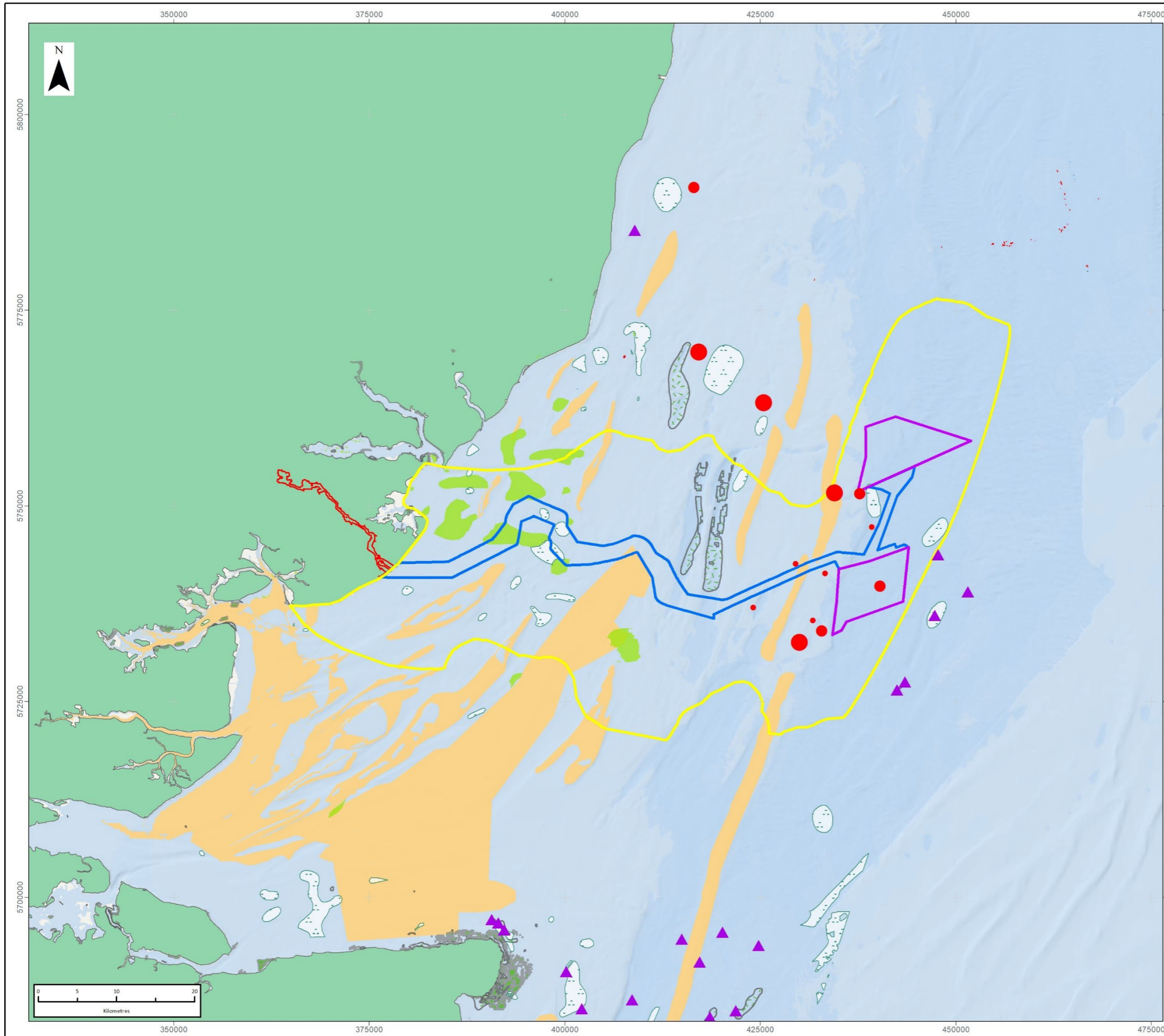


- > D2c - represented a faunal assemblage that was characterised by polychaetes including *Nephtyidae*, *Spionidae* and *Opheliidae*. All of which are typically found in sands and muddy sands. This faunal cluster is widespread across the array areas and offshore ECC.
- 5.7.15 The results of the benthic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



FEATURES OF CONSERVATION INTEREST

- 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 Margate and Long Sands 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 micrositied 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).



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Red Line Boundary
- Benthic Ecology Study Area
- Annex I Sandbanks
- ▲ Reefs (BGS)
- Galloper EIA (2009):
- Extensive
- Present
- abundant patches
- EA ONE EIA (2009):
- Potential low quality reef
- Potential low-medium quality reef
- Annex I Reefs by Subtype (JNCC 2021):
- Bedrock
- Bedrock / Mixed
- Biogenic
- Stony

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
Potential Annex I habitats across the VE benthic, subtidal and intertidal ecology study area and wider region (CMACS, 2010; JNCC, 2019, 2021; MESL, 2012).

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	KL

DRAWING NUMBER:
5.5

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

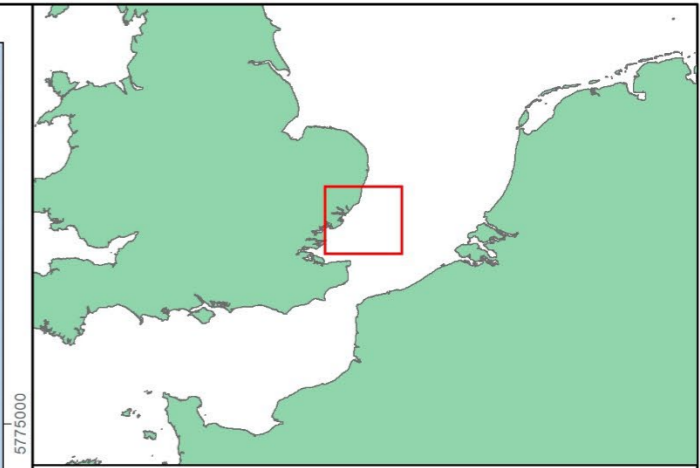
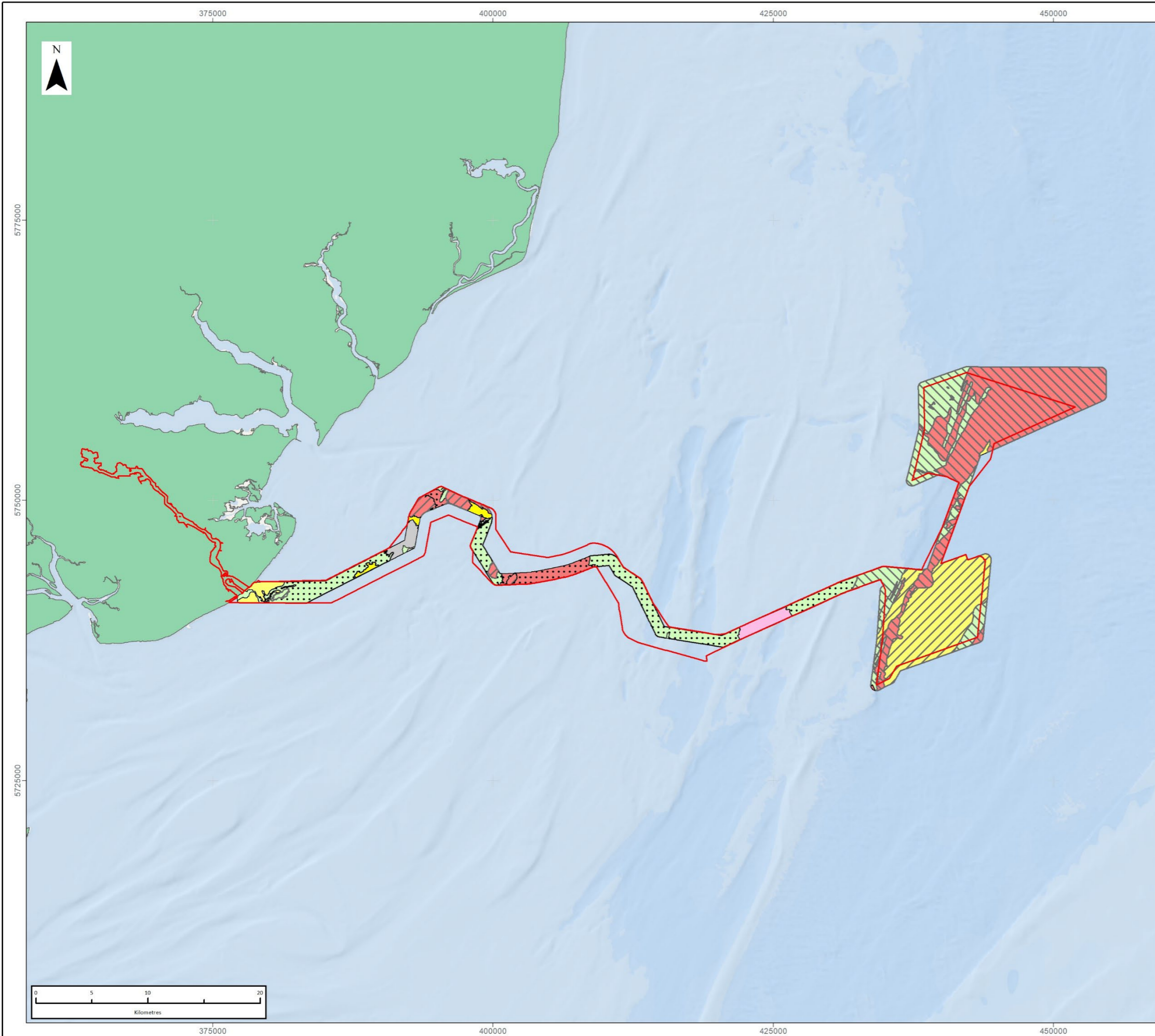




ARRAY AREAS

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).



- LEGEND**
- Project PEIR Red Line Boundary
 - EUNIS Biotypes (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 - Infralittoral coarse sediment
 - A5.13 - Infralittoral coarse sediment
 - A5.13 Infralittoral coarse sediment
 - MC32 - Circalittoral coarse sediment
 - MD3 - Deep circalittoral coarse sediment
 - MC5 - Circalittoral muddy sand
 - 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

Data Source:
 Basemap: 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 VE RLB (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	AdB

DRAWING NUMBER:
 5.3

SCALE: 1:350,000 PLOT SIZE: A3 DATUM: WGS84 PROJECTION: UTM31N





SEDIMENT CHEMISTRY

5.7.29 As presented in Volume 4, 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);
- > 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 Further details of sediment contamination is provided in Volume 2, Chapter 2: Marine Water and Sediment Quality and Volume 4, Annex 5.1: Main Array - Benthic Ecology Monitoring Report.

SEABED HABITAT AND COMMUNITIES

5.7.32 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).

5.7.33 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.

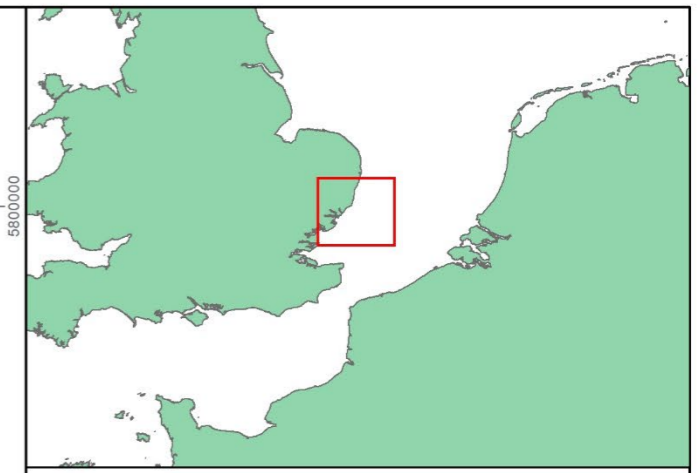
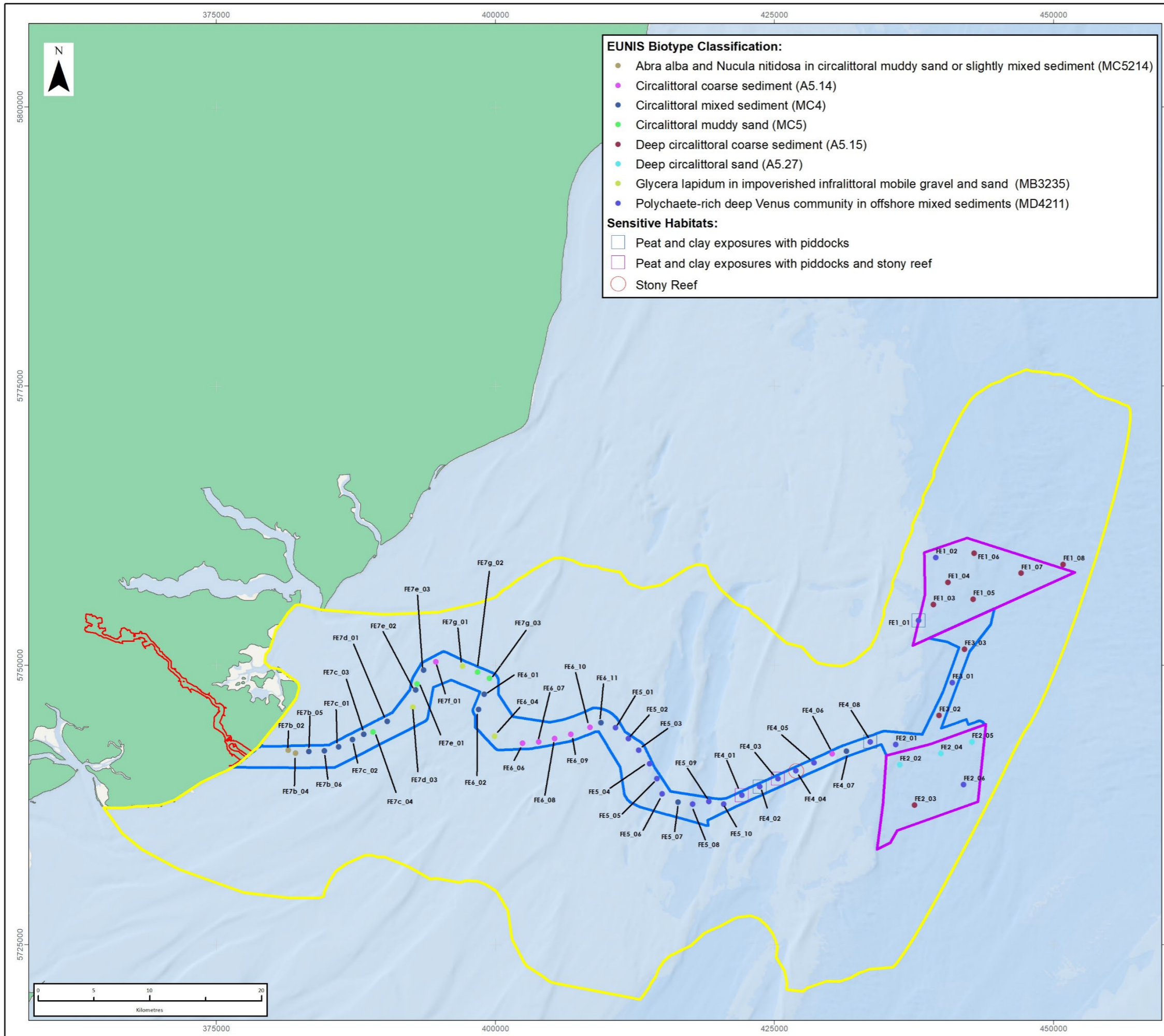
5.7.34 There was a clear spatial distribution in the habitat types present within the array areas which is reflected by sediment character. By combining and considering collectively the macrofaunal data, DDV data, PSA data and geophysical data, two biotope complexes and two biotopes within the array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



- 5.7.35 The predominant biotope complex across the VE array areas was faunal communities in ‘Atlantic offshore circalittoral coarse sediment’ (MD321) which was recorded predominantly across the northern array, array areas corridor and present in the southern array. The higher coarseness of the sediment provides suitable substrate for the attachment of epifauna while the gravelly interstices provide microhabitats for smaller fauna. These stations generally had higher richness and diversity than those of the predominantly sandy stations. Infaunal analysis showed typical taxa including polychaetes, (*Lagis koreni*, *Lumbrineris cf. cingulate*, *Aonides paucibranchiata*), crustacean amphipods (*Ampelisca spinipes*) and echinoderms (*O. albida* and *E. pusillus*).
- 5.7.36 Faunal communities in Atlantic offshore circalittoral sand (MD521) dominated the southern array due to the high sand and low gravel content and faunal assemblages being typical of clean sands with moderate exposure to wave or tidal action. Faunal richness and abundance were low and represented by the polychaete *Nephtys cirrosa*.
- 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). 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. cf. 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 A5.45 included echinoderms *O. albida*, *Amphipholis squamata*, and *E. pusillus* and bryozoans, hydroids and sponges.
- 5.7.38 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)	Biotope Name
Array Areas	
MD3	Offshore circalittoral coarse sediment
MD5	Offshore circalittoral sand
MD4211	Polychaete-rich deep Venus community in offshore circalittoral mixed sediment
MC1251	Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Red Line Boundary
- Benthic Ecology Study Area

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
EUNIS biotopes and seabed sediment features across VE (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	KL

DRAWING NUMBER:
5.4

SCALE: 1:350,000 | PLOT SIZE: A3 | DATUM: WGS84 | PROJECTION: UTM31N





FEATURES OF CONSERVATION INTEREST

- 5.7.39 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.
- 5.7.40 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.
- 5.7.41 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).
- 5.7.42 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.
- 5.7.43 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).
- 5.7.44 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

- 5.7.45 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.
- 5.7.46 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).
- 5.7.47 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

- 5.7.48 As presented in Volume 4, 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)); and
 - > Organochlorine pesticides (OCPs).
- 5.7.49 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.
- 5.7.50 The following metals were recorded above CAL1, but less than CAL2, within the offshore ECC:
- > Arsenic;
 - > Cadmium;
 - > Chromium; and
 - > Nickel.



5.7.51 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 2, Chapter 2: Marine Water and Sediment Quality and Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.

SEABED HABITAT AND COMMUNITIES

5.7.52 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 4.20) 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.

5.7.53 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 (**Error! Reference source not found.**).

5.7.54 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.

5.7.55 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.

5.7.56 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*).

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



- 5.7.58 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.
- 5.7.59 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.
- 5.7.60 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 Sartiidae) and *A. rubens*.

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

EUNIS Code (2022)	Biotope Name
Offshore ECC	
MC4	Circalittoral mixed sediment
MC4215	<i>Ophiothrix fragilis</i> and/ or <i>Ophiocomina nigra</i> brittlestar beds on sublittoral mixed sediment
MD4211	Polychaete-rich deep Venus community in offshore circalittoral mixed sediment
MC5	Circalittoral sand
MC5214	<i>Abra alba</i> and <i>Nucula nitidosa</i> in circalittoral muddy sand or slightly mixed sediment
MC32	Circalittoral coarse sediment
MB3235	<i>Glycera lapidum</i> in impoverished Atlantic infralittoral mobile gravel and sand
MC1251	Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay
MC2211	<i>Sabellaria spinulosa</i> on stable circalittoral mixed sediment



5.7.61 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

5.7.62 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).

5.7.63 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.

5.7.64 The biotope 'Piddocks with sparse associated fauna in sublittoral very soft chalk or clay' (MC1251) was observed at three location 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.

5.7.65 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).

5.7.66 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.



5.7.67 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

5.7.68 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.

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

5.7.70 THE INTERTIDAL EXPORT CABLE CORRIDOR

SEDIMENT CHARACTERISTICS

5.7.71 The foreshore of the offshore ECC comprise 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

5.7.72 As presented in Volume 4, 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.

5.7.73 Further details of sediment contamination is provided in Volume 2, Chapter 2: Marine Water and Sediment Quality and Volume 4, Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.



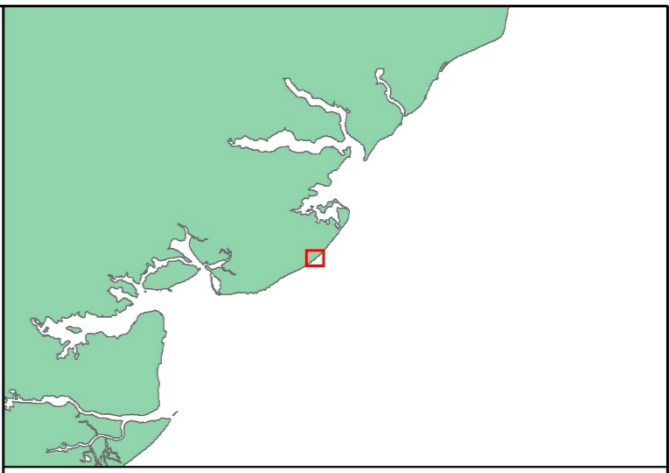
HABITAT AND COMMUNITIES

- 5.7.74 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).
- 5.7.75 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.
- 5.7.76 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 cumacean and amphipods.
- 5.7.77 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.
- 5.7.78 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).
- 5.7.79 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	<i>Mytilus edulis</i> and/or barnacle communities on wave-exposed Atlantic littoral rock
MA123	Seaweed communities on full salinity Atlantic littoral rock
MA1242	<i>Fucus spiralis</i> on exposed to moderately exposed upper eulittoral rock
MA3211	Barren littoral shingle
MA1243	<i>Fucus vesiculosus</i> and barnacle mosaics on moderately exposed mid eulittoral rock
MA1244	<i>Fucus serratus</i> on moderately exposed lower eulittoral rock
MA5255	<i>Lanice conchilega</i> in littoral sand
MA123H	<i>Porphyra purpurea</i> or <i>Enteromorpha</i> spp. on sand-scoured mid or lower eulittoral rock
MA123G	<i>Enteromorpha</i> spp. on freshwater-influenced and/or unstable upper eulittoral rock
MA1223	<i>Semibalanus balanoides</i> on exposed to moderately exposed or vertical sheltered eulittoral rock
MA12132	<i>Verrucaria maura</i> on very exposed to very sheltered upper littoral fringe rock



- LEGEND**
- ▬ Offshore Export Cable Corridor
 - ▬ Onshore Red Line Boundary
 - Biotope**
 - Barren littoral shingle MA3211
 - Fucus serratus on moderately exposed lower eulittoral rock (MA1244)
 - Fucus spiralis on full salinity exposed to moderately exposed littoral fringe rock (MA1242)
 - Littoral rock and other hard substrata (MA1)
 - Littoral sand and muddy sand (MA5255)
 - Mussel and/or barnacle communities (MA122) and Lancea 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

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
 Spatial distribution of intertidal habitats and biotopes (Fugro, 2022)

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	AdB

DRAWING NUMBER:
 5.6

SCALE: 1:8,000 PLOT SIZE: A3 DATUM: WGS84 PROJECTION: UTM31N





DESIGNATED SITES

- 5.7.80 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).
- 5.7.81 The VE study area overlaps spatially with the Margate and Long Sands 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.
- 5.7.82 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 Volume 4, 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 Zol have been screened into the assessment.
- 5.7.83 An assessment of the potential impacts on MCZs is provided in Volume 7, Report 7: 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.
- 5.7.84 An assessment of the supporting habitats within the Outer Thames Estuary SPA has been detailed within Section 5.10 to 5.12. 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 5.10 to 5.12.

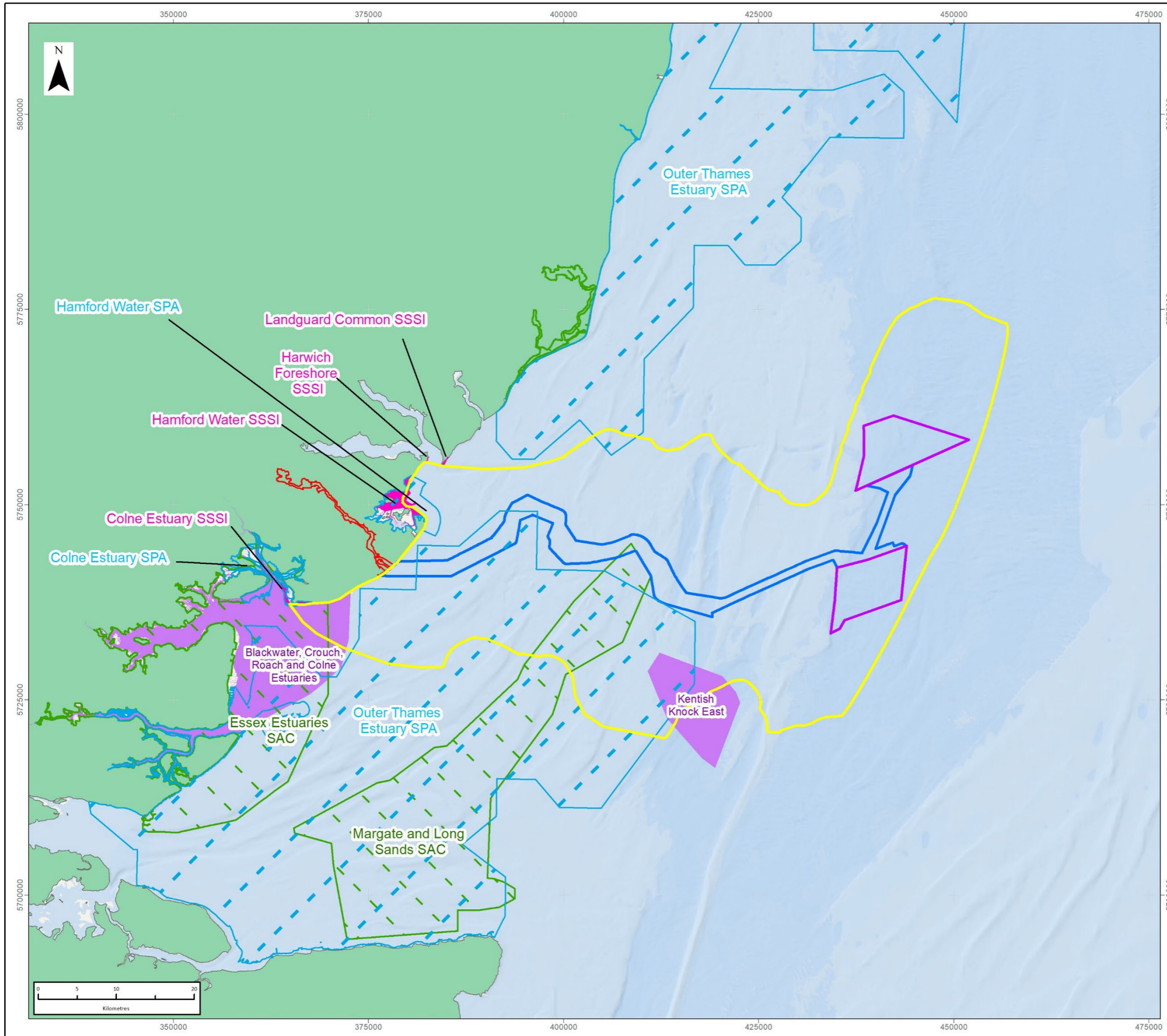


Table 5.10: National conservation designations of relevance to benthic subtidal and intertidal ecology within the area of potential direct and indirect impact of VE.

Site	Qualifying features	Distance from VE
Sites forming part of the National Site Network		
Margate and Long Sands SAC	Annex I habitat: <ul style="list-style-type: none"> > 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: <ul style="list-style-type: none"> > Estuaries > Mudflats and sandflats not covered by seawater at low tide > Salicornia and other annuals colonizing mud and sand > Spartina swards (<i>Spartinion maritimae</i>) 	7.5 km away from the offshore ECC, and overlaps with the secondary Zol
Outer Thames Estuary SPA	Annex I species of bird: Red-throated diver <i>Gavia stellata</i> , Common tern <i>Sterna hirundo</i> , Little tern <i>Sternula albifrons</i> 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 Zol
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, Saltmarsh spp., and the estuarine fish communities.	3.1 km distance from the offshore ECC and is located within the VE indirect Zol
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 Zol
National		
Kentish Knock East MCZ	<ul style="list-style-type: none"> > Subtidal sand > Subtidal coarse sediment > Subtidal mixed sediment 	6.2 km distance from the offshore ECC
Blackwater, Crouch, Roach	<ul style="list-style-type: none"> > Intertidal mixed sediments > Native oyster (<i>Ostrea edulis</i>) beds 	4.2 km distance from the offshore ECC



Site	Qualifying features	Distance from VE
and Colne Estuaries MCZ	<ul style="list-style-type: none"> > Native oyster (<i>Ostrea edulis</i>) > 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 Red Line Boundary
- Benthic Ecology Study Area
- Sites of Special Scientific Interest
- Marine Conservation Zones
- Special Areas of Conservation

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

PROJECT TITLE:
 FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:
 Designated sites overlapping the VE study area with relevance to benthic and intertidal ecology

VER	DATE	REMARKS	Drawn	Checked
1	17/02/2023	For Issue	SWM	AdB

DRAWING NUMBER:
 5.7

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





VALUED ECOLOGICAL RECEPTORS (VERS)

- 5.7.85 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.
- 5.7.86 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 5.10 and 5.11).
- 5.7.87 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 the northern part of the southern array (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



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
Peat and clay exposure with piddocks	MC1251	None	Habitats of Principal importance and UK BAP (Littoral and sublittoral chalk) FOCI under the Nature Conservation part (Part 5) of the MCAA 2009	Single station in the northern array and three stations in the offshore area of the offshore ECC (Figure 5.5)	National – Habitats of Principal Importance protected under Section 41 of the NERC Act 2006
Brittlestar dominated communities in mixed sediments	MC4215	None	Habitats of Principal importance and UK BAP	Brittles stars (<i>Ophiothrix fragilis</i> and/or <i>Ophiocomina nigra</i>) 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
<i>Sabellaria spinulosa</i> reef	A5.611	Within an SAC: Annex I Habitats Directive	OSPAR List of threatened and/or declining species for the Greater North	<i>S. spinulosa</i> individuals were recorded at four stations within the array areas and at	<i>S. spinulosa</i> habitat was not recorded in reef form therefore no national or international importance applied to this habitat



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
			Sea (OSPAR Region II) FOCI under the Nature Conservation part (Part 5) of the MCAA 2009 Habitats of Principal importance	23 stations with the offshore ECC. No reef was recorded during site specific surveys (Fugro, 2022). <i>S. spinulosa</i> reef has been predicted and recorded throughout the wider study area (Figure 5.3)	within the offshore ECC or the array Indirect impacts to this habitat within in the wider study area have been assessed (Section 5.10 to 5.12)
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



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
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
Littoral sand dominated by <i>Lanice conchilega</i>	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 Zol (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)



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
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 Zol (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)
<i>Salicornia</i> 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 Zol (Figure 5.7)	National – part of the National Site Network of designated sites within the UK (Essex Estuaries SAC)
Features of MCZs					
Native oyster (<i>Ostrea edulis</i>) beds and <i>Ostrea edulis</i>	N/A	MCZ	Protected features within the Blackwater, Crouch, Roach and Colne Estuaries MCZ	No direct overlap with the MCZ. Overlap with secondary Zol (Figure 5.7)	National – included as broadscale feature of Blackwater, Crouch, Roach and Colne Estuaries MCZ. <i>O. edulis</i> is appraised within Volume 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 Zol (Figure 5.7)	National – included as broadscale feature of Blackwater, Crouch, Roach and Colne Estuaries MCZ



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 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

- 5.7.88 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.
- 5.7.89 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).
- 5.7.90 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).



5.7.91 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 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 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 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	<p>Temporary subtidal habitat disturbance of 50,255,630 m²</p> <p><u>Array areas:</u></p> <p>Foundation seabed preparation = 298,400 m²</p> <ul style="list-style-type: none"> > 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. <p>Jack-up vessels (JUV) and anchoring operations = 933,480 m²</p> <ul style="list-style-type: none"> > 504 JUV operations, with a maximum disturbance of 1,100 m² per operation = 554,400 m² > Total impact area for WTG and OSP installation in the array = 379,080 m² <p>Cable seabed preparation and installation in the array area = 13,600,000 m²</p> <ul style="list-style-type: none"> > 100% of the inter-array cable route may require boulder clearance > Total area of seabed disturbed by boulder plough/ clearance for inter-array cables = 3,600,000 m² > Total area of seabed disturbed by pre-lay grapple run is = 3,000,000 m² (as this area overlaps it has only been calculated once to form the total) 	<p>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.</p> <p>The MDS for temporary habitat disturbance in the intertidal area from the HDD works is included.</p>



Potential effect	Maximum design scenario assessed	Justification
	<ul style="list-style-type: none"> > 50% of the inter-array cable route may require sandwave clearance > Total area of seabed disturbed by sandwave clearance = 7,000,000 m² <p>Burial of inter-array cables (total length 200 km length) = 3,600,000 m²</p> <p><u>Offshore ECC</u></p> <p>Cable seabed preparation and installation in the offshore ECC = 25,160,000 m²</p> <ul style="list-style-type: none"> > 100% of the export cable route may require boulder clearance > Total area of seabed disturbed by boulder plough/ clearance for export cables = 6,660,000 m² > Total area of seabed disturbed by pre-lay grapple run is = 5,550,000 m² (as this area overlaps with boulder clearance it has only been calculated once to form the total) > 50% of the export cable route may require sandwave clearance > Total area of seabed disturbed by sandwave clearance = 12,950,000 m² <p>Burial of export cables (total length 370 km length) = 6,660,000 m²</p> <p>The seabed footprint for cable jointing is within the design envelope for seabed preparation and cable installation</p> <p>Temporary intertidal habitat disturbance of 3,750 m²</p> <p>Temporary habitat disturbance from horizontal directional drilling (HDD) exit pit excavation within the intertidal (or shallow subtidal):</p> <ul style="list-style-type: none"> > HDD pits will be in either the intertidal or below lowest astronomical tide; > Stage 1: Up to 5 HDD exit pits (10 m width x 5 m length x 2.5 m depth) 	



Potential effect	Maximum design scenario assessed	Justification
	<p>excavated via backhoe dredger (or similar) with material side-cast for backfill;</p> <ul style="list-style-type: none"> > 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 > Any inter-tidal cable installation is captured within the MDS for the installation of export cables in the offshore ECC. 	
<p>Impact 2: Temporary increase in suspended sediment and sediment deposition</p>	<p>Total subtidal sediment volume = 116,658,900 m³</p> <p>Seabed preparation for foundations (1,193,600 m³)</p> <ul style="list-style-type: none"> > 79 small GBS (Wind Turbine Generator (WTG)) foundations = 1,137,600 m³; and > 2 GBS foundations for OSP = 56,000 m³. <p>Drill arisings from foundation installation in array area (567,430 m³)</p> <ul style="list-style-type: none"> > 79 small GBS (WTG) foundations and 2 GBS foundations for OSP = 567,430 m³ <p>Cable trenching (5,306,175 m³):</p> <ul style="list-style-type: none"> > Installation of 200 km of inter-array cables by jetting resulting in the suspension of 3,150,000 m³ of sediment; and > Installation of 370 km of export cables by jetting resulting in the suspension of 2,156,175 m³ of sediment. <p>Sandwave clearance for cable installation (99,750,000 m³):</p> <ul style="list-style-type: none"> > Sandwave clearance for 100 km of array cables resulting in the 	<p>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.</p> <p>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.</p> <p>The MDS for temporary habitat disturbance in</p>



Potential effect	Maximum design scenario assessed	Justification
	<p>suspension of 35,000,000 m³ of sediment; and</p> <ul style="list-style-type: none"> > Sandwave clearance for 185 km of export cables resulting in the suspension of 64,750,000 m³ of sediment. <p>Jack-up vessels (JUV) and anchoring operations = 9,832,320 m³</p> <ul style="list-style-type: none"> > 504 JUV operations, with a maximum disturbance of 16,500 m³ per operation = 8,316,000 m³ > 81 anchoring locations, and 405 deployments (for WTG and OSP installation) = 1,516,320 m³ <p>Total intertidal sediment volume = 9,375 m³</p> <ul style="list-style-type: none"> > Five offshore HDD exit pits require excavation of 9,375 m³ 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. 	<p>the intertidal area from the HDD works is included.</p> <p>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.</p>
<p>Impact 3: Direct and indirect seabed disturbances leading to the release of sediment contaminants</p>	<p>The MDS for seabed disturbance are presented in Impact 2</p>	<p>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.</p>
<p>Impact 4: Increased risk of introduction or spread of Marine INNS</p>	<p>The MDS for the total number of vessel return trips made during construction (or decommissioning) = 5,110 (based on 79 WTGs installed)</p>	<p>Maximum design scenario with regards to maximum number of vessel movements during construction activities in relation to the maximum number of WTG (79).</p>



Potential effect	Maximum design scenario assessed	Justification
Operation and Maintenance		
Impact 5: Permanent habitat loss/ alteration	<p>Total habitat loss of 3,102,322 m²</p> <ul style="list-style-type: none"> > Turbine total structure footprint including scour protection, based on 79 GBS (WTG-type) foundations = 1,313,612 m² > OSP total structure footprint including scour protection, based on two GBS monopile foundations = 81,656 m² > Total area of seabed covered by cable protection (export cables and inter-array) = 1,428,000 m² > It is assumed that up to 20% of scour protection may be replaced over the lifetime of VE (Total scour are for all foundations = 1,395,268 m²) = 279,054 m² 	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.
Impact 6: Temporary habitat disturbance	<p>Total direct disturbance to seabed = 848,336 m²</p> <ul style="list-style-type: none"> > Indicative max seabed disturbance per year from jacking-up activities = 312,400 m² > Total seabed disturbance for array cables over project lifetime = 276,656 m² > Total seabed disturbance for offshore export cables over project lifetime = 259,280 m² 	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.
Impact 7: Colonisation of hard substrates	<p>Total surface area of introduced hard substrate in the water column = 3,210,272 m²</p> <p>Total area of introduced hard substrate at seabed level = 2,766,322 m² (see Impact 5)</p> <p>Total surface area of subsea portions of foundations in contact with the water column: 443,950 m²</p> <ul style="list-style-type: none"> > 79 GBS (WTG-type) foundations, with a total surface area of 430,550 m² 	Maximum scenario for introduced hard substrate is as for the maximum scenario for loss of habitat.



Potential effect	Maximum design scenario assessed	Justification
	<ul style="list-style-type: none"> > OSP structure area, based on two GBS monopile foundations, assuming, with a total surface area of 13,400 m² 	
Impact 8: Increased risk of introduction or spread of Marine INNS	<p>Total surface area of introduced hard substrate in the water column = 443,950 m² (see Impact 7)</p> <p>Total of 1,776 annual round trips for all O&M vessels</p>	<p>Maximum scenario for introduced hard substrate is as for the maximum scenario for loss of habitat.</p> <p>MDS with regards to maximum number of vessel movements during O&M activities.</p>
Impact 9: Changes in physical processes	See MDS presented in Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes.	Full justification of the worst-case scenarios can be found within Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes.
Impact 10: EMF effects generated by inter-array and export cables during operational phase	<p>Inter-array cables</p> <ul style="list-style-type: none"> > Up to 200 km of inter-array cable, operating up to 132 kV > Inter-array cable depth = 0 – 3.5 m <p>Offshore export cables</p> <ul style="list-style-type: none"> > Up to 370 km of export cable, operating up to 400 Kv > Inter-array 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.

5.9 EMBEDDED MITIGATION

The embedded mitigation 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: Embedded mitigation relating to Benthic Ecology

Project phase	Mitigation measures embedded into the project design
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	<p>A PEMP 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 PEMP will be secured as a condition in the deemed Marine Licence(s).</p> <p>Typical measures will include:</p> <ul style="list-style-type: none"> > 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. <p>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.</p>
Pollution prevention	VE OWFL 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 ⁶ .
Construction	
Cable Specification and Installation Plan (CSIP)	Development of, and adherence to, a Cable Specification and Installation Plan (CSIP) 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 designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment (CBRA) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance

⁶ <https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx>



Project phase	Mitigation measures embedded into the project design
	to that which is necessary. The CSIP will be conditioned in the deemed Marine Licence.
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.
Scour Protection Management Plan	Development of a Scour Protection Plan (SPP) which will consider the need for scour protection where there is the potential for scour to develop around wind farm infrastructure, including turbine and substation/ platform foundations and cables. The plan will be secured via a condition in the deemed Marine Licence.
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 embedded mitigation measure will be similar to those for the construction phase. The Decommissioning Plan will be secured as a condition in the deemed Marine Licence.

5.10 ENVIRONMENTAL ASSESSMENT: CONSTRUCTION AND DECOMMISSIONING PHASE

- 5.10.1 The effects of construction on 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.
- 5.10.2 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.
- 5.10.3 A description of the significance of effect upon benthic and intertidal receptors caused by each identified impact is also provided below.



5.10.4 IMPACT 1: TEMPORARY HABITAT DISTURBANCE

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF IMPACT

- 5.10.5 The total maximum area of temporary loss/ disturbance of subtidal habitat due to construction activities is described in Table 5.12. This equates to approximately 17% of the total seabed area within the VE array areas and offshore ECC. 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 and offshore ECC. 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.
- 5.10.6 Of the total area of temporary habitat loss described in Table 5.12, a maximum of approximately 18.8 km² 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 15% of the total seabed area within the VE array areas.
- 5.10.7 Of the total area of temporary habitat loss described in Table 5.12, a maximum of approximately 31 km² will be temporarily disturbed within the subtidal areas of the VE ECC as a result of seabed preparation, export cable installation, burial and jointing. This equates to approximately 18% of the total seabed area within the VE offshore ECC.
- 5.10.8 As described in Section 5.7, the benthic habitats comprise macrofaunal assemblages associated with the predominantly coarse and mixed sediment habitats that characterise the array and offshore ECC. Sandy sediments and clay outcrops are also encountered. Whilst these are considered VERs (see Table 5.11), 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 functions or diminish biodiversity.
- 5.10.9 The impact on benthic habitats is predicted to be of local spatial extent (i.e. restricted to discrete areas within VE, 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.



5.10.10 The offshore ECC overlaps with 1.26 km² of the Margate and Long Sands SAC, which is designated for sandbank features. The maximum total area that is expected to be disturbed by sandwave clearance is 0.7 km² which equates to 0.11% of the total SAC. The duration of this impact is 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 an nationally designated feature the magnitude is low adverse due to the limited extent.

SENSITIVITY OF THE RECEPTOR

5.10.11 The sensitivity of all biotopes that are known to characterise the VE array areas and offshore ECC (Section 5.7) have been assessed according to the detailed MarESA sensitivity assessment (Table 5.14).

Table 5.14: MarESA assessment for the benthic subtidal habitats for abrasion/ disturbance.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
<i>G. lapidum</i> 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)
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
<i>A. alba</i> and <i>Nucula nitidosa</i> 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
<i>Ophiothrix fragilis</i> and/ or <i>Ophiocomina nigra</i> 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)
<i>Sabellaria spinulosa</i> 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



- 5.10.12 As demonstrated in Table 5.14, the majority of sand and mixed sediment communities were determined as having a low 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 infaunal mobile species 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 a combination of recruitment from surrounding unaffected areas and larval dispersal, and recovery is likely to occur within one to ten years (based on the MarESA assessments).
- 5.10.13 Further evidence to support recovery is supported by research at aggregate extraction sites, where it was reported that the characteristic recovery time for typical North Sea sandy sediment communities may be two to three years, following cessation of dredging activity (Newell *et al.* 2004). Research indicated that following the initial suppression of species' diversity, abundance and biomass recovery of species' diversity to within 70 – 80% of that in non-dredged areas was achieved within 100 days (Newell *et al.* 2004). 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).
- 5.10.14 Abrasion of coarser sediments is likely to disturb epifauna and may damage a proportion of those characterising epifaunal species for coarser sediments. However, opportunistic species are likely to recruit rapidly, and some damaged characterising species may recover or recolonise, resulting in a high resilience.
- 5.10.15 The biotope 'Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (MC1251)' was recorded at one location within the array area and within a portion of the offshore ECC (Section 5.7), which is expected within the region due to the underlying London clay formation that is found regionally (MALSF, 2009). Piddocks are afforded some protection from surface abrasion due to the species inhabiting burrows, however where abrasion or disturbance impacts occur deeper than the surface of the soft rock, individuals inhabiting the chalk or clay are vulnerable to damage. Whilst denuded areas of exposed clay will likely be recolonised by piddocks once construction activities have ceased, where removal of clay results in a loss of exposed soft substratum, these specific parts of the substratum directly impacted cannot recover through natural processes. 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 5.14).



- 5.10.16 The biotope *Ophiothrix fragilis* and/ or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment was also 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.
- 5.10.17 The biotope 'S. *spinulosa* on stable circalittoral mixed sediment' (MC2211) is described as having a 'medium' MarESA sensitivity to a disturbance of this nature. Whilst *S. spinulosa* reef itself wasn't observed from site-specific investigations, individuals were prevalent across the array areas and offshore ECC and are known to occur throughout the wider region in both reef and encrusting form (Section 5.7). The species is fixed to the substratum, so substratum abrasion and disturbance is likely to lead to mortality. However, *S. spinulosa* is most frequently found in disturbed sediment conditions and is a 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.
- 5.10.18 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 Margate and Long Sands 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 array areas and offshore ECC is '*G. lapidum* in impoverished infralittoral mobile gravel and sand' (MB3235). As detailed in Table 5.14 this biotope has a low sensitivity to an impact of this nature.
- 5.10.19 As detailed within the SAC documentation⁷ it states that the structure of these banks are 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 Margate and Long Sands SAC is therefore, regarded as medium as per the evidence provided.

⁷ <https://sac.jncc.gov.uk/site/UK0030371>



5.10.20 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.

5.10.21 The sensitivity of the majority of benthic subtidal features of the array areas and 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

5.10.22 Overall, it is predicted that the 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 effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

5.10.23 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 5.14. 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.

INTERTIDAL AT LANDFALL

MAGNITUDE OF IMPACT

5.10.24 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.

5.10.25 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

5.10.26 The sensitivity of all intertidal sedimentary biotopes (Section 5.7) have been assessed according to the detailed MarESA sensitivity assessments (Table 5.15). 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 5.15: MarESA assessment for the intertidal habitats for abrasion/ disturbance.

Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Barren littoral shingle	LS.LCS.Sh.Bar Sh/ A2.111	Not sensitive (based on high resistance and high resilience).	Confidence is high as the assessment is based on published literature.
<i>Lanice conchilega</i> in littoral sand	LS.LSa.MuSa.Lan/ A2.245	Not sensitive (based on high resistance and high resilience).	Confidence is high as the assessment is based on published literature.

5.10.27 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.

5.10.28 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 5.14. 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

5.10.29 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.

5.10.30 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. As such, the assessment of the significance of effects as not significant is considered to be robust.

5.10.31 IMPACT 2: TEMPORARY INCREASE IN SUSPENDED SEDIMENT AND SEDIMENT DEPOSITION

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF IMPACT

5.10.32 Temporary localised increases in SSC and associated sediment deposition and smothering are expected from foundation and cable installation works (including HDD installation) and seabed preparation works (including sandwave clearance). This assessment should be read in conjunction with Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 4, 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).



- 5.10.33 Background surface SSCs 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. Within the offshore ECC, SSCs are much higher, reaching 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 4, Annex 2.1: Physical Processes Baseline Technical Report).
- 5.10.34 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.
- 5.10.35 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).
- 5.10.36 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. The majority of the offshore ECC is dominated by circalittoral mixed and circalittoral coarse sediments. Figure 4.3 within Volume 4, Annex 5.1: Main Array - Benthic Ecology Monitoring Report and Figure 4.6 in Volume 4, 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 array areas and offshore ECC.
- 5.10.37 Figure 2 within Volume 4, 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.
- > 500m 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.



- 5.10.38 Further information on sediment plume distances and modelling are provided in Volume 2, Chapter 2: Marine Geology, Oceanography and Physical Processes and Volume 4, Annex 2.1: Physical Processes Baseline Technical Report.
- 5.10.39 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.
- 5.10.40 The indirect impacts to the Margate and Long Sands 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 (0.11% 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.
- 5.10.41 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.
- 5.10.42 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 negatively impact benthic features and there will be no measurable thickness of deposition expected. The magnitude to these features is therefore assessed as negligible.
- 5.10.43 Release of bentonite (a non-toxic, natural clay mineral) during the trenchless installation technique punch out may result in a single, large plume of sediment in suspension into the water column. This will result in localised high levels of SSC within the nearshore, shallow waters. As presented in Volume 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



- 5.10.44 The communities and habitats identified during the benthic ecology study area are typical of the wider southern North Sea. All biotopes identified within the array areas, offshore ECC and across the wider benthic ecology study area 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.
- 5.10.45 The contemporary MarESA assessment 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).
- 5.10.46 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 5.16.

Table 5.16: 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
<i>G. lapidum</i> in impoverished infralittoral mobile gravel and sand	MB3235	<ul style="list-style-type: none"> > 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	<ul style="list-style-type: none"> > Not sensitive to longer term changes in SSC; > Medium sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy 	<p>Confidence is low as the assessment is based on expert judgement.</p> <p>Confidence in the quality of the evidence is medium for the smothering assessments</p>



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
		smothering (5 - 30 cm).	as they are based upon published literature.
<i>A. alba</i> and <i>Nucula nitidosa</i> in circalittoral muddy sand or slightly mixed sediment	MC5214	<ul style="list-style-type: none"> > Low sensitivity to changes in SSC; > Not sensitive to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm). 	<p>Confidence is low for the SSC assessment as assessment is based on expert judgement.</p> <p>Confidence is low to medium for smothering and siltation.</p> <p>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.</p>
<i>Ophiothrix fragilis</i> and/ or <i>Ophiocomina nigra</i> brittlestar beds on sublittoral mixed sediment	MC4215	<ul style="list-style-type: none"> > 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	<ul style="list-style-type: none"> > Low sensitivity to changes in SSC; > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm). 	<p>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.</p> <p>Confidence in the quality of the evidence is high for the smothering assessments, although the applicability and agreement between the</p>



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
			evidence is low to medium.
<i>Sabellaria spinulosa</i> on stable circalittoral mixed sediment	MC2211	<ul style="list-style-type: none"> > 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.
<i>Mediomastus fragilis</i> , <i>Lumbrineris</i> spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	MC3212	<ul style="list-style-type: none"> > 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.
<i>Nephtys cirrosa</i> and <i>Bathyporeia</i> spp. in infralittoral sand	MB5233	<ul style="list-style-type: none"> > Low sensitivity to changes in SSC; > Not sensitive to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 – 30 cm). 	Confidence is low for changes in SSC. Confidence in the quality of the evidence and the agreement of the evidence is high and the applicability of the evidence is medium for smothering.
<i>Spirobranchus triqueter</i> with barnacles and bryozoan crusts on	MC3211	<ul style="list-style-type: none"> > Not sensitive to changes in SSC and turbidity; 	Confidence in the quality of the evidence is high for the assessments.



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Atlantic circalittoral unstable cobbles and pebbles		<ul style="list-style-type: none"> > Not sensitive to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 – 30 cm) 	
<i>Spisula subtruncata</i> and <i>Nephtys hombergii</i> in Atlantic infralittoral muddy sand	MB5238	<ul style="list-style-type: none"> > Low sensitivity to changes in SSC; > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 – 30 cm). 	<p>Confidence is low as the assessment is based on expert judgement.</p> <p>Confidence in the quality of the evidence is high for the smothering assessments.</p>

5.10.47 The benthic habitats that characterise the 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 5.16 demonstrates that lower levels of sensitivity are recorded for light smothering (which will be the spatially larger impact) and longer-term changes in SSC.

5.10.48 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’ (Table 5.16), 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).

5.10.49 Given the national importance of some of the benthic features protected within the Margate and Long Sands SAC and the supporting features of the Outer Thames Estuary SPA which overlap with the secondary Zol 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



5.10.50 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.

INTERTIDAL AT LANDFALL

MAGNITUDE OF IMPACT

5.10.51 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 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.

5.10.52 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. 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)⁸.

5.10.53 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.

5.10.54 Up to 5 HDD conduits might be required, with up to 4,940m³ of drilling fluid potentially released per conduit (up to 24,700m³ total for all conduits). Lesser amounts are more likely, depending on the final drilling method, length and diameter required.

5.10.55 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).

5.10.56 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

⁸ <https://www.cefas.co.uk/data-and-publications/ocns/downloads-and-useful-links/>



- > 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.

5.10.57 As detailed within the Volume 4, Annex 2.3: Physical Processes Technical Assessment, the magnitude of impact resulting from temporarily elevated levels of siltation in the would be negligible.

5.10.58 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

5.10.59 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 5.17). 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 5.17 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.

Table 5.17: 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
<i>Verrucaria maura</i> on very exposed to very sheltered upper littoral fringe rock	MA12132	<ul style="list-style-type: none"> > 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.
<i>Enteromorpha spp.</i> on freshwater-influenced and/or unstable upper eulittoral rock	MA123G	<ul style="list-style-type: none"> > Not sensitive to longer term or to short-term changes in SSC; > Not sensitive to increases in turbidity; 	Confidence in the quality of the evidence is high for the assessments as they are based upon published literature.



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
		<ul style="list-style-type: none"> > Low sensitivity to light smothering (< 5 cm); and > Low sensitivity to heavy smothering (5 - 30 cm). 	
<i>Porphyra purpurea</i> and <i>Enteromorpha</i> spp. on sand-scoured mid or lower eulittoral rock	MA123H	<ul style="list-style-type: none"> > 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.
<i>Fucus spiralis</i> on full salinity exposed to moderately exposed upper eulittoral rock	MA1242	<ul style="list-style-type: none"> > Medium sensitivity to changes in SSC. > Low sensitivity to light smothering (< 5 cm); and > Medium sensitivity to heavy smothering (5 - 30 cm). 	Confidence is medium for the SSC assessment and low light smothering assessment as this 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 heavy smothering assessment as it is based on some peer reviewed papers.
<i>Semibalanus balanoides</i> on exposed to moderately exposed or vertical sheltered eulittoral rock	MA1223	<ul style="list-style-type: none"> > 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



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
			are based upon published literature.
<i>Fucus vesiculosus</i> and barnacle mosaics on moderately exposed mid eulittoral rock	MA1243	<ul style="list-style-type: none"> > Medium sensitivity to changes in SSC; > Medium sensitivity to smothering (< 5 cm – 30 cm). 	<p>Confidence is medium for the SSC assessment as based on some peer reviewed papers but relies on expert judgment on feature.</p> <p>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.</p>
<i>Fucus serratus</i> on moderately exposed lower eulittoral rock	MA1244	<ul style="list-style-type: none"> > Low sensitivity to short-term increases in SSC and turbidity, not 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). 	Confidence is medium as based on some peer reviewed papers, but all assessments are based on proxies for pressures and rely on expert judgment.
Barren littoral shingle	MA3211	<ul style="list-style-type: none"> > 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.



Biotope name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
<i>Lanice conchilega</i> in littoral sand	MA5255	<ul style="list-style-type: none"> > 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) 	<p>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.</p> <p>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 been done investigating the effects of such a factor.</p> <p>Confidence is low for all remaining assessments as they are based on expect judgement.</p>

5.10.60 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

- 5.10.61 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 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.
- 5.10.62 The MarESA assessment confidence scores were variable (Table 5.17), low confidence scores were predominately due 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 resilience 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.

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

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

- 5.10.64 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.
- 5.10.65 Contaminant surveys in both the array areas and the ECC reported in Volume 4, Annex 5.1: Main Array - Benthic Ecology Monitoring Report and Annex 5.2: Export Cable Route and Intertidal Benthic Ecology Monitoring Report.
- 5.10.66 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.
- 5.10.67 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



5.10.68 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

5.10.69 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.

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

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.10.71 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 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).

5.10.72 As detailed within

5.10.73 Table **5.13**, embedded environmental 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.

5.10.74 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).

5.10.75 Embedded measures, including a PEMP with a marine biosecurity plan (

5.10.76 Table **5.13**) will, however, ensure that the risk of potential introduction and spread of MINNS will be minimized as low as practicable

5.10.77 Taking into consideration the embedded mitigation (

5.10.78 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

5.10.79 The sensitivity of benthic receptors within the benthic study area to an introduction or spread of Marine INNS is deemed to be at worst 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

5.10.80 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.

5.11 ENVIRONMENTAL ASSESSMENT: OPERATIONAL PHASE

5.11.1 IMPACT 5: PERMANENT HABITAT LOSS/ ALTERATION

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.11.2 The presence of foundations and the associated scour protection, along with the cable protection measures used at cable crossings and areas where 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 and a potential negative 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.

5.11.3 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 1% of the array areas and offshore ECC combined. 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.

5.11.4 Where the offshore ECC crosses the Margate and Long Sands 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. However, whilst this permanent loss of habitat might occur within the SAC where the offshore ECC overlaps, this is only a discreet location (0.11% of the offshore ECC overlaps with the SAC) and the magnitude of the impact is therefore considered to be negligible, and the impact is expected to be localised.

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



SENSITIVITY OF THE RECEPTOR

5.11.6 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 and 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

5.11.7 Overall, for habitats outside the Margate and Long Sands 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.

5.11.8 Within the discreet location of the Margate and Long Sands SAC the magnitude is regarded as **negligible** due to the limited impact on the benthic resource and the sensitivity of the receptor is deemed **high** because the sandbank has no resistance to permanent habitat loss/change. The significance of the residual effect is therefore concluded to be **minor adverse**, which is not significant in EIA terms.

5.11.9 IMPACT 6: TEMPORARY HABITAT DISTURBANCE

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.11.10 Temporary subtidal habitat loss will arise from the use of jack-up vessels for operational and maintenance activities as well as from cable maintenance and cable replacement. The total MDS is presented in Table 5.12, which is predicted to arise over the design life of VE (equating to approximately 0.2% of the array areas and offshore ECC combined).

5.11.11 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.

5.11.12 The magnitude of temporary habitat disturbance from jack-up vessels and 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 and offshore ECC.



SENSITIVITY OF THE RECEPTOR

5.11.13 As detailed within paragraph 915.10.11 *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 5.10.44 *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

5.11.14 Overall, the impact of temporary habitat disturbance 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

5.11.15 IMPACT 7: COLONISATION OF HARD SUBSTRATES

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.11.16 The introduction of hard substrate 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), which accounts for approximately 1% of the total array areas and offshore ECC.

5.11.17 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 and offshore ECC (where cable protection is laid).

5.11.18 The impact is therefore predicted to be of local spatial extent, long-term duration but reversible 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.

SENSITIVITY OF THE RECEPTOR

5.11.19 The introduction of new hard substrate will represent a potential shift in the baseline condition within a small proportion of the array areas and offshore ECC. Potential beneficial effects that may occur are associated with the likely increase in biodiversity and biomass, as has been observed at the Egmond aan 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.



- 5.11.20 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).
- 5.11.21 Given the presence of epifaunal species and colonising fauna within discrete parts of the array areas of offshore ECC (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.
- 5.11.22 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

- 5.11.23 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.
- 5.11.24 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.

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

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

- 5.11.26 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.
- 5.11.27 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.



- 5.11.28 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.
- 5.11.29 Embedded measures, including a PEMP with a marine biosecurity plan (
- 5.11.30 Table **5.13**) will, however, ensure that the risk of potential introduction and spread of MINNS will be minimized as low as practicable.
- 5.11.31 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.

SENSITIVITY OF THE RECEPTOR

- 5.11.32 As described in paragraph 5.10.79 *et seq.*, benthic biotopes 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

- 5.11.33 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.

5.11.34 IMPACT 9: CHANGES IN PHYSICAL PROCESSES

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

- 5.11.35 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.
- 5.11.36 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.



5.11.37 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.

5.11.38 Volume 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.

SENSITIVITY OF THE RECEPTOR

5.11.39 As detailed within paragraph 915.10.11 *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 5.10.44 *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

5.11.40 Overall, the impact 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

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

ARRAY AREAS AND OFFSHORE ECC

MAGNITUDE OF THE IMPACT

5.11.42 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 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.



- 5.11.43 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.
- 5.11.44 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 negative 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.

SENSITIVITY OF THE RECEPTOR

- 5.11.45 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 2, Chapter 6: Fish and Shellfish Ecology.
- 5.11.46 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.
- 5.11.47 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.
- 5.11.48 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).



- 5.11.49 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).
- 5.11.50 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.
- 5.11.51 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

- 5.11.52 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.

5.12 ENVIRONMENTAL ASSESSMENT: CUMULATIVE EFFECTS

- 5.12.1 This cumulative impact assessment for benthic and intertidal ecology has been undertaken in accordance with the methodology provided in Volume 1, Annex 3.1: Cumulative Effects Assessment Methodology.
- 5.12.2 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 fish and shellfish in the region, the cumulative effect assessment technical note submitted through the EIA Evidence Plan and forming Volume 1, Annex 3.1: Cumulative Effects Assessment Methodology of this PEIR screened in a number of projects and plans as presented in Table 5.19 and are illustrated in Figure 5.8.
- 5.12.3 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 RLB 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.



- 5.12.4 The operational projects included within Table 5.19 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 5.19 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.
- 5.12.5 In line with PINS advice, Table 5.18 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 5.18: 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.

- 5.12.6 Note that Table 5.19 only includes the projects screened into the assessment for benthic and intertidal ecology based on the criteria outlined above.



Table 5.19: Projects considered within the benthic and intertidal ecology cumulative effect assessment.

Development type	Project	Status	Data confidence assessment/ phase	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	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	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'	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'	Tier 1
Aggregate Production Area	CEMEX UK Marine Ltd (510/2)	Operation	Medium - Third party project details	Tier 1



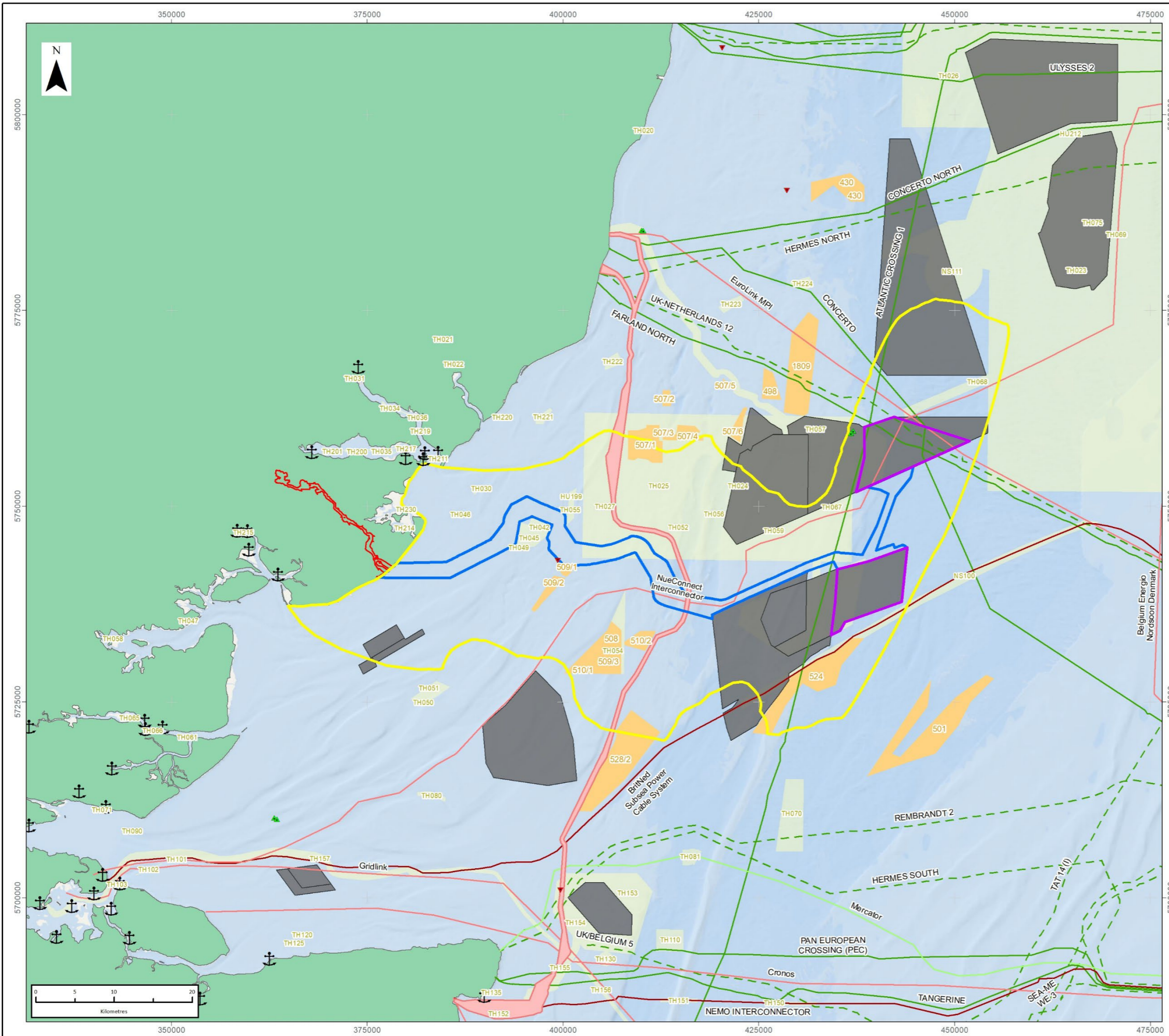
Development type	Project	Status	Data confidence assessment/ phase	Tier
			published in the public domain and confirmed as being 'accurate'	
Sea Disposal Site	Inner Gabbard (TH052)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	Tier 1
Sea Disposal Site	Harwich Haven (TH027)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	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'	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'	Tier 1
Aggregate Production Area	Britannia Aggregates Ltd (508)	Operation	Medium - Third party project details published in the	Tier 1



Development type	Project	Status	Data confidence assessment/ phase	Tier
			public domain and confirmed as being 'accurate'	
Sea Disposal Site	Inner Gabbard East (TH056)	Open	Medium - Third party project details published in the public domain and confirmed as being 'accurate'	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'	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'	Tier 1
Interconnector	NeuConnect	Consented	Medium - Third party project details published in the public domain but not confirmed as being 'accurate'	Tier 1
Interconnector	Sea Link	Proposed	Medium - Third party project details published in the public domain	Tier 2



Development type	Project	Status	Data confidence assessment/ phase	Tier
			but not confirmed as being 'accurate'	
Interconnector	Nautilus Multi-Purpose Interconnector (MPI)	Proposed	Medium - Third party project details published in the public domain but not confirmed as being 'accurate'	Tier 3
Interconnector	EuroLink	Proposed	Low	Tier 3



LEGEND

- Array Areas
- Offshore Export Cable Corridor
- Onshore Red Line Boundary
- Benthic Ecology Study Area
- ⚓ Major Ports
- ▲ Oil and Gas (Surface Infrastructure)
- ▼ Oil and Gas (Subsurface Infrastructure)
- Offshore Wind Farm
- TCE - Wave Energy Site
- TCE - Tidal Energy Site
- TCE - Carbon Capture and Storage Site
- Aggregates Site
- Disposal Sites
- EMODnet - Renewables:
 - Tidal Projects
 - Wave Projects
- Subsea Cable (Type - Status)
 - Power - Active
 - Power - Disused
 - Power - Proposed
 - Telecom - Active
 - Telecom - Disused
 - Telecom - Proposed
 - SeaLink Interconnector

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

PROJECT TITLE:
FIVE ESTUARIES OFFSHORE WIND FARM

DRAWING TITLE:
Projects and plans screened into the VE cumulative effect assessment on benthic ecology

VER	DATE	REMARKS	Drawn	Checked
1	23/02/2023	For Issue	SWM	AdB

DRAWING NUMBER:
5.8

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



Z:\GIS\Projects\0144 Five Estuaries\GIS\Figures\PEIR\BenthicVE_Benthic_PEIR_Fig8_CEA_V3.mxd



5.12.7 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.

5.12.8 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.

5.12.9 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.

5.12.10 The cumulative MDS described in Table 5.20 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 5.20: Cumulative MDS.

Impact	Scenario	Justification
Cumulative temporary habitat disturbance	<p>Tier 1:</p> <ul style="list-style-type: none"> > 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 <p>Tier 2:</p> <ul style="list-style-type: none"> > Construction and O&M of OWF North Falls > Construction and O&M of Sea Link interconnector cable <p>Tier 3:</p> <ul style="list-style-type: none"> > Construction and O&M Nautilus MPI > Construction and O&M of EuroLink interconnector cable 	<p>If these intermittent activities overlap temporally with either the construction or maintenance of VE, there is potential for cumulative temporary habitat disturbance</p>
Cumulative temporary increase in SSC and sediment deposition	<p>Tier 1:</p> <ul style="list-style-type: none"> > 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 	<p>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</p>



Impact	Scenario	Justification
	<p>East (TH056) and Harwich Haven (TH027)</p> <ul style="list-style-type: none"> > Construction of NeuConnect Interconnector <p>Tier 2:</p> <ul style="list-style-type: none"> > Construction of OWF North Falls > Construction and O&M of Sea Link interconnector cable <p>Tier 3:</p> <ul style="list-style-type: none"> > Construction of Nautilus MPI > Construction of EuroLink interconnector cable 	
<p>Cumulative permanent habitat loss/alteration</p>	<p>Tier 1:</p> <ul style="list-style-type: none"> > O&M of OWF East Anglia Two > O&M of NeuConnect Interconnector <p>Tier 2:</p> <ul style="list-style-type: none"> > O&M of OWF North Falls > O&M of Sea Link interconnector cable <p>Tier 3:</p> <ul style="list-style-type: none"> > O&M Nautilus MPI > O&M EuroLink interconnector cable 	<p>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</p>

5.12.11 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.



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

CUMULATIVE TEMPORARY HABITAT DISTURBANCE

5.12.13 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 5.20. 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 5.4.6 *et seq.*

5.12.14 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).

5.12.15 The consented NeuConnect Interconnector is proposed to cross with 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.

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

5.12.17 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 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 in the early days of its road to consent the construction and operation and maintenance of this Tier 2 project has the potential to cause cumulative temporary habitat disturbance with VE construction.

5.12.18 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 OWF's 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



- 5.12.19 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, EuroLink 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.
- 5.12.20 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.
- 5.12.21 The Tier 3 project 'EuroLink' 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, EuroLink and Nautilus MPI construction activities will overlap with VE construction.
- 5.12.22 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.
- 5.12.23 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.
- 5.12.24 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.
- 5.12.25 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.



CUMULATIVE TEMPORARY INCREASE IN SSC AND SEDIMENT DEPOSITION

- 5.12.26 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 5.20. 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 5.20 identifies the projects that have the potential to contribute to cumulative temporary SSC's and deposition.
- 5.12.27 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 5.10.32 *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 5.10.32 *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.
- 5.12.28 The consented NeuConnect Interconnector is proposed to cross approximately 79 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.
- 5.12.29 The magnitude of impacts from the Tier 1 projects identified is therefore considered to be worst-case low adverse.
- 5.12.30 Tier 2 project 'North Falls OWF' and 'Sea Link' Interconnector and the Tier 3 'Nautilus' and 'EuroLink' 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 4, Annex 2.3: Physical Processes Technical Assessment).
- 5.12.31 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.



- 5.12.32 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.
- 5.12.33 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.

CUMULATIVE PERMANENT HABITAT LOSS/ ALTERATION

- 5.12.34 Cumulative permanent habitat loss is predicted to occur because of the presence of VE infrastructure and projects identified in Table 5.20. 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 km², the transmission assets do not overlap with the study area.
- 5.12.35 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.
- 5.12.36 It should be noted that as outlined in Chapter 3 of the EA Report (AECOM, 2019), under the licence application no cable protection will be added to the seabed within Margate and Long Sands SAC as part of either the installation or maintenance phase of the GB Offshore Scheme.
- 5.12.37 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.



5.12.38 The Tier 2 Project 'Sea Link' and Tier 3 projects 'Nautilus' and 'EuroLink' MPAs 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 localized. The magnitude of loss for Tier 3 projects is therefore currently assessed as negligible. As previously discussed in impact paragraph 5.11.19, 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.

5.12.39 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.

5.13 INTER-RELATIONSHIPS

5.13.1 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.

5.13.2 A description of the likely inter-related effects arising from VE on benthic and intertidal ecology is provided in Volume 2, Chapter 14: Inter-Relationships, with a summary of assessed inter-relationships provided below.

5.13.3 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.



5.14 TRANSBOUNDARY

5.14.1 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.

5.15 SUMMARY OF EFFECTS

5.15.1 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 5.21.

5.15.2 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 5.21: 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 required	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 required	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 required	Minor adverse (not significant in EIA terms)



Description of Impact	Effect	Additional mitigation measures	Residual impact
Impact 4: Increased risk of introduction or spread of Marine INNS	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)
Operation and Maintenance			
Impact 5: permanent habitat loss/ alteration	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)
Impact 6: Temporary habitat disturbance	Negligible	No mitigation required	Negligible (not significant in EIA terms)
Impact 7: Colonisation of hard substrates	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)
Impact 8: Increased risk of introduction or spread of Marine INNS	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)
Impact 9: Changes in physical processes	Negligible	No mitigation required	Negligible (not significant in EIA terms)
Impact 10: EMF effects generated by inter-array and export cables during operational phase	Negligible	No mitigation required	Negligible (not significant in EIA terms)
Cumulative effects			
Cumulative temporary habitat disturbance	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)
Cumulative temporary increase in SSC	Minor adverse	No mitigation required	Minor adverse (not significant in EIA terms)



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

5.15.3 Further consultation and engagement that will be undertaken to inform the benthic subtidal and intertidal ecology assessment and presented within the ES. As detailed in Section 5.3 under ETG engagement the following stakeholders: the MMO, Cefas, Natural England and Environment Agency, will address any issues that may arise, through ongoing consultation as part of the EPP Steering Group and Benthic subtidal and Intertidal Ecology ETG to confirm that the assessment is satisfactory.

5.16 NEXT STEPS

5.16.1 The following steps will be undertaken in order to progress the benthic and intertidal ecology assessment from PEIR stage to DCO Application stage.

- > Further consultation and engagement will be undertaken through the Marine Ecology and Processes ETG.
- > All feedback post-PEIR will be used to inform and update the benthic subtidal and intertidal ecology assessment and presented within the ES, where necessary.



6 REFERENCES

- Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C. and Buck, A.L. (1998), 'Coasts and seas of the United Kingdom. Region 7 South-east England: Lowestoft to Dungeness', Joint Nature Conservation Committee, (Coastal Directories Series).
- Bioconsult (2006). Benthic communities at Horns Rev, before, during and after construction of Horns Rev offshore wind farm. Final annual report 2005.
- Boles, L.C. and Lohmann, K.J. (2003). True navigation and magnetic maps in spiny lobsters. *Nature*, 421(6918), pp.60–63.
- Boyd, S., Limpenny, D., Rees, H. & Cooper, K., 2005. The effects of marine sand and gravel extraction on the macrobenthos at a commercial dredging site (results 6 years post-dredging). *ICES Journal of Marine Science: Journal du Conseil*, 62 (2), 145-162.
- Breitburg, D., Levin, L.A., Oschlies, A., Grégoire, M., Chavez, F.P., Conley, D.J., Garçon, V., Gilbert, D., Gutiérrez, D., Isensee, K., Jacinto, G.S., Limburg, K.E., Montes, I., Naqvi, S.W.A., Pitcher, G.C., Rabalais, N.N., Roman, M.R., Rose, K.A., Seibel, B.A., Telszewski, M., Yasuhara, M., Zhang, J. (2018) Declining oxygen in the global ocean and coastal waters. *Science*, 359, p.1–13.
- Buchanan, J.B., 1964. A comparative study of some of the features of the biology of *Amphiura filiformis* and *Amphiura chiajei* (Ophiuroidea) considered in relation to their distribution. *Journal of the Marine Biological Association of the United Kingdom*, 44, 565-576.
- Carlton J. T. (1992). Marine species introductions by ships' ballast water: an overview. In: *Proceedings of the conference and workshop on introductions and transfers of marine species: achieving a balance between economic development and resource protection*, Hilton Head Island, South Carolina October 30 - November 2, 1991, ed. by M.R. De Voe. pp. 23-25. South Carolina Sea Grant Consortium.
- Caswell, B., Paine, M. and Frid, C. (2018). Seafloor ecological functioning over two decades of organic enrichment. *Marine Pollution Bulletin*, 136, p.212-229.
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2002). Guidelines for the conduct of benthic studies at aggregate dredging sites. Report for the UK Department for Transport, Local Government and the Regions.
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2004). Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Report for the UK Marine Consents and Environment Unit.
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2016). Suspended Sediment Climatologies around the UK. Report for the UK Department for Business, Energy & Industrial Strategy offshore energy Strategic Environmental Assessment programme.



- Centre for Marine and Coastal Studies (CMACS). (2005), 'London Array Environmental Impact Assessment. Benthic Ecology Technical Report'.
- Centre for Marine and Coastal Studies (CMACS). (2010), 'Galloper Offshore Wind Farm Benthic Survey Technical Report 2010', Prepared for OSIRIS PROJECTS (NRL and SSER).
- CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal. Chartered Institute of Ecology and Environmental Management. Second Edition. January 2016.
- Coates, D.A., Deschutter, Y., Vincx, M. & Vanaverbeke, J., 2014. Enrichment and shifts in macrobenthic assemblages in an offshore wind farm area in the Belgian part of the North Sea. *Marine Environmental Research*, 95, 1-12.
- Collin, S.B. and Shucksmith R.J. (2022). Developing biosecurity plans for non-native species in marine dependent areas: the role of legislation, risk management and stakeholder engagement. *Management of Biological Invasions*, 13, 1: 1-23.
- Connor, D.W., Allen, J.H., Golding, N., Howell, K.I., Lieberknecht, L.M., Northern, N. and Reker, J.B. (2004). *The Marine Habitat Classification for Britain and Ireland Version 04.05*. JNCC, Peterborough ISBN 1 861 07561 8.
www.jncc.gov.uk/MarineHabitatClassification [Accessed July 2022].
- Cook, E.J., Payne, R.D. and Macleod, A. (2014). *Marine Biosecurity Planning – Identification of best practice: A Literature Review*. Report by SRSL Ltd. in conjunction with Robin Payne to the Firth of Clyde Forum and Scottish Natural Heritage Commissioned Report No. 748 – 45.
- Cooper, K. and Barry, J. (2017). *RSMP Baseline Dataset*. Cefas, UK. V1. Available at: <https://doi.org/10.14466/CefasDataHub.34> [Accessed September 2021].
- Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C. and Vincent, M., (2001). *Marine Monitoring Handbook*. Joint Nature Conservation Committee, Peterborough. 405.
- Department for Business, Energy & Industrial Strategy (BEIS) (2021a), *Draft Overarching National Policy Statement for Energy (EN-1)*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015233/en-1-draft-for-consultation.pdf [Accessed: July 2022].
- Department for Business, Energy & Industrial Strategy (BEIS) (2021b), *Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015236/en-3-draft-for-consultation.pdf [Accessed July 2022].
- Department for Business, Energy & Industrial Strategy (BEIS) (2021c), *Draft National Policy Statement for Electricity Networks Infrastructure (EN-5)*.



https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015238/en-5-draft-for-consultation.pdf [Accessed: July 2022].

Department of Trade and Industry [DTI] (2002). North Sea Geology. Technical report produced for Strategic Environmental Assessment – SEA2 & SEA3. Technical Report TR_008_Rev1.

Department of Energy and Climate Change (DECC) (2011a), Overarching National Policy Statement for Energy (EN-1).

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf [Accessed: July 2022].

Department of Energy and Climate Change (DECC) (2011b), National Policy Statement for Renewable Energy Infrastructure (EN-3).

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf [Accessed: July 2022].

Department for Environment, Food and Rural Affairs (Defra). (2014) East Inshore and East Offshore Marine Plans

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/312496/east-plan.pdf [Accessed: December 2022].

Department for Environment, Food and Rural Affairs (Defra). (2019) Kentish Knock East Marine Conservation Zone. Available at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914728/mcz-kentish-knock-east-2019.pdf [Accessed: August 2022].

Dittel, A.I. and Epifanio, C.E., 2009. Invasion biology of the Chinese mitten crab *Eriocheir sinensis*: A brief review. *Journal of Experimental Marine Biology and Ecology*, 374(2), pp.79-92.

Dudgeon, S., Kübler, J., Wright, W., Vadas Sr, R. and Petraitis, P.S., (2001). Natural variability in zygote dispersal of *Ascophyllum nodosum* at small spatial scales. *Functional Ecology*. 15 (5), pp595-604.

Ellis, J.R., Milligan, S.P. Readdy, L. Taylor, N. and Brown, M.J. (2012), 'Spawning and nursery grounds of selected fish species in UK waters'. Cefas Scientific Series Technical Report 147.

European Marine Observation and Data Network (EMODnet). (2022) Seabed Habitats EUSeaMap. Available at: <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=6¢er=-3.837,55.397&layerIds=500,501,502&baseLayerId=-3&activeFilters=> [Accessed: October 2022].



- Emson, R.H., & Wilkie, I.C., 1980. Fission and autotomy in echinoderms. *Oceanography and Marine Biology: an Annual Review*, 18, 155-250.
- Eno, C., Clark, R., Sanderson, W (1997)/01/01. Non-Native Marine Species in British Waters: A Review and Directory.
- Foden, J., Rogers, S.I. and Jones, A.P., 2011. Human pressures on UK seabed habitats: a cumulative impact assessment. *Marine Ecology Progress Series*, 428, pp.33-47.
- Forewind, (2013) Dogger Bank Creyke Beck Environmental Statement.
- Furgo. (2018), 'Thanet Extension Offshore Wind Farm: Environmental Investigation Report Thanet Benthic Characterisation Report'.
- Fugro (2022a). Fugro - WPM1, WPM2 & WPM3 - Main Array & ECR - Environmental Features Report. Fugro Document No. 004032870. Fugro GB Marine Limited.
- Gilkinson, K.D., Gordon, D.C., MacIsaac, K.G., McKeown, D.L., Kenchington, E.L., Bourbonnais, C. & Vass, W.P., 2005. Immediate impacts and recovery trajectories of macrofaunal communities following hydraulic clam dredging on Banquereau, eastern Canada. *ICES Journal of Marine Science: Journal du Conseil*, 62 (5), 925-947.
- Golding, N., Albrecht, J. & McBreen, F. (2020) Refining criteria for defining areas with a 'low resemblance' to Annex I stony reef; Workshop Report. (JNCC Report No. 656). JNCC, Peterborough, ISSN 0963-8091.
- Greater Gabbard Offshore Wind Limited (GGOWL). (2005), 'Greater Gabbard Offshore Wind Farm Environmental Statement, October 2005'.
- Groenewold, S. & Fonds, M., 2000. Effects on benthic scavengers of discards and damaged benthos produced by the beam-trawl fishery in the southern North Sea. *ICES Journal of Marine Science*, 57 (5), 1395-1406.
- Gubbay, S. (2007) Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency workshop 1-2 May 2007. JNCC Report No. 405.
- Hartnoll, R.G. and Hawkins, S.J. (1985). Patchiness and fluctuations on moderately exposed rocky shores. *Ophelia*. 24, pp.53-63.
- Heip, C., Basford, J.A., Craeymeersch, J.A., Dewarumez, J. Dörjes, J., De Wilde, P., Duineveld, G., Eleftheriou, A., Herman, P.M.J., Niermann, U. Kingstone, P., Künitzer, A., Rechor, E. Rumohr, H., Soetaert, K. & Soltwedel, T. (1992). Trends in biomass, density and diversity of North Sea macrofauna. *ICES Journal of Marine Science*, 49, 13-22.
- Heip, C. and Craeymeersch, J.A., 1995. Benthic community structures in the North Sea. *Helgoländer Meeresuntersuchungen*, 49(1), pp.313-328.



- Hendrick, V.J. and Foster-Smith, R.L., 2006. Sabellariaspinulosa reef: a scoring system for evaluating 'reefiness' in the context of the Habitats Directive. *Journal of the Marine Biological Association of the United Kingdom*, 86(4), pp.665-677.
- Holdich, D.M. and Sibley, P.J. (2009). ICS and NICS in Britain in the 2000s. Crayfish Conservation in the British Isles. pp. 13-33.
- Holt, T.J., Hartnoll, R.G. and Hawkins, S.J. (1997). The sensitivity and vulnerability to man-induced change of selected communities: intertidal brown algal shrubs, *Zostera* beds and Sabellaria spinulosa reefs. English Nature, Peterborough, English Nature Research Report No. 234.
- International Union for Conservation of Nature [IUCN]. (2022). The IUCN red list of threatened species. Version 2021-3. <https://www.iucnredlist.org> [Accessed July 2022].
- IPCC (2013) Climate change 2013: the physical science basis. In: Working Group I Contribution to the IPCC Fifth Assessment Report of the Intergovernmental Panel on Climate Change, UK and New York, p. 1535.
- Irving, R. (2009). The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008 (Report No. 432).
- Jenkins, C., Eggleton, J., Albrecht, J., Barry, J., Duncan, G., Golding, N., & O'Connor, J. (2015). North Norfolk Sandbanks and Saturn reef SCI management investigation report. Cefas and JNCC report 87.
- Joint Nature Conservation Committee (JNCC) (2007). Report on the Species and Habitat Review. Report by the Biodiversity Reporting and Information Group (BRIG) to the UK Standing Committee June 2007.
- Joint Nature Conservation Committee (JNCC) (2015) The Marine Habitat Classification for Britain and Ireland Version 15.03. <https://mhc.jncc.gov.uk/> [Accessed July 2022].
- Joint Nature Conservation Committee (JNCC) (2018). Marine habitat correlation tables version 201801 – spreadsheet version 2018. <https://hub.jncc.gov.uk/assets/62a16757-e0d1-4a29-a98e-948745804aec> [Accessed August 2022].
- Joint Nature Conservation Committee (JNCC) (2019). UK Biodiversity Action Plan. <https://jncc.gov.uk/our-work/uk-bap/> [Accessed July 2022].
- Jones, L.A., Coyle, M.D., Evans, D., Gilliland, P.M. and Murray, A.R. (2004), 'Southern North Sea Marine Natural Area Profile: A contribution to regional planning and management of the seas around England', English Nature
- Jones, L.A., Hiscock, K. & Connor, D.W. (2000). Marine habitats reviews. A summary of ecological requirements and sensitivity characteristics for the conservation and



management of marine SACs. Peterborough, Joint Nature Conservation Committee (UK Marine SACs Project report).

Kröncke I (2011) Changes in Dogger Bank macrofauna communities in the 20th century caused by fishing and climate. *Estuarine, Coastal and Shelf Science*, 94, p.234-245.

Kröncke I (1995) Long-term changes in North Sea benthos. *Senckenberg Marit*, 26, p.73-80.

Künitzer, A., Basford, D., Craeymeersch, J.A., Dewarumez, J.M., Dörjes, J., Duineveld, G.C.A., Eleftheriou, A., Heip, C. Herman, P. Kingston, P., Niermann, U., Rachor, E., Rumohr, H. & De Wilde, P.A.J. (1992). The benthic infauna of the North Sea: species distribution and assemblages. *ICES Journal of Marine Science*, 49, 127-143.

Levin, L.A., Ekau, W., Gooday, A.J., Jorissen, F., Middelburg, J.J., Naqvi, S.W.A., Neira, C., Rabalais, N.N., Zhang, J., 2009. Effects of natural and human-induced hypoxia on coastal benthos. *Biogeosciences*, 6, p. 2063–2098.

Limpenny, D.S., Foster-Smith, R.L., Edwards, T.M., Hendrick, V.J., Diesing, M., Eggleton, J.D., Meadows, W.J., Crutchfield, Z., Pfeifer, S. and Reach, I.S., 2010. Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef. *Aggregate Levy Sustainability Fund Project MAL0008*, 134.

Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., Haan, De d., Dirksen, S., Hal, R. van., Hille Ris Lambers, R., Hofsted, R ter., Krijgsveld, K.L., Leopold, M. and Scheidat, M.(2011) Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environmental Research Letters*, 6 (3).

Lohmann, K.J. and Willows, A.O.D. (1987). Lunar-modulated geomagnetic orientation by a marine mollusk. *Science*, 235, pp.331-334.

MarLIN. (2019). Habitat sensitivity a-z [Online] [Accessed August 2022]. Available at: <https://www.marlin.ac.uk/habitats/az>.

Marine Aggregate Levy Sustainability Fund [MALSF]. (2009). Outer Thames Estuary Regional Environmental Characterisation. Report commissioned by the Marine Environment Protection Fund (MEPF).

Marine Climate Change Impacts Partnership (2015) Marine climate change impacts; implications for the implementation of marine biodiversity legislation. (Ed.) Frost M, Bayliss-Brown G, Buckley P, Cox M, Stoker B and Withers Harvey N. Summary Report. MCCIP, Lowestoft, p. 16.

Marine Climate Change Impacts Partnership (2013) Marine Climate Change Impacts Report Card.



- Marine Climate Change Impacts Partnership (2020) The impacts of climate change on temperature (air and sea), relevant to the coastal and marine environment around the UK. *MCCIP Science Review* pp1-30.
- Marine Ecological Surveys Limited (MESL) (2012), 'East Anglia Offshore Wind Farm: East Anglia One Benthic Biological Characterisation Report', Prepared for East Anglia Offshore Wind Ltd., (Document No. ERMEA10111).
- Marine Management Organisation (MMO) (2014), 'Review of post-consent offshore wind farm monitoring data associated with licence conditions'. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031.
- Macleod, A., Cottier-Cook, E., Hughes, D., & Allen, C. (2016). Investigating the Impacts of Marine Invasive Non-Native Species. Natural England.
- National Biodiversity Network [NBN]. (2022). NBN Atlas <http://www.nbnatlas.org> [Accessed July 2022].
- National Museum Wales (2016). Marine bivalve shells of the British Isles. <https://naturalhistory.museumwales.ac.uk/BritishBivalves/browse/record.php?recid=283> [Accessed July 2022].
- Nehls, G., Diederich, S., Thielges, D.W. and Strasser, M., 2006. Wadden Sea mussel beds invaded by oysters and slipper limpets: competition or climate control?. *Helgoland Marine Research*, 60(2), pp.135-143.
- Newell, R.C., Seiderer, L.J., Simpson, N.M. and Robinson, J.E., 2004. Impacts of marine aggregate dredging on benthic macrofauna off the south coast of the United Kingdom. *Journal of Coastal Research*, 20(1), pp.115-125.
- Non-native Species Information Portal (NNSIP) (2020) GB Non-Native Species Report Card. Available from: <https://www.nonnativespecies.org/assets/NNSIP-Scorecard-2020.pdf> [Accessed August 2020].
- North Falls Offshore Wind Farm Limited. (2021) 'Environmental Impact Assessment Scoping Report, July 2021'.
- Norton, T.A. (1992). Dispersal by macroalgae. *British Phycological Journal*. 27, pp.293-301.
- Oslo and Paris Commission [OSPAR]. (2021). List of Threatened and/or Declining Species & Habitats. <https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats> [Accessed July 2022].
- Planning Inspectorate (August 2019) Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects.
- Pearce, B., Fariñas-Franco, J.M., Wilson, C., Pitts, J., de Burgh, A., and Somerfield, P.J. (2014), 'Repeated mapping of reefs constructed by *Sabellaria spinulosa* Leuckart 1849 at an offshore wind farm site', *Continental Shelf Research*, 83: 3–13.



- Pearce, F., Peeler E. and Stebbing, P. (2012). Modelling the risk of the introduction and spread of non-indigenous species in the UK and Ireland. Project report for E5405W.
- Premier Oil. (2018) Tolmount to Easington Pipeline – Offshore Environmental Statement. Document no: AB-TO-XGL-HS-SE-SN-0004.
- Rees, E.I.S. (2001). Habitat specialization by *Thia scutellata* (Decapoda: Brachyura) off Wales. *Journal of the Marine Biological Association of the United Kingdom*, 81(4), 697-694.
- Roy, H. E., Peyton, J., Aldridge, D. C., Bantock, T., Blackburn, T. M., Britton, R., Clark, P., Cook, E., Dehnen-Schmutz, K., Dines, T., Dobson, M., Edwards, F., Harrower, C., Harvey, M. C., Minchin, D., Noble, D. G., Parrott, D., Pocock, M. J., Preston, C. D., Roy, S., Salisbury, A., Schönrogge, K., Sewell, J., Shaw, R. H., Stebbing, P., Stewart, A. J. and Walker, K. J. 2014. Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain.
- RPS Group. (2007) 'Gunfleet Sands 2 Offshore Wind Farm, Environmental Statement, June 2007'.
- Schiel, D.R. and Foster, M.S. (1986). The structure of subtidal algal stands in temperate waters. *Oceanography and Marine Biology: an Annual Review*. 24, pp.265-307.
- Scott, Kevin, Petra Harsanyi, Blair Easton, Althea Piper, Corentine Rochas, Alastair Lyndon, and Ka Chu. (2021) 'Exposure to Electromagnetic Fields (EMF) from Submarine Power Cables Can Trigger Strength-Dependent Behavioural and Physiological Responses in Edible Crab, *Cancer Pagurus* (L.)'. *Journal of Marine Science and Engineering* 9: 776.
- Southward, A.J. and Southward, E.C. (1978). Recolonisation of rocky shores in Cornwall after use of toxic dispersants to clean up the Torrey Canyon spill. *Journal of the Fisheries Research Board of Canada*. 35, pp.682-706.
- Stramma, L., Schmidtko, S., Levin, L.A., Johnson, G.C., (2010) Ocean oxygen minima expansions and their biological impacts. *Deep-Sea Res. I Oceanogr. Res. Pap.* 57, p.587–595.
- Switzer, T. and Meggitt, D. (2010). Review of Literature and Studies on Electro Magnetic Fields (EMF) Generated by Undersea Power Cables and Associated Influence on Marine Organisms. Presented at OCEAN 2010, pp.1–5.
- Tappin, D R, Pearce, B, Fitch, S, Dove, D, Gearey, B, Hill, J M, Chambers, C, Bates, R, Pinnion, J, Diaz Doce, D, Green, M, Gallyot, J, Georgiou, L, Brutto, D, Marzialetti, S, Hopla, E, Ramsay, E, and Fielding, H. (2011) The Humber Regional Environmental Characterisation. British Geological Survey Open Report OR/10/54. P.357.
- Tillin, H.M., (2010). Marine Ecology: Annex 4 Ecological (logistic regression and HABMAP) modelling-based predictions., Parsons Brinkerhoff Ltd, Bristol.



- Tillin, H.M. (2016). Polychaete-rich deep Venus community in offshore gravelly muddy sand. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom.
- Ugolini, A. and Pezzani, A. (1995). Magnetic compass and learning of the Y, axis (sea-land) direction in the marine isopod *Idotea baltica* basteri. *Animal Behaviour*, 50, pp.295–300.
- Ugolini, A. (2006). Equatorial sandhoppers use body scans to detect the earth's magnetic field. *Journal of Comparative Physiology A*, 192, pp.45–49.
- UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3) (2016) Environmental Report. Appendix 1a.2 – Benthos.
- Van Dalssen, J. A., Essink, K., Toxvig Madsen, H., Birklund, J., Romero, J., and Manzanera, M. 2000. Differential response of macrozoobenthos to marine sand extraction in the North Sea and the western Mediterranean. *ICES Journal of Marine Science*, 57: 1439e1445.
- VE OWFL, 'EIA Scoping Report' Available online:
<https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010115/EN010115-000012-5EST%20-%20Scoping%20Report.pdf> [Accessed November 2022].
- Ware, S.J. and Kenny, A.J., 2011. Guidelines for the conduct of benthic studies at marine aggregate extraction sites. *Cefas, Lowestoft (UK). Project Code: MEPF*, 8, p.P75.
- Whalley, C., Rowlatt, S., Bennett, M. and Lovell, D., 1999. Total arsenic in sediments from the Western North Sea and the Humber Estuary. *Marine Pollution Bulletin*, 38(5), pp.394-400.
- Woodruff, D.L., Ward, J.A., Schultz, I.R., Cullinan, V.I. and Marshall, K.E. (2012). Effects of Electromagnetic Fields on Fish and Invertebrates. Task 2.1.3: Effects on Aquatic Organisms Fiscal Year 2011 Progress Report. Pacific NorthWest National Laboratory, Richland, Washington. PNNL-20813 Final, pp.1–69.



F I V E 
ESTUARIES
OFFSHORE WIND FARM

PHONE
EMAIL
WEBSITE
ADDRESS

COMPANY NO

0333 880 5306

fiveestuaries@rwe.com

www.fiveestuaries.co.uk

Five Estuaries Offshore Wind Farm Ltd

Windmill Hill Business Park

Whitehill Way, Swindon, SN5 6PB

Registered in England and Wales

company number 12292474

